ELSEVIER

Veterinary Parasitology 109 (2002) 129–139

veterinary parasitology

www.elsevier.com/locate/vetpar

Prevalence of ectoparasites in a population of feral cats from north central Florida during the summer

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Received 11 January 2002; received in revised form 5 July 2002; accepted 19 July 2002

Abstract

Ectoparasites are a common and important cause of skin disorders in cats. Ectoparasites are capable of disease transmission and can cause life-threatening anemia in young or debilitated animals. The objective of this study was to determine the potential feline ectoparasites in domestic cats by using a cohort of feral cats from north central Florida that have not received veterinary care and have no known exposure to insecticide application. A total of 200 feral cats were randomly selected for this study. Four monthly sessions were scheduled for feral cat ectoparasite examination and sample collection. Five minutes flea combing revealed that 185/200 (92.5%) of the cats were infested with fleas. The cat flea, *Ctenocephalides felis* was the most common flea infesting 92.5% feral cats (mean = 13.6; standard deviation ± 16.4 fleas per cat). *Pulex simulans* was identified on 9/200 (4.5%) (mean = 1 ± 0.50 fleas per cat). *Echidnophaga gallinacea* was found on 11/200 (5.5%) of cats (mean = 14.8 ± 9.63 fleas per cat). There was a significant difference ($P = 0.0005$) in the average number of *C. felis* counted per cat between months. Mean counts in June (18.3 ± 2.4) and July (16.6 ± 2.1) were significantly ($P < 0.01$) higher than in August (8.4 ± 2.5) and September (7.7 ± 2.0). Only 15/200 cats had skin disease. Flea infestation may potentially be the underlying cause in 10/15. Otoscopic examination of both ears revealed mite movement and black ceruminous exudate typically indicative of the presence of *Otodectes cynotis* in 45/200 (22.5%) cats. Examination of a swab specimen from both ear canals of all cats revealed *O. cynotis* in 74/200 (37%) cats. Of 74 cats positive on ear swab, 8 (10.8%) showed a normal ear canal appearance (no or mild ceruminous exudate) in both ears upon otoscopic examination. A total of nine ticks were recovered from five cats. The number and species of ticks recovered were: one adult female *Rhipicephalus sanguineus*; one adult female *Amblyomma americanum*; one adult male *A. americanum*; five adult female *Dermacentor variabilis*; and one adult female *Ixodes scapularis*. All superficial skin scrapes

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PII: S0304-4017(02)00205-4

were negative. Hair clippings from the abdomen of all cats revealed 2/200 (1%) of the cats were infested with *Felicola subrostratus*.

Keywords: Feral cats; Fleas; Ear mites; Ticks; Ectoparasite; Florida

1. Introduction

Ectoparasites are a common and important cause of pruritic and nonpruritic skin disorders in cats. Ectoparasites can transmit a variety of diseases and cause hypersensitivity disorders in animals. They also may cause life-threatening anemia in young or debilitated animals (Araujo et al., 1998). However, most cats and dogs with ectoparasites have no clinical symptoms. Recently, there has been an introduction of several new insect growth regulators, ovicidal and adulticidal products for control of flea, tick and various mite populations. This has enhanced our ability to control infestation of many common ectoparasites.

The most common group of ectoparasites infesting the cat in North America are fleas. The most common species in the United States are *Ctenocephalides felis*, *Pulex* spp. and *Echidnophaga gallinacea* (Dryden, 1993; Dryden and Rust, 1994). Almost 100% of domestic cats have been shown to harbor *C. felis*: 97% in Indiana (Dryden, 1988), and 100% in Florida (Harman et al., 1987). Studies performed in Virginia (Amin, 1974) and Wisconsin (Painter and Echerlin, 1985), reported *C. felis* to be the most prevalent flea species found on both dogs and cats.

Tick infestation may be noted in outdoor cats. However, the tick infestation is less serious than the diseases they transmit. The species reported most frequently infesting cats are *Dermacentor variabilis*, *Rhipicephalus sanguineus*, *Amblyomma* spp. and *Ixodes* spp. (Sosna and Medleau, 1992). Ticks can transmit to animals and humans serious diseases such as anaplasmosis, cytauxzoonosis, tularemia, Rocky Mountain spotted fever, Lyme disease, and cause tick paralysis (Scott et al., 2001a–c).

