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*Short Communication*

# Evaluation of the presence of *Sarcocystis* spp. in dogs raised in alpaca farm enterprises in Cajamarca, Peru

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***Abstract***

The apicomplexans of the genus *Sarcocystis* are parasites that infect various animal species, including humans. Both dogs and other carnivores can act as definitive hosts of this protozoan. The present study aimed to determine the frequency of *Sarcocystis* spp. in domestic dogs raised in three alpaca breeding areas in Cajamarca. Random fecal samples were collected from 102 dogs of different ages and both sexes in three locations related to alpaca breeding: Atahualpa Jerusalén Agricultural Workers Cooperative - Cajamarca (N = 35), SAIS Huacraruco - San Juan (N = 33), and Alpacas Project - Foncreagro - Sorochuco (N = 34). The samples were processed using the Sheather flotation technique. Through microscopic observation, ellipsoidal, light gray sporocysts with average dimensions of 13.87±1.61 µm in length and 9.12±1.05 µm in width were identified. In the data analysis, an overall frequency of *Sarcocystis* spp. of 42.16% (95% CI: 32.57 - 51.74) was determined, with a higher presence in the dogs from Huacraruco ($P<0.05$). The age and sex of the dogs did not statistically influence the presence of *Sarcocystis* spp ($P>0.05$). In conclusion, this study reveals a high prevalence of *Sarcocystis* spp. in domestic dogs from the studied areas in Cajamarca. This emphasizes the pressing need to explore practical and optimal control measures.

**Keywords:** apicomplexan, *Canis lupus familiaris*, protozoan parasite, *Sarcocystidae*, sarcocystosis

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## Introduction

In regions where South American camelids are bred, this disease takes on special significance due to the economic importance of these animals in the lives of local communities (Regensburger *et al*., 2015; Moré *et al*., 2016). South American camelids, such as alpacas, are raised by families in high-altitude areas and play a fundamental role in family economies, providing high-quality meat, leather, and fiber (McGregor, 2006; Romero *et al*., 2017). However, sarcocystosis has proven to be a significant obstacle for this industry, as sarcocysts affect the muscles of these animals, deteriorating the quality of their meat and causing considerable economic losses (Carletti *et al*., 2013; Rooney *et al*., 2014).

Alpaca breeding in Peru has been hampered by *Sarcocystis* spp., with infections nearing 100% in this species (Castro *et al*., 2004; Rodríguez *et al*., 2023). It has been observed that herding dogs in alpaca breeding areas play a significant role in the transmission of these parasites to alpacas (Choque *et al*., 2007). These dogs, commonly used to guard alpaca and llama herds, are often infected with *Sarcocystis* spp., which could favor the persistence of the parasitic cycle and impact the health of the animals.

Sarcocystiosis, a disease caused by intracellular protozoan parasites of the genus *Sarcocystis* (Apicomplexa: *Sarcocystidae*), represents a global concern due to its widespread distribution and economic impact on the livestock industry (Dubey *et al*., 2015). This group of parasites has a complex life cycle involving definitive hosts, such as carnivores and omnivores, that become infected through the consumption of muscular/cardiac tissues containing the parasites. These hosts release oocysts/sporocysts into the environment, which infect intermediate hosts, including herbivores, where the parasites develop in various tissues, including skeletal muscles, tongue, neck, diaphragm, legs, cardiac muscles, smooth intestinal muscle, and the central nervous system (Fitzgerald *et al*., 1993; Dubey *et al*., 2015; Sazmand and Joachim, 2017). Human infections can cause symptoms ranging from enteritis to extraintestinal manifestations with a wide clinical spectrum (Rosenthal, 2021).

*Sarcocysts* found in South American camelids have been classified under various names, such as *S. aucheniae*, *S. lamacanis*, and *S. lamacenis* (Taylor *et al*., 2007). Currently, according to standard nomenclature, *S. aucheniae* is proposed as the only valid name for the species of *Sarcocystis* that forms macroscopic sarcocysts in llamas and alpacas (Dubey *et al*., 2015). Microscopic cysts have also been described in alpacas, llamas, and guanacos from South American countries, and the parasite has been named *S. masoni* (Moré *et al*., 2016). Cardiac sarcocystosis is an endemic disease in Peruvian alpacas (Rosenthal, 2021). Consumption of inadequately cooked alpaca heart muscle infected with *Sarcocystis masoni* n. sp. (previously known as *S. lamacanis*) can lead to a foodborne illness syndrome in humans (Rodríguez *et al*., 2023).

