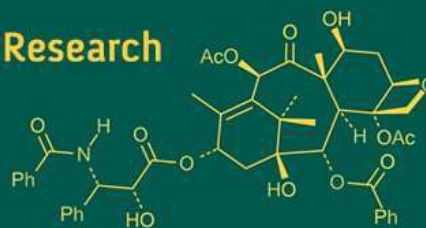


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Under the skin, inside the heart: Prevalence of arrhythmias triggered by bovine tick-borne diseases

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Abstract

This study was undertaken at Dr. G.C. Negi College of Veterinary and Animal Sciences, CSKHPKV, Palampur, to investigate the prevalence and electrocardiographic characteristics of cardiac arrhythmias in cattle affected with tick-borne diseases (TBDs). Between April 2024 and August 2025, 616 bovine cases were examined, and 158 (25.64%) were confirmed positive for tick-borne haemoparasites on Giemsa-stained blood smear evaluation. Theileriosis was the predominant infection (15.90%), followed by anaplasmosis (7.95%), mixed infections (1.46%) and babesiosis (0.32%). Of the infected animals, 75 (47.46%) demonstrated distinct ECG abnormalities, comprising 1 case of babesiosis (1.33%), 47 of theileriosis (62.66%), 20 of anaplasmosis (26.66%) and 7 of mixed infection (9.33%). The most frequently recorded arrhythmias included P mitrale (76%), tachycardia (45.33%), arrhythmia (42.66%), wide QRS complexes (41.33%), ST elevation (32%), P pulmonale (30.66%), QT interval shortening (21.33%) and deep QRS complexes (18.66%). Females (98.66%) and cattle aged 1–5 years (70.66%) were most commonly affected. The overall findings highlight the substantial burden of cardiac involvement in TBDs and emphasize the importance of routine ECG assessment for early detection, prognosis and guiding timely therapeutic interventions in clinically suspected cases.

Keywords: Bovine arrhythmias, electrocardiography (ECG), prevalence, tick-borne diseases

Introduction

Tick-borne diseases continue to be among the most widespread health challenges affecting cattle in tropical and subtropical regions, where they significantly reduce productivity, weaken overall health and impair reproductive efficiency. Conditions such as theileriosis, anaplasmosis and babesiosis are primarily recognized for the systemic and haematological disturbances they produce, yet recent findings point to a broader impact, particularly on the heart. The combined effects of anaemia, inflammatory stress and altered physiological balance can interfere with normal cardiac conduction, making infected animals susceptible to various rhythm abnormalities. According to Gupta *et al.*, (2018) ^[4], calves suffering from tick-borne infections frequently show electrocardiographic deviations, including increased heart rate, 1st-degree AV block, atrial premature complex, left atrial hypertrophy and right atrial hypertrophy changes suggestive of considerable myocardial strain. Hasanpour *et al.*, (2008) ^[6] similarly noted that ECG alterations are commonly overlooked in tick-affected buffalo, implying that cardiac involvement may be more widespread than earlier believed. However, information on the actual prevalence and types of arrhythmias associated with these infections is still limited, especially in state like Himachal Pradesh where tick pressure remains high throughout the year. To address this gap, the present study investigates the prevalence of tick-borne infections in cattle and documents the electrocardiographic changes observed in affected animals, highlighting the need to integrate routine ECG monitoring into clinical evaluation of suspected cases.

Materials and Methods**Study area and duration**

The investigation was carried out at the Department of Veterinary Medicine, Dr. G.C. Negi College of Veterinary and Animal Sciences, CSK Himachal Pradesh Agricultural University, Palampur, situated in the mid-Himalayan region.

This area is endemic for tick-borne diseases in cattle. The study was conducted over a period of 17 months, from April 2024 to August 2025.

Study population

A total of 616 cattle of varying breeds, ages and sexes presented to the Department of Veterinary Medicine were examined. Animals showing clinical signs suggestive of tick-borne infections were further investigated and only those confirmed positive were included for cardiac assessment.

Diagnosis of tick-borne infections

Blood samples were collected aseptically from the jugular vein into EDTA-containing tubes. Thin blood smears were prepared, fixed in methanol, stained with Giemsa and examined under a light microscope for the presence of haemoparasites. Animals were classified according to infection type as Theileriosis, Anaplasmosis, Babesiosis or mixed infections based on the parasitological findings (Harrison *et al.*, 2010) [5].