Otodectes cynotis are mites that may cause otitis externa and occasionally dermatitis (Sosna and Medleau, 1992). Two types of *Demodex* mites infest cats. *Demodex cati* lives in the hair follicles, hair follicle infundibula, or stratum corneum (Medleau, 1990). In addition, *D. cati* can manifest as a ceruminous otitis externa (Logas, 1994; Kontos et al., 1998). *Demodex gatoi* is a short, stubby mite and lives superficially, not in hair follicles, as does *D. cati*. The sarcoptid mite, *Notoedres cati*, causes an intensely pruritic skin disease primarily of cats (Sousa, 1995). It has been reported on bobcats (Pence et al., 1982) and Florida panthers (Maehr et al., 1995) in the southern United States. C*heyletiella* blakei most commonly infests the cat, but can be found on other species (Sousa, 1995). *Lynxacarus radovskyi*, the cat fur mite, has been reported in Hawaii, Texas and Florida (Craig, 1993). *Felicola subrostratus* is the principal louse that infests cats (Grant, 1989).

Due to the use of individual and environmental ectoparasite control programs in our domestic cats, information regarding the current prevalence of feline ectoparasites is difficult to obtain. There has been no prior study assessing the full compliment of ectoparasites on cats in one geographical area within the United States. The ectoparasites found on these feral cats represent the population range of ectoparasites to which outdoor free-ranging domestic

cats may be exposed. The objective of this study was to determine the potential feline ectoparasites in domestic cats by using a cohort of feral cats from north central Florida that have not received veterinary care and have no known exposure to insecticide application.

2. Materials and methods

2.1. Subject selection criteria

Feral cats from Operation Catnip, a spay and neuter program conducted at the College of Veterinary Medicine, University of Florida were used in this study (http://vetmed.ufl.edu/sacs/catnip/index.htm). These cats were trapped from north central Florida and brought in for neutering by volunteers on specific Operation Catnip days (Operation Catnip, 2001). These cats lived totally outdoors and were not client owned. Following surgery and vaccination, these cats were released to their original location of capture. The exact ages, history and feline immunodefeciency virus and feline leukemia virus (FIV/FeLV) status of these cats were unknown.

Four dates (3 June, 8 July, 5 August and 9 September) were selected (based on the scheduled Operation Catnip dates) and used for feral cat ectoparasite examination and collection. All cats were placed under anesthesia using TKX (50 mg of tiletamine, 50 mg of zolazepam, 80 mg of ketamine, and 20 mg of xylazine per ml of solution) (Williams et al., 2002) during examination and collection sessions. Cats were selected at random. The examination and collection occurred immediately after induction of anesthesia and prior to surgery for each cat.

2.2. Dermatologic examination

Each cat had a complete examination of the skin, visually and by palpation. The primary investigator, a veterinary dermatologist, performed all examinations. Dermatologic findings were recorded for each cat examined throughout the study.

2.3. Flea assessment

All cats were assessed for fleas by flea combing for exactly 5 min (Zakson et al., 1995). The combing samples were collected in Zip-loc® Baggies in 70% ethanol. All fleas were counted at 40× and identified at 400× microscopically, according to the Center Of Disease Control (CDC) key (Anon, 1967).

2.4. Ear canal examination and sampling

Bilateral otoscopic examination on each of the 200 feral cats included assessment for clinical signs of erythema, inflammation, excess debris or exudate and the visual presence of mite movement and black ceruminous exudate typically indicative of *O. cynotis*. Deep ear swab specimens were obtained from both ears from all cats. All ear swab specimens

were examined microscopically (at 40× for detection and 400× for species identification) within 24 h with mineral oil for the presence of *O. cynotis* and *Demodex* spp. Any life stage noted was considered positive. All arthropods were identified using the CDC keys (Anon, 1967).

2.5. Tick assessment

The skin of all cats was palpated and visually inspected thoroughly for the presence of ticks. All ticks were removed carefully to ensure that the mouthparts remained intact. The ticks were placed in 70% ethanol. Each tick was identified microscopically at 40× to species using the CDC key (Anon, 1967).