The present study was conducted to identify and determine the frequency of sporocysts of *Sarcocystis* spp. in domestic dogs (*Canis lupus familiaris*) raised in three alpaca-influenced areas in Cajamarca: Cooperativa Agraria de Trabajadores Atahualpa Jerusalén, SAIS (Sociedad Agrícola de Interés Social) José Carlos Mariátegui, and Proyecto Alpacas Foncreagro.

## Materials and Methods

The present study was conducted in locations dedicated to alpaca breeding in the Cajamarca region, Peru. The first area corresponds to the Cooperativa Agraria de Trabajadores Atahualpa Jerusalén in Porcón, at an altitude of 3120 meters above sea level (masl) and with temperatures ranging from 4 to 18 °C. The second study area is located in SAIS José Carlos Mariátegui in Huacraruco, covering altitudes ranging from 2800 to 4216 masl, with recorded temperatures between 2.9 and 12.6 °C, and situated in the district of San Juan, Cajamarca province. The third evaluated zone corresponds to the Proyecto Alpacas Foncreagro in Sorochuco, located at 3608 masl, with a temperature range of 7.7 to 21 °C, in the district of Sorochuco, Celendín province (Figure 1).

Due to the limited population of dogs under observation, sampling included all the dogs in each location. These dogs were part of the communities engaged in alpaca breeding and provided companionship to local families in the areas of alpaca breeding and their surroundings.

Following informed consent from dog owners and considering necessary biosecurity measures, external stimulation of the dogs' anal sphincter was performed using gentle finger massages with glycerin-lubricated index fingers. The objective was to obtain fecal samples directly from the rectum. These fecal samples were collected in appropriately labeled polyethylene bags and placed in a styrofoam box for transportation.

Dogs in the three areas lived freely and could roam at any time and in any place. Their defecation habits were primarily observed on the sides of roads and in pastures.

The analyses were conducted in the Laboratorio de Inmunología e Investigación of the Facultad de Ciencias Veterinarias at the National University of Cajamarca within 24 hours after sample collection.

The samples were processed using the sugar flotation concentration technique (Sheather, 1923). Subsequently, observations were made using an optical microscope with a 10X eyepiece and a 40X objective lens. Sarcocystis sporocysts were identified based on their morphometric characteristics, following reference guidelines (Miró, 1999; Saeed *et al*., 2018). Sporocysts were measured using a micrometric eyepiece at 40X, and the values obtained were multiplied by the correction factor of 2.45 corresponding to this specific magnification.

The data were organized in Microsoft Excel, and the frequency and its 95% confidence interval were calculated. Subsequently, statistical analysis was performed using SPSS version 27.0.1 (USA) software to determine the influence of location, age, and sex on the presence of *Sarcocystis* spp. This analysis was conducted using the Kruskal-Wallis test. In cases where statistical differences were found, the Mann-Whitney U test was employed to identify the group

that exhibited differences. A significance level of $P<0.05$ was considered.