Electrocardiographic Evaluation

All positive animals underwent electrocardiographic examination using base apex limb lead II (Devadevi *et al.*, 2022) [1]. ECG recordings were taken while the animals were in a standing position. Parameters such as heart rate, rhythm, P-wave, PR interval, QRS complex, ST segment and QT interval were assessed. ECG was performed using the RMS Vesta 301i machine.

Data analysis

The prevalence of cardiac alterations was calculated for each infection type as a percentage of total positive animals.

Descriptive statistics were used to summarize the data and associations between infection type and ECG abnormalities were evaluated.

Results

Incidence of tick-borne diseases

A total of 616 cattle were presented, among which 158 (25.64%) tested positive for one or more tick-borne pathogens (Table 1).

Table 1: Incidence of Tick-borne diseases in Cattle

Parameters	No. of Cases	Percentage (%)
Total cattle presented	616	
Cattle with Tick-borne diseases	158	25.64%

Incidence of Tick-borne diseases in cattle by Giemsa-stained blood smear examination

Between May 2024 and August 2025, 158 cattle (25.64%) were confirmed positive for tick-borne infections (Figure 1 and 2). Among these, Theileriosis was the most prevalent, affecting 98 animals (15.90%), followed by Anaplasmosis with 49 cases (7.95%). Mixed Theileria–Anaplasma infections were recorded in 9 animals (1.46%), while Babesiosis was least common, detected in only 2 cases (0.32%). The detailed distribution is presented in Table 2.

Table 2: Incidence of Tick-borne diseases in Cattle by Giemsa-stained blood smear examination

Type of Tick-borne Diseases	No. of Cattle	Percentage (%)
Babesiosis	2	0.32%
Theileriosis	98	15.90%
Anaplasmosis	49	7.95%
Mixed Infection	9	1.46%

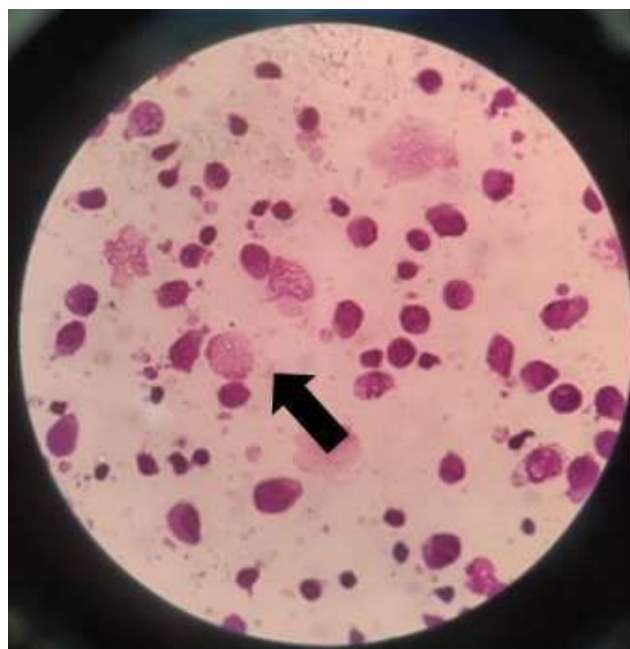


Fig 1: Lymph smear stained with Giemsa stain showing Koch's blue bodies (40X)