2.6. Other ectoparasites

A superficial skin scraping was performed with mineral oil and a number 10 scalpel blade on the chin area of each cat. The hair was initially clipped and then a superficial skin scraping was performed. The specimen was mounted on a glass slide with mineral oil preparation. Each slide was completely and carefully examined microscopically (at 40× for detection and 400× for species identification) for superficial ectoparasites such as *N. cati* and *D. gatoi*. Deep skin scrapes to assess for *D. cati* were not performed due to the invasiveness of the procedure.

A 3 in. × 3 in. section of hair was clipped from the ventral abdomen on each cat. The clipped hair was collected in Zip-loc® Baggies in 70% ethanol. All hair samples were thoroughly examined with aid of stereo and compound microscopes for the presence of nits, lice, fur mites, fleas and *Cheyletiella* spp.

2.7. Climatological data

Temperature and precipitation data are from the Annual Climatological Summary, 2001 by the National Climatic Data Center (NCDC), a division of the National Oceanic and Atmospheric Administration (NOAA) (http://ncdc.noaa.gov). Average relative humidity data are from the Florida Automated Weather Network (FAWN) (http://fawn.ifas.ufl.edu). Normal relative humidity data are from the Comparative Climatic Data Publication by the NOAA National Data Centers (NNDC) (http://nndc.noaa.gov).

2.8. Statistics

Monthly prevalences of *C. felis* and *O. cynotis* were analyzed using Fisher's exact test. The number of *C. felis* counted per cat at each month was analyzed using least squared analysis of variance (LSANOVA). Differences among months were analyzed using orthogonal contrast analysis. These results are reported as mean ± standard deviation, unless otherwise indicated. A $P < 0.05$ was considered significant. All analyses were performed using the statistical software package The SAS System for Windows, Version 8.2 (SAS Institute, Cary, NC).

3. Results

3.1. Subject selection

A total of 200 feral cats were randomly selected from approximately 500 cats presented during the four time periods. There were 100 males and 100 females. Samples were collected from 42 cats in June, 56 cats in July, 40 cats in August, and 62 cats in September.

3.2. Dermatologic physical exam

Only 15 of the 200 cats had skin lesions, excluding the ear canals, and all 15 of these cats had fleas. Head and neck miliary dermatitis was noted in 4/185 (2.2%) of the flea infested cats. Bilateral lip ulcers, clinically compatible with feline indolent ulcer, were found on 4/185 (2.2%) of the flea infested cats. Multifocal plaques, suggestive of the feline eosinophilic plaque syndrome, were noted on 2/185 (1.1%) of flea infested cats. Multifocal alopecia was noted in 3/185 (1.6%) of flea infested cats. One of these cats with multifocal alopecia also was positive for *F. subrostratus*. One cat positive for *O. cynotis* was noted to have bilateral ear margin crusting and scale. Chin acne was noted as a clinical finding on one additional cat.

3.3. Fleas

Five minutes flea combing revealed that 185/200 (92.5%) of the cats were infested with fleas. The cat flea, *C. felis* (92.5%) was the most common flea infesting feral cats in north central Florida. Of the cats that were infested with *C. felis* (185/200) the mean number of *C. felis* noted with a 5 min flea combing was 13.6 ± 16.41. *Pulex simulans* was identified on 9/200 (4.5%). Of the cats with *P. simulans*, the mean number found within a 5 min flea combing was 1.3 ± 0.50. *Echinophaga gallinacea* was found on 11/200 (5.5%) of cats. Of those cats, the mean number of *E. gallinacea* recovered was 14.8 ± 9.63.

The month in which samples were collected did not influence prevalence of *C. felis* or *O. cynotis* ($P = 0.4852$ and 0.5652, respectively). There was a significant difference ($P = 0.0005$) in the average number of *C. felis* counted per cat between months. Mean counts in June (18.3 ± 2.4) and July (16.6 ± 2.1) were significantly ($P < 0.0121$) higher than in August (8.4 ± 2.5) and September (7.7 ± 2.0) (Fig. 1).