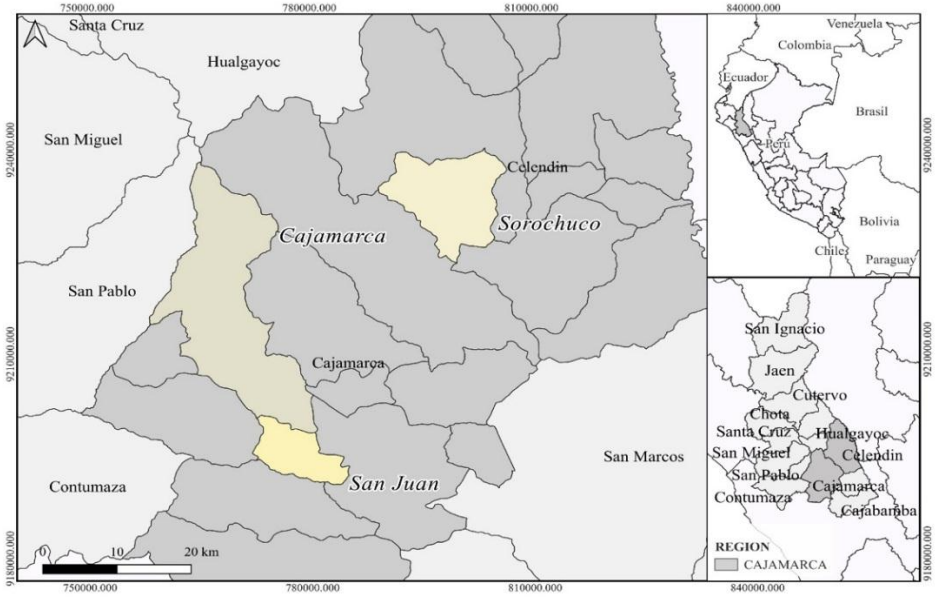


**Figure 1** Location of the three assessed alpaca breeding zones in Camajarca, Peru.

**Table 1** Frequency (%) of *Sarcocystis* spp. oocysts in the feces of dogs raised in three alpaca-influenced zones in Cajamarca, Peru.

| Variable | Category | N | Positives | Frecuency (CI 95%) |
|---|---|---|---|---|
| Place | Porcón | 35 | 11 | 31.43 (16.05 - 46.81)[a] |
| | Huacraruco | 33 | 22 | 66.67 (50.58 - 82.75)[b] |
| | Sorochuco | 34 | 10 | 29.41 (14.10 - 44.73)[a] |
| Age | < 1 year | 44 | 19 | 43.18 (28.55 - 57.82)[a] |
| | > 1 year | 58 | 24 | 41.38 (28.70 - 54.05)[a] |
| Sex | Female | 43 | 16 | 37.21 (22.76 - 51.66)[a] |
| | Male | 59 | 27 | 45.76 (33.05 - 58.48)[a] |
| **TOTAL** | | **102** | **43** | **42.16 (32.57 - 51.74)** |

[a,b] Different letters indicate statistical differences within each variable (Kruskal-Wallis + Mann-Whitney U Post hoc, $P<0.05$).

**Table 2** Morphometry of *Sarcocystis* spp. sporocysts found in the feces of dogs raised in three alpaca-influenced zones in Cajamarca, Peru.

| Sporocyst ($n$ = 43) | Length (µm) | Width (µm) | Characteristics |
|---|---|---|---|
| Mean | 13.87 | 9.12 | |
| Mode | 14.7 | 9.8 | |
| Standard deviation | 1.64 | 1.05 | Ellipsoidal, light gray |
| Variance | 2.70 | 1.09 | (Figure 2) |
| Minimum | 11.03 | 7.35 | |
| Maximum | 17.15 | 11.03 | |

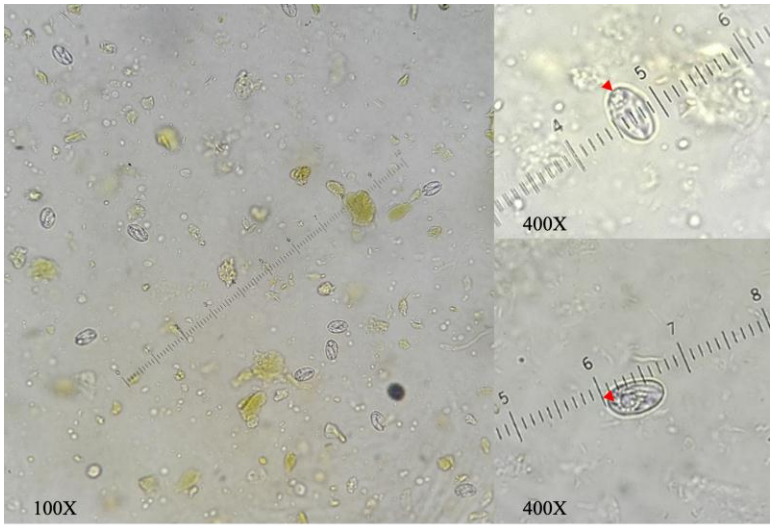


**Figure 2** Sporocysts of *Sarcocystis* spp. They appear ellipsoidal, sporulated (sporozoites), and with dispersed granular residue at the poles inside (arrowhead).