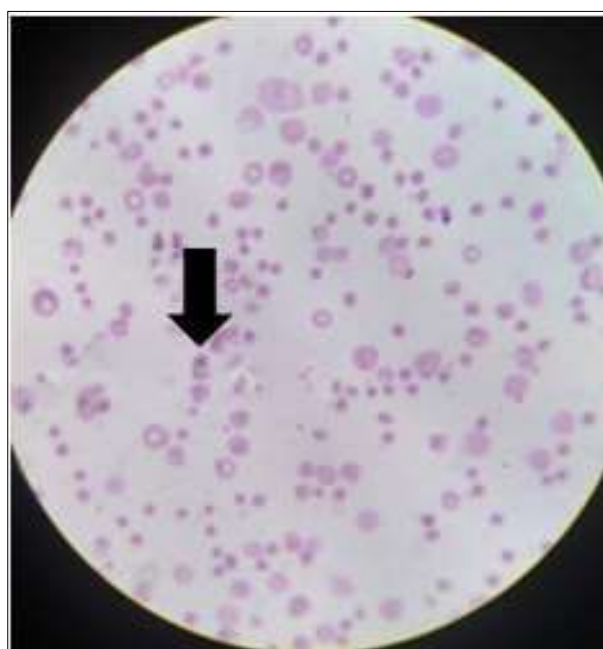


Fig 2: Blood film stained with Giemsa stain showing *Anaplasma marginale* in blood smear examination of infected cattle (40X)

Month and Season wise incidence of Tick-borne diseases in cattle

The monthly prevalence of tick-borne infections from May 2024 to August 2025 showed a distinct seasonal pattern

(Table 3), with infection levels increasing gradually throughout the summer and peaking in September 2024 (42.22%). Anaplasmosis (20.00%) and Theileriosis (15.55%) were the primary causes of this increase, with

Babesiosis (4.44%) and mixed infections (2.22%) occurring on occasion. With elevated positivity of 36.66% in July and 25.86% in August, the monsoon months (July–September) consistently displayed the highest burden, indicating extremely favourable conditions for tick activity. Winter and early summer, on the other hand, showed significantly lower rates, especially in February (8.00%) and March (11.90%).

Theileriosis continued to be the most common infection throughout every month, but anaplasmosis fluctuated significantly. Throughout the study, babesiosis and mixed infections remained at very low levels. Overall, the temporal pattern highlights the significant impact of climate on tick dynamics and disease transmission, particularly temperature, humidity, and rainfall.

Table 3: Month and Season wise incidence of Tick-borne diseases (N=158)

Month-Year	Total cattle cases	Positive	Babesiosis	Babesiosis (%)	Theileriosis	Theileriosis (%)	Anaplasmosis	Anaplasmosis (%)	Mixed-Infection	Mixed-Infection (%)
May, 2024	43	7	0	0%	4	9.30%	3	6.97%	0	0%
June, 2024	34	9	0	0%	8	23.52%	1	2.94%	0	0%
July, 2024	60	22	0	0%	14	23.33%	7	11.66%	1	1.66%
August, 2024	58	15	0	0%	12	20.68%	3	5.17%	0	0%
September, 2024	45	19	2	4.44%	7	15.55%	9	20%	1	2.22%
October, 2024	36	8	0	0%	5	13.88%	2	5.55%	1	2.77%
November, 2024	27	6	0	0%	1	3.70%	5	18.51%	0	0%
December, 2024	14	3	0	0%	3	21.42%	0	0%	0	0%
January, 2025	28	9	0	0%	1	3.57%	6	21.42%	2	7.14%
February, 2025	25	2	0	0%	2	8%	0	0%	0	0%
March, 2025	42	5	0	0%	3	7.14%	2	4.76%	0	0%
April, 2025	22	3	0	0%	2	9.09%	1	4.54%	0	0%
May, 2025	38	8	0	0%	6	15.78%	1	2.63%	1	0%
June, 2025	50	13	0	0%	10	20%	1	2%	2	4%
July, 2025	47	16	0	0%	11	23.40%	4	8.51%	1	2.12%
August, 2025	47	13	0	0%	9	19.14%	4	8.51%	0	0%

Incidence of Tick-borne diseases in relation to age, sex and breed

Table 4 summarizes the prevalence of tick-borne illnesses according to age, sex and breed. Cattle aged 1 to 5 years had the highest susceptibility (55.06%), whereas cattle aged 9

and older had the lowest involvement (4.43%). This clearly demonstrated an age-related pattern. While native breeds like Sahiwal and Red Sindhi were infrequently impacted (0.63%), Jersey crossbreds showed the highest disease burden (61.39%).