3.4. Ear sample results

Otoscopic examination of both ears revealed mite movement and black ceruminous exudate typically indicative of the presence of *O. cynotis* in 45/200 (22.5%) of the cats. Examination of swab specimens taken from both ear canals of the cats revealed *O. cynotis* in 74/200 (37%). Of the cats positive for mites, 25/74 (33%) had erythema, inflammation, as well as black exudate in both ear canals on otoscopic exam. Black ceruminous exudate was noted in 66/74 (89%) cats positive for ear mites. Of 74 cats positive on ear swab, 8 (10.8%) showed a normal ear canal appearance (no or mild ceruminous exudate) in both ears upon

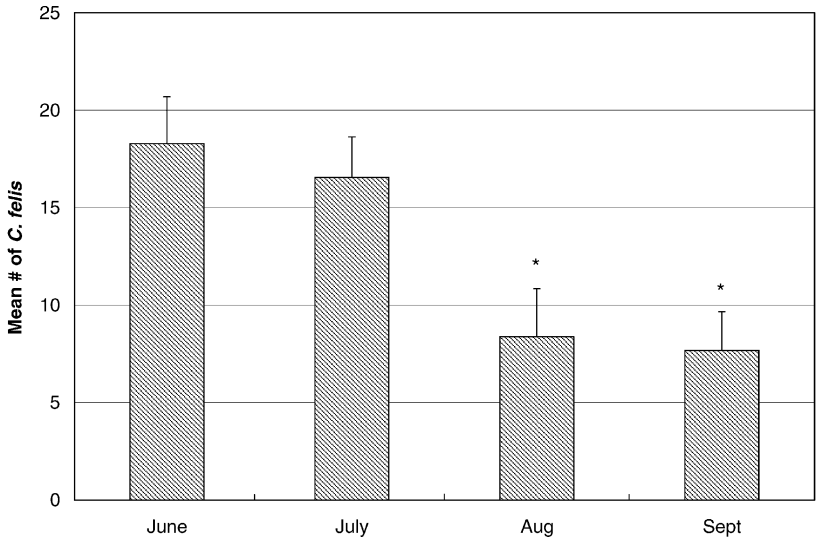

Fig. 1. Mean *Ctenocephalides felis* counted per cat by month. Star indicates significantly different from June and July.

otoscopic examination. These eight cats were positive for ear mites microscopically. The presence any life stage of *O. cynotis* was considered positive.

3.5. Ticks

Ticks were noted on only 5/200 (2.5%) cats. A total of nine ticks were recovered from these five cats. Three of the five infested cats were examined in June. The species of ticks recovered were: one adult female *R. sanguineus*; one adult female *A. americanum*; one adult male *A. americanum*; five adult female *D. variabilis*; and one adult female *I. scapularis*. Two cats had only a single tick; *A. americanum* and *R. sanguineus*, respectively. One cat was found to have three *D. variabilis*. Two cats were found to have two ticks each. One of the two had *D. variabilis* and *A. americanum*. The other cat had *D. variabilis* and *I. scapularis*.

3.6. Additional ectoparasites

No mites were detected by skin scrapings. Hair clippings from the abdomens of all cats revealed 2/200 (1%) of the cats were infested with *F. subrostratus*.

3.7. Climatological data

The average temperature for June–September were 26.3, 27.1, 27.2, and 24.3 °C, respectively. These deviated from normal by 0.22, 0.06, 0.28, −1.33°, respectively. The average precipitation for June–September were 27.4, 20.6, 7.1, and 20.8 cm, respectively. These