## Result

A total of 102 fecal samples from dogs were collected from the three locations: N = 35 from the Cooperativa Agraria de Trabajadores Atahualpa Jerusalén – Cajamarca, N = 33 from SAIS José Carlos Mariátegui in San Juan, and N = 34 from the Proyecto Alpacas Foncreagro in Sorochuco, Celendín.

Upon processing and analyzing the data, a general frequency of *Sarcocystis* spp. was determined to be 42.16% (95% CI: 32.57 – 51.74), with a significantly higher presence in the feces of dogs from Huacraruco ($P<0.05$). There was no statistically significant influence of age and sex of the dogs on the presence of *Sarcocystis* spp. ($P>0.05$) (Table 1).

Microscopic examination of the samples revealed the presence of ellipsoidal sporocysts of light gray color. The measurement of $n = 43$ sporocysts gave an average of 9.12±1.05 µm width by 13.87±1.61 µm length (Table 2).

## Discussion

Through microscopic observation of the samples, ellipsoidal sporocysts with characteristics of *Sarcocystis* spp. were identified. However, molecular studies are required to determine the specific species of *Sarcocystis*. This parasite was observed in 43 of the 102 analyzed dog fecal samples (42.16%). Additionally, no significant differences were observed in the presence of the parasite based on the sex or age of the dogs ($P>0.05$).

Morphologically, it is not possible to definitively identify the species of a parasite. In the case of *Sarcocystis*, within a specific host, numerous species overlap in terms of dimensions. The values found (13.87±1.64 × 9.12±1.05 µm) are similar to those reported by other authors. Most canine sporocyst species have dimensions around 15 × 10 µm (Dubey *et al*., 2015). Dogs fed on infected camelid meat have been found to harbor sporocysts ranging from 14.6 - 15.0 × 10.4 - 10.6 µm (Saeed *et al*., 2018). Measures of 13 × 8 µm have also been recorded (Miró, 1999). Furthermore, like in the present study, sporulated oocysts are colorless, have thin walls (<1 µm), and contain 2 elongated sporocysts. Each sporocyst houses 4 slender sporozoites and a granular sporocyst residue, which can be compact or dispersed (Dubey *et al*., 2015).

However, only dogs fed infected camelid meat have been shown to produce sporocysts in their feces; thus, the dog is considered the definitive host of *Sarcocystis aucheniae* (Schnieder *et al*., 1984; Cornejo *et al*., 2007; Zacarías *et al*., 2013). On the other hand, the definitive host of *Sarcocystis masoni* is still unknown, although it has been suggested that dogs and other canids are possible definitive hosts for this parasite (Moré *et al*., 2016). Nevertheless, further studies on canids and wild animals in the high-altitude alpaca breeding areas and other South American camelids are needed to identify potential additional definitive hosts of sarcocysts affecting these animals.

In rural areas (like this study), dogs play a fundamental role in labor, and their owners often seek to minimize maintenance costs, which translates into limited investment in their well-being and animal health. In contrast, dogs in urban areas tend to receive greater attention and care. Therefore, in other studies, rural area dogs have been found to have a higher prevalence of infections caused by a wide variety of helminth and protozoan parasites (Gonzáles-Ramírez *et al*., 2021; Santos *et al*., 2021).

There have been a few similar studies to the present one. Maranganí (Cusco) values consistent with those in this research have been reported. In this study, 211 fecal samples from shepherd dogs belonging to alpaca producers in the area were analyzed, revealing a frequency of 42.3±9.2% (47/111) in the dry season and 72.0±8.8% (72/100) in the rainy season, with statistical significance of $P<0.05$ (Choque *et al*., 2007). Additionally, significant differences were observed based on age group, with a higher prevalence in dogs older than three years. Despite finding a higher frequency of *Sarcocystis* spp. in Sorochuco, further studies are needed to identify factors influencing the prevalence of these coccidia in each location.