Table 4: Incidence of Tick-borne diseases in relation to age, sex and breed (N=158)

Parameter		No. of cases	Percentage (%)
Age	0-1 years	22	13.92%
	1-5 years	87	55.06%
	5-9 years	42	26.58%
	More than 9 years	7	4.43%
Sex	Male	9	5.69%
	Female	149	94.30%
Breed	Jersey cross bred	97	61.39%
	H.F. cross bred	17	10.75%
	Non-descript	42	26.58%
	Sahiwal	1	0.63%
	Red Sindhi	1	0.63%

Incidence of Tick-borne affected cattle with cardiac alterations in relation to age, sex and breed

Table 5 summarizes the distribution of cardiac changes in cattle infected with ticks. ECG-based evidence of cardiac involvement was found in nearly half of the affected population (47.46%). Female cattle accounted for 98.66% of all recorded cases, indicating a significantly higher predisposition than male cattle, demonstrating a clear sex bias.

Age-wise, cardiac alterations were concentrated predominantly in the 1–5-year category, which constituted

the major proportion of cases across all tick-borne pathogens, whereas cattle over 9 years and those below 1 year contributed minimally.

The largest affected group, according to breed-related trends, was Jersey crossbred cattle, followed by HF crossbreds and non-descript animals. Indigenous breeds, like Red Sindhi, were only occasionally involved. The overall pattern shows that younger female Jersey crossbreds are more susceptible to tick-borne infections linked to cardiac alterations.

Table 5: Incidence of Tick-borne affected cattle with cardiac alterations (N=75)

Total positive cases (N=75)															
Babesiosis				Theileriosis				Anaplasmosis				Mixed Infection			
1		47		20		7									
Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0	1	1	46	0	20	0	7								
Age (Years)															
0-1 yr.	1-5 yr.	5-9 yr.	More than 9 yr.	0-1 yr.	1-5 yr.	5-9 yr.	More than 9 Yr.	0-1 yr.	1-5 yr.	5-9 yr.	More than 9 Yr.	0-1 yr.	1-5 yr.	5-9 yr.	More than 9 Yr.
0	1	0	0	4	34	6	3	1	13	4	2	0	5	2	0
Breed															
Jersey cross bred	H.F. cross bred	Non-descript	Sahiwal	Jersey cross bred	H.F. cross bred	Non-descript	Red Sindhi	Jersey cross bred	H.F. cross bred	Non-descript	Sahiwal	Jersey cross bred	H.F. cross bred	Non-descript	Sahiwal
1	0	0	0	37	6	3	1	12	5	3	0	3	2	2	0

Incidence of different type of arrhythmias in Tick-borne affected cattle with cardiac alterations

P mitrale was found to be the most common electrocardiographic abnormality among tick-borne affected cattle with cardiac involvement, as shown in Table 6 and figure (3-5). Tachycardia, arrhythmia, wide QRS complexes, and ST-segment elevation came next. P pulmonale, QT interval changes, 1st-degree AV block, deep

and low-amplitude QRS complexes, biphasic T waves, and changes in T-wave amplitude and morphology were among the findings that were moderately represented. Inverted T waves, ventricular premature complexes, ST depression, T-wave notching, sinus arrest, prolonged ST segment, sinus escape activity, atrial flutter, bundle branch block, biphasic P waves, and mixed-polarity T waves were among the less common anomalies.

Table 6: Incidence of different type of arrhythmias in Tick-borne affected cattle with cardiac alterations

S. No.	Type of arrhythmias	Total Cases	Prevalence (%)
1	P mitrale	57	76%
2	ST Elevation	24	32%
3	ST Depression	3	4%
4	Prolonged ST segment	2	2.66%
5	Wandering Pacemaker	9	12%
6	T wave notching	3	4%
7	Atrial flutter	1	1.33%
8	Tachycardia	34	45.33%
9	1st degree AV block	15	20%
10	Arrhythmia	32	42.66%
11	Inverted T waves	4	5.33%
12	Biphasic T waves	13	17.33%
13	VPC	4	5.33%
14	APC	7	9.33%
15	Low amplitude QRS complexes	13	17.33%
16	Intermittent Atrial Standstill	3	4%
17	Intermittent sinus escape Activity	2	2.66%
18	Deep QRS	14	18.66%
19	Tall T wave	11	14.66%
20	2 nd degree AV block type 1 and 2	3	4%
21	Bradycardia	7	9.33%
22	Atrial Standstill/Sinus arrest	3	4%
23	Bundle branch block	1	1.33%
24	Atrial Fibrillation	2	2.66%
25	Biphasic P wave	1	1.33%
26	Both positive and negative T waves	1	1.33%
27	Wide T wave	10	13.33%
28	Wide QRS Complexes	31	41.33%
29	P Pulmonale	23	30.66%
30	Prolonged QT interval	9	12%
31	Shortening of QT interval	16	21.33%
32	Deep Q wave	11	14.66%