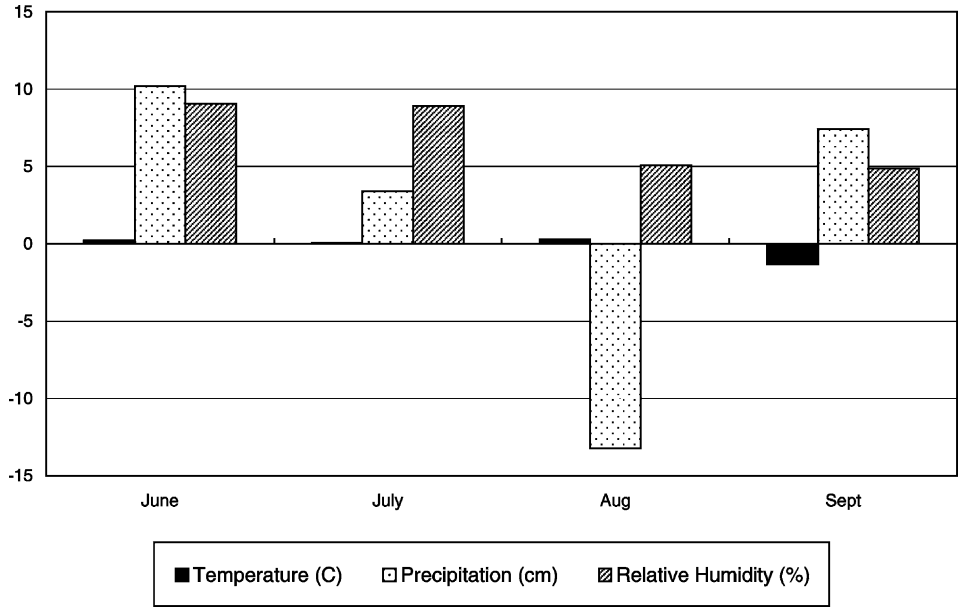

Fig. 2. Climatological departures from normal by month.

deviated from normal by 10.2, 3.4, −13.2, and 7.39 cm, respectively. The average relative humidity for June, July, August and September were 80.0, 82.4, 80.1, and 84.8%. These deviated from normal by 9.05, 8.91, 5.08, and 4.85%, respectively (Fig. 2).

4. Discussion

The cat flea, *C. felis* was the most common flea and the most common ectoparasite infesting feral cats in northern Florida, infesting 185/200 (92.5%) cats. These results are consistent with previous studies (Dryden, 1988; Harman et al., 1987; Painter and Echerlin, 1985). The mean *C. felis* number was only 13.6 ± 16.4, suggesting that the flea density found in general on infested cats was not high.

An earlier study in north central Florida found that 20% of dogs were infested with *Pulex* spp. and only one dog was found to have *E. gallinacea*. Of the 60 cats assessed in that study, only one cat was positive with *Pulex* spp. and no *E. gallinacea* were found (Harman et al., 1987). A recent study in Tampa, Florida assessing the efficacy of an insect growth regulator and an insecticide, evaluated 35 dogs and cats and found all animals to be infested with only *C. felis* (Dryden et al., 2001). However, in our study *P. simulans* was identified on 9/200 (4.5%) and *E. gallinacea* was found on 11/200 (5.5%) cats. Of the cats with *P. simulans*, the mean number of *P. simulans* found within a 5 min flea combing was 1.3 ± 0.50. Of the cats with *E. gallinacea*, the mean number of *E. gallinacea* recovered was 14.8 ± 9.6. A higher percentage of cats positive for *E. gallinacea* may reflect the

environment in which feral cats live, as they may have an increased exposure to chickens or wild fowl.

Environmental conditions can affect the proliferation and survival of ectoparasites. For example, flea larvae development occurs in protected microhabitats that combine moderate temperatures and high relative humidity (Dryden and Rust, 1994). In our study, we noted a significant difference in the average number of *C. felis* counted per cat between months. The flea count was significantly lower in August and September than in June and July. Minimal temperature differences were noted during the collection period (Fig. 2). Precipitation was higher than normal in the months of June (27.4 cm versus 17 cm) and July (20.3 cm versus 17 cm) and decreased considerably in August (7.14 cm versus 20 cm). The relative humidity was higher than normal for all 4 months, but August and September had relative humidities approximately 55% of that in June and July. Therefore, the lower relative humidity and precipitation in August/September when compared to June/July may have reflected in reduced flea counts noted.

A 5-min flea combing for each cat was selected based on a study performed in dogs evaluating the effect of combing time on flea recovery from dogs. In this study, it was concluded a combing time of 5 min provided a precise and accurate representation of the numbers of fleas present on a dog (Zakson et al., 1995). An additional technique has been described to estimate *C. felis* populations has been documented (Dryden et al., 1994). This technique was not used because it does not actually capture the fleas for proper identification.

The most common presenting clinical signs of flea allergic dermatitis in the cat are pruritus and miliary dermatitis. Other common dermatologic presentations suggesting possible flea allergic dermatitis are the eosinophilic plaque, indolent ulcers and eosinophilic granuloma (Scott et al., 2001a–c). Five percent of cats with dermatologic signs seen in this study are consistent with flea bite hypersensitivity (Scott et al., 2001a–c).