Breeding conditions and the level of care may influence the prevalence and latency of *Sarcocystis* spp. in dogs from rural areas, which could lead to the infection of other animals. In general, rural dog owners tend to be unaware of the risk of parasitic infection, and a large percentage of them do not administer antiparasitic treatments (Michalczyk *et al*., 2019). However, there is no sanitary care or routine antiparasitic treatment that can affect the cycle of *Sarcocystis* spp.; it is only feeding control. Furthermore, shepherd dogs in alpaca breeding areas have been observed to play a significant role in the transmission of *Sarcocystis* spp. to the alpacas themselves (Choque *et al*., 2007).

Although the present study did not find an association between *Sarcocystis* spp. and age and sex categories, it is important to note that only two categories and a small population of dogs were considered. In other studies, a relationship has been observed between *Sarcocystis* spp. and longevity in both intermediate and definitive hosts. In these cases, *Sarcocystis* spp. has been more frequently detected in older animals, as they have had more time to be exposed to *Sarcocystis* spp. oocysts/sporocysts, regardless of sex (Choque *et al*., 2007; Omer *et al*., 2017).

It is important to note that dogs raised in rural areas tend to defecate anywhere, primarily away from homes, such as in the fields where pastures for herbivores grow. Thus, the alpaca, as an intermediate host, becomes infected with *Sarcocystis* spp. by ingesting sporulated oocysts or sporocysts present in the environment when consuming grass or water. On the other hand, the dog, as a definitive host, acquires the infection by consuming infected meat containing sarcocysts. Once inside the dog, the process of sexual reproduction takes place until oocysts are formed, which are then excreted into the environment through feces, thus contaminating the pastures and water. This completes the parasite's life cycle (Abdel-Ghaffar *et al*., 2009; Dubey *et al*., 2015).

It should be noted that the life cycle of *Sarcocystis* spp. is completed due to ecological and behavioral factors, such as the availability and proximity of definitive hosts (carnivores) and intermediate hosts (herbivores and omnivores), as well as environmental conditions (humidity, temperature) that favor the

survival of sporocysts. Additionally, the feeding behavior of the hosts, particularly the ingestion of raw meat or grass contaminated with feces, plays a crucial role. The migration of animals and the interaction between domestic and wild animals in production systems also contribute to the spread of the parasite (Taylor *et al.,* 2007; Dubey *et al.,* 2015).

The present study has revealed a high prevalence of *Sarcocystis* spp. in domestic dogs within the surveyed areas of Cajamarca. This emphasizes the pressing need to explore practical and optimal control measures. Additionally, it is important to note that only morphometric analysis was conducted to identify *Sarcocystis* spp., and these techniques solely are often insufficient for definitive species identification. Therefore, the lack of molecular analysis to confirm the species was a limitation, as such results would have provided more precise data.

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## *References*

Abdel-Ghaffar F, Mehlhorn H, Bashtar AR, Al-Rasheid KAS, Sakran T and El-Fayoumi H 2009. Life cycle of *Sarcocystis camelicanis* infecting the camel (*Camelus dromedarius*) and the dog (*Canis familiaris*), light and electron microscopic study. Parasitol Res. 106: 189-195.

Carletti T, Martin M, Romero S, Morrison DA, Marcoppido G, Florin-Christensen M and Schnittger L 2013. Molecular identification of *Sarcocystis aucheniae* as the macrocyst-forming parasite of llamas. Vet Parasitol. 19; 396-400.

Castro E, Sam R, López T, Gonzáles A and Silva A 2004. Evaluación de la edad como factor de riesgo de seropositividad a *Sarcocystis* sp. en alpacas. Rev Inv Vet Perú. 15: 83-86.

Choque J, Chávez A, Pacheco A, Leyva V, Panez S and Ticona D 2007. Frequency of *Sarcocystıs* sp. ın sheepdogs from alpaca associatıon breeders, Maranganí, Cusco. Rev Inv Vet Perú. 18: 84-88.

Cornejo R, Chávez A, Leyva V, Falcón N, Panez S and Ticona D 2007. Relationship between the size of macrocysts of *Sarcocysistis aucheniae* and its viability in Canis familiaris. Rev Inv Vet Perú. 18: 76-83.

Dubey J, Calero-Bernal R, Rosenthal B, Speer C, Fayer R 2015. Sarcocystosis of animals and humans. 2nd ed. Boca Raton: CRC Press. 501 pp.

Fitzgerald SD, Janovitz EB, Kazacos KR, Dubey J and Murphy DA 1993. Sarcocystosis with involvement of the central nervous system in lambs. J Vet Diagn Invest. 5: 291-296.