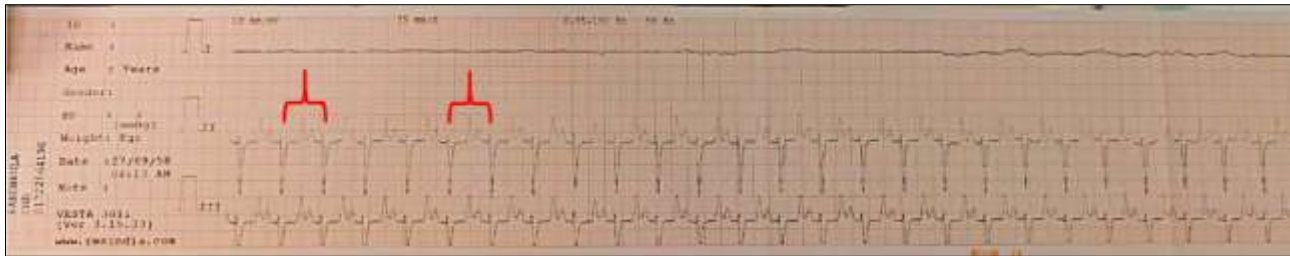


Fig 3: ECG of cattle affected with tick-borne diseases showing sinus tachycardia HR-119 bpm (recorded at 25mm/s paper speed and 10 mm/mV gain)

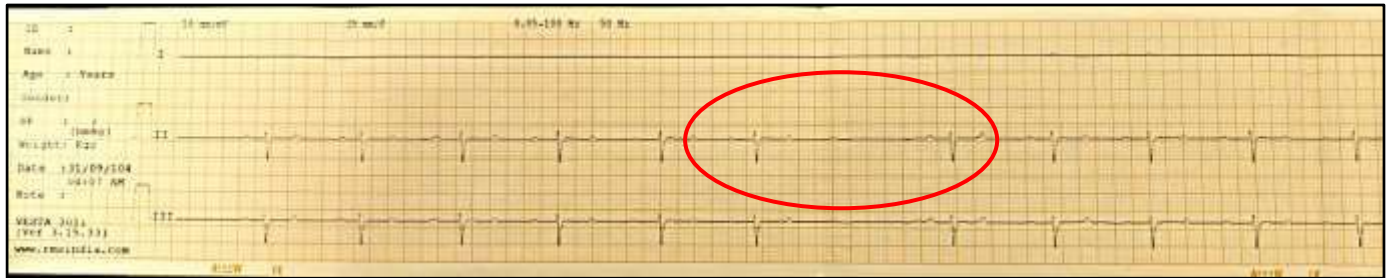


Fig 4: ECG of cattle affected with tick-borne diseases showing 2nd degree AV block (recorded at 25mm/s paper speed and 10 mm/mV gain)

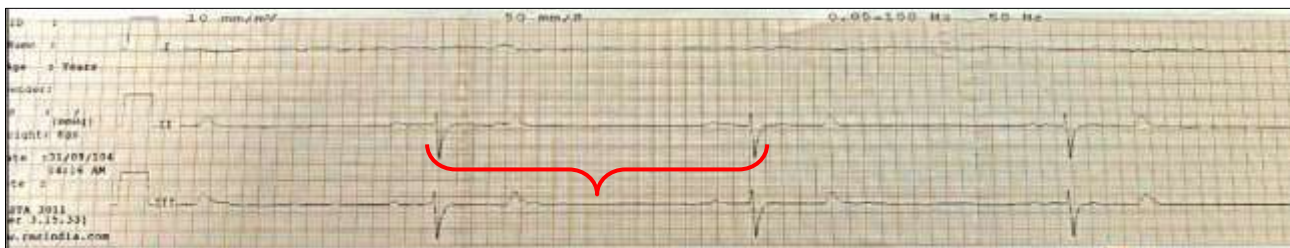


Fig 5: ECG of cattle affected with tick-borne diseases showing sinus bradycardia HR-31 bpm (recorded at 50mm/s paper speed and 10 mm/mV gain)