To the authors' knowledge this is the first study in the United States examining the prevalence of various ectoparasites, including *O. cynotis*, in a feral cat population. We determined that 37% of feral cats were infested with *O. cynotis*. Ear mites have been reported to live off the host for months (Larkin and Daillard, 1981). Recently, a study of 161 domestic cats in Greece reported a prevalence of 25.5% with *O. cynotis* (Sotiraki et al., 2001). Studies in the United States have reported a significantly lower prevalence, 7% (Murphy et al., 1982) and 5% (McCallum, 1967) when compared to this study. The previous studies examined only domestic cats, possibly explaining the difference. The higher prevalence of ear mites in our study may be due to the differences in the population of cats addressed. Feral cats do not receive veterinary care and have an increased likelihood of interacting and living in close contact with multiple cats where potential transmission may be higher.

In our study, an otoscopic examination did not always reveal the presence of mite movement to confirm the diagnosis of *O. cynotis*. Black ceruminous exudate was noted in cats positive for ear mites in 66/74 (89%). Mite movement was not visibly seen in all cats even with the typical black ceruminous exudate. A deep ear swab sample was required to visualize the presence of mites in these cats. Inflammation, exudate and secondary infection create a difficult environment for these mites to survive, stimulating them to exit the ear canal or die (Scott et al., 2001a–c). This may result in significantly lower numbers of mites in an infested animal, therefore, making it more difficult to identify the mites on otoscopic

exam alone. It has been estimated that 50–84% of all cases of feline otitis externa are due to ear mites (Rose, 1976; Scott et al., 2001a–c). However, infested cats can be asymptomatic (Sotiraki et al., 2001).

Otoscopic examination was recorded to have a normal ear canal appearance (with no or mild ceruminous exudate) in both ears in eight cats that were positive microscopically. This indicates that cats infested with ear mites do not always exhibit the typical ear discharge and inflammation of the ear canals. It has been previously reported that the majority of parasitized cats will have the suggestive ear discharge, however, a smaller percentage will not (Sotiraki et al., 2001). It is possible that these cats had a more recently acquired ear mite infestation. It is important to emphasize that examining an ear sample by ear swab must be done to enhance making an accurate diagnosis of *O. cynotis*.

Only 2.5% of the feral cat population were found to have tick infestations. A total of nine ticks were recovered from five cats. The most common tick recovered was identified as *D. variabilis*. There is a paucity of studies assessing tick prevalence in cats in the United States with which to compare our data. A previous study (Wehinger et al., 1995) identified 3251 ticks from panthers and bobcats in Florida and found the presence of *D. variabilis* and *I. scapularis* among the most common. *R. sanguineus* was not detected from this wildlife study, however, one cat in the present study was found to have this tick. In our study. tick infestation was noted on a relatively small number of cats even though they were feral with constant exposure to the outdoor environment.

Various mites can infect cat skin and ears. Superficial skin scrapings were performed to identify the prevalence of mites in this feral cat population. *Demodex* spp., *N. cati*, *Cheyletiella* spp., and *L. radovskyi* were not identified in this study. Superficial skin scrapings will generally reveal numerous mites in cats infected with *D. gatoi* or *N. cati* (Kuhl, 1994). We were unable to a make a significant conclusion regarding *D. cati*, other than in otitis externa, because it often lives in the hair follicles and requires a deep skin scrape, which was not conducted in this study.

F. subrostratus is the principal louse that affects cats (Grant, 1989). It was found in 2 cats in this study (1%). We do not know if these two cats lived in the same area. It is not a major ectoparasite in the feral cat population in north central Florida.

In this study, we found that cat fleas and ear mites were the most common ectoparasites of feral cats in north central Florida in the summer. There is an increased prevalence of *P. simulans*, *E. gallinacea* and *O. cynotis* in this feral cat population when compared to previous studies on domestic cats from the same region. Because otitis externa and clinical signs of ear mites are not always apparent, examining an ear sample by ear swab should be done to enhance making an accurate diagnosis of *O. cynotis*. Based on this study, examining an ear swab is the optimum way of detecting *O. cynotis* in cat ears.

Acknowledgements

The authors would like to thank Dr. Julie Levy for her cooperation, support and for allowing us to use the Operation Catnip animals and facilities. We would also like to thank our clinical dermatology technician, Jennifer Lopez, for her help throughout this project.

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