Gonzáles-Ramírez LC, Vásquez C, Chimbaina M, Djabayan-Djibeyan P, Prato-Moreno J, Trelis M and Vincent M 2021. Ocurrence of enteroparasites with zoonotic potential in animals of the rural area of San Andres, Chimborazo, Ecuador. Vet Parasitol Reg Stud Rep. 26: 100630.

McGregor B 2006. Production, attributes and relative value of alpaca fleeces in southern Australia and implications for industry development. Small Rumin Res. 61: 93-111.

Michalczyk M, Sokół R and Gałęcki R 2019. Internal parasites infecting dogs in rural areas. Ann Parasitol. 65: 151-158.

Miró G, 1999. Parasitosis del perro y del gato: parasitosis del aparato digestivo. In: Parasitología veterinaria, 1st ed, Mc Graw-Hill Interamericana, Madrid, España: 615 - 618.

Moré, G, Regensburger C, Gos ML, Pardini L, Verma SK, Ctibor J, Serrano-Martínez ME, Dubey JP and Venturini MC 2016. *Sarcocystis masoni*, n. sp. (Apicomplexa: Sarcocystidae), and redescription of *Sarcocystis aucheniae* from llama (*Lama glama*), guanaco (*Lama guanicoe*) and alpaca (*Vicugna pacos*). Parasitology. 143: 617-26.

Omer SA, Alzuraiq AA and Mohammed OB 2017. Prevalence and molecular detection of *Sarcocystis* spp. infection in the dromedary camel (*Camelus dromedarius*) in Riyadh city, Saudi Arabia. Biomed Res (Aligarh, India). 28: 4962-4965.

Regensburger C, Gos ML, Ctibor J and Moré G 2015. Morphological and molecular characteristics of *Sarcocystis aucheniae* isolated from meat of guanaco (*Lama guanicoe*). J Food Qual Hazards Control. 2: 118-21.

Rodríguez A, Quispe-Solano M, Rodríguez JL and Lucas JR 2023. The occurrence of *Sarcocystis* spp. in the myocardium of alpacas (*Vicugna pacos*) with associated risk factors in the Peruvian Andes. Trop Anim Health Prod. 55: 66.

Romero S, Carletti T, Franco CD, Moré G, Schnittger L and Florin-Christense M 2017. Seropositivity to Sarcocystis infection of llamas correlates with breeding practices. Vet Parasitol. 10: 65-70.

Rooney AL, Limon G, Vides H, Cortez A and Guitian J 2014. *Sarcocystis* spp. in llamas (*Lama glama*) in Southern Bolivia: a cross sectional study of the prevalence, risk factors and loss in income caused by carcass downgrades. Prev Vet Med. 116: 296-304.

Rosenthal BM 2021. Zoonotic Sarcocystis. Res Vet Sci. 136: 151-157.

Saeed MA, Rashid MH, Vaughan J and Jabbar A 2018. Sarcocystosis in South American camelids: The state of play revisited. Parasit Vectors. 11: 146.

Santos K, Viozzi G and Flores V 2021. Dog care and parasitosis in a rural community of Patagonia: An integrative approach. Vet Parasitol Reg Stud Rep. 25: 100583.

Sazmand A and Joachim A 2017. Parasitic diseases of camels in Iran (1931–2017) - a literature review. Parasite. 24: 1-15.

Schnieder T, Kaup FJ, Drommer W, Thiel W and Rommel M 1984. Zur Feinstruktur und Entwicklung von *Sarcocystis aucheniae* beim Lama. Zeitschrift für Parasitenkunde. 70: 451-8.

Sheather AL 1923. The detection of intestinal protozoa and mange parasites by a floatation technique. J Comp Pathol Therap. 36: 266-275.

Taylor MA, Coop RL and Wall RL 2007. Veterinary Parasitology. 3rd ed. Oxford: Blackwell Publishing. 717 pp.

Zacarías F, Sam R, Ramos D, Lucas O and Lucas J 2013. Techniques for the isolation and purification of *Sarcocystis aucheniae* oocysts from small intestine of experimentally infected dogs. Rev Inv Vet Perú. 24: 396-403.