Discussion

According to previous epidemiological reports, *Theileria annulata* predominates in cattle throughout India (Ganguly *et al.*, 2017; Krishnamoorthy *et al.*, 2021) [3, 7]. This is consistent with the incidence pattern found in this study, where Theileriosis accounted for the majority of infections, followed by Anaplasmosis. In a similar vein, the low detection of Babesiosis supports earlier research showing that *Babesia bigemina* circulates relatively less in Indian herds (Singh *et al.*, 2022) [9]. The observed seasonal pattern, with lower prevalence in winter and early summer and peaks during the monsoon (July–September), is consistent with earlier reports from India. Similar seasonal trends, with *Theileria annulata* peaking during rainy and summer months and Babesia and Anaplasma remaining low, have been reported by (Ganguly *et al.*, 2017; Shit *et al.*, 2023 and Devi *et al.*, 2025) [3, 8, 2], reflecting the influence of temperature, humidity, and rainfall on tick activity and disease transmission. The results in relation to incidence of tick-borne diseases in relation to age, sex and breed supports previous research showing that crossbred and exotic cattle are more vulnerable to haemoparasitic infections (Singh *et al.*, 2022) [9]. There was a clear sex predisposition, with males making up only a small percentage of cases (5.69%) and females making up the majority of the affected population (94.30%). Similar to the results of Shit *et al.*, (2023) [8] and Ganguly *et al.*, (2017) [3], the predominance of females is probably due to herd management techniques and

possible hormonal effects on immunity. The current study's prevalence of P mitrale, tachycardia, and arrhythmias is consistent with earlier reports showing abnormalities in electrocardiograms in cattle infected with Theileria and Anaplasma (Devadevi *et al.*, 2022; Hasanpour *et al.*, 2008) [1, 6]. With a variety of ECG abnormalities seen in infected animals, these results bolster the idea that tick-borne infections can seriously impair cardiac conduction and highlight the importance of ECG monitoring in the treatment of disease. The findings of this study clearly indicate that cardiac alterations represent an important clinical dimension of bovine tick-borne infections, with nearly half of the infected animals exhibiting measurable electrocardiographic disturbances. Theileriosis and Anaplasmosis were the principal contributors to myocardial involvement, with the highest susceptibility noted in females, Jersey crossbreds and cattle aged 1–5 years. P mitrale, tachycardia, conduction delays and rhythm disturbances emerged as the dominant ECG abnormalities, reflecting significant atrial and ventricular functional stress. The evidence highlights that tick-borne diseases impose substantial cardiovascular strain that may not be apparent through routine clinical examination alone. Incorporating ECG assessment into diagnostic workflows can improve early detection of cardiac compromise. Overall, the study emphasizes the need for enhanced monitoring and timely intervention to mitigate cardiac risks in endemic bovine populations.

Conclusion

The present study highlights that tick-borne diseases constitute a major health challenge in cattle and are frequently accompanied by significant disturbances in cardiac electrical activity. A considerable proportion of infected animals exhibited electrocardiographic abnormalities, confirming that cardiac involvement is a common and clinically relevant consequence of these infections. Among the haemoparasitic diseases identified, theileriosis and anaplasmosis were the principal contributors, with affected cattle showing a wide range of rhythm and conduction disturbances indicative of myocardial stress and altered cardiac function.

The higher occurrence of infection and associated cardiac alterations in young, crossbred and female cattle suggests increased vulnerability in these groups, possibly due to differences in immunity, physiological demands and management practices. The diversity and frequency of ECG changes observed in this study indicate that cardiac dysfunction may develop even in the absence of obvious clinical signs, thereby increasing the risk of overlooked cardiac compromise.

These findings underscore the importance of incorporating electrocardiographic evaluation into the routine diagnostic approach for cattle suspected of tick-borne diseases. Early identification of cardiac involvement can improve clinical assessment, support timely therapeutic intervention and enhance disease outcome. In addition, effective tick control and regular health monitoring are essential to minimize the impact of these infections. Overall, this study provides valuable evidence that tick-borne diseases have a measurable effect on cardiac function and reinforces the need for integrated diagnostic and preventive strategies in endemic cattle populations.

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