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Source: Journal of Wildlife Diseases, 27(4) : 710-715

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-27.4.710

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Journal of Wildlife Diseases, 27(4), 1991, pp. 710–715
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Monthly Prevalences of *Physaloptera retusa* in Naturally Infected Yarrow's Spiny Lizard

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ABSTRACT: The gastrointestinal tracts of 167 of 489 (34%) Yarrow's spiny lizards (*Sceloporus jarrovii jarrovii*) collected in Pima County, Arizona (USA) from October 1967 through January 1970 were infected with *Physaloptera retusa*. Of the infected lizards, 88 (18%) had only larvae, 45 (9%) had larvae and adults and 32 (7%) had only adult nematodes. The ratio of larval nematodes to adults was approximately 8:1. Monthly prevalences varied from 71% in April 1969 to 10% in July 1969; seasonal patterns of infection were not observed.

Key words: Nematoda, *Physaloptera retusa*, Yarrow's spiny lizard, *Sceloporus jarrovii jarrovii*, monthly prevalences, survey.

Yarrow's spiny lizard (*Sceloporus jarrovii jarrovii*) occurs in the mountains of southeastern Arizona (USA) and western Mexico at elevations of 1,370 to 3,550 m (Stebbins, 1985). It is an ovoviviparous lizard that mates during September and October; ovulation occurs in November with birth of a single litter the following June (Goldberg, 1971). These lizards spend the winter (November to April) aggregated in hibernacula (Ruby, 1977). *Physaloptera retusa* has only recently been reported as a parasite of *S. jarrovii jarrovii* (Goldberg and Bursey, 1990a). The purpose of this paper is to report the monthly prevalences and intensities of infections of third and fourth-stage larvae and adults of *P. retusa* in a population of *S. jarrovii jarrovii* collected in Arizona from October 1967 through January 1970.

Monthly samples of *S. jarrovii jarrovii* were collected at an elevation of 1,730 to 1,884 m on Kitt Peak (31°95'N, 111°59'W) in the Baboquivari Mountains (Pima County, Arizona, USA) from October 1967 through January 1970. Lizards were weighed, measured (snout–vent length, SVL), decapitated and preserved in 10% formalin. Four hundred eighty-nine lizards were used in this study. They were previously utilized in a survey of gastrointestinal helminths (Goldberg and Bursey, 1990a) and in an examination of stomach contents (Goldberg and Bursey, 1990b). All specimens were deposited in the Department of Biology Vertebrate Collection (Whittier College, Whittier, California 90608, USA).

The gastrointestinal tract was excised by cutting across the esophagus and rectum. The esophagus, stomach, small intestine and large intestine were slit longitudinally and examined for nematodes separately with the aid of a dissecting microscope. Each previously formalin preserved nematode was identified utilizing a glycerol wet mount. All specimens of *Physaloptera retusa* were categorized as third-stage larva, fourth-stage larva or adult. Patterns of occurrence were tested for correlation and for statistical significance by Chi square and the Kruskal-Wallace test. Representative specimens of *P. retusa* were deposited in the U.S. National Parasite Collection (Beltsville, Maryland 20705, USA; accession number 80868).

Physaloptera retusa was recovered from 167 of 489 (34%) lizards (Fig. 1). No seasonal patterns of occurrence were noted since there was no significant difference in January 1968, 1969 and 1970 prevalences ($\chi^2 = 3.26$, 2 df, $P > 0.05$) or January 1968, 1969, 1970 and July 1968 prevalences ($\chi^2 = 4.09$, 3 df, $P > 0.05$). However, July 1968 and 1969 prevalences were significantly different ($\chi^2 = 19.22$, 1 df, $P < 0.001$). There were no correlations among the mean intensities of any of the life stages (Fig. 2). In the month after a high mean

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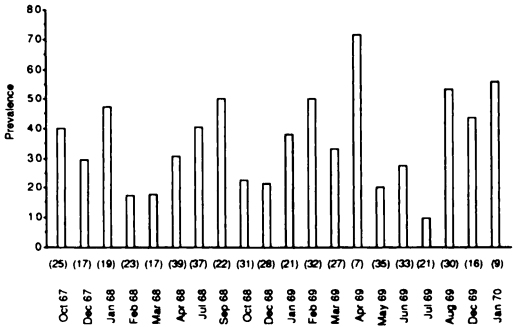


FIGURE 1. Monthly prevalence of *Physaloptera retusa* in 489 naturally infected *Sceloporus jarrovii jarrovii*. Numbers in parentheses are the number of lizards examined each month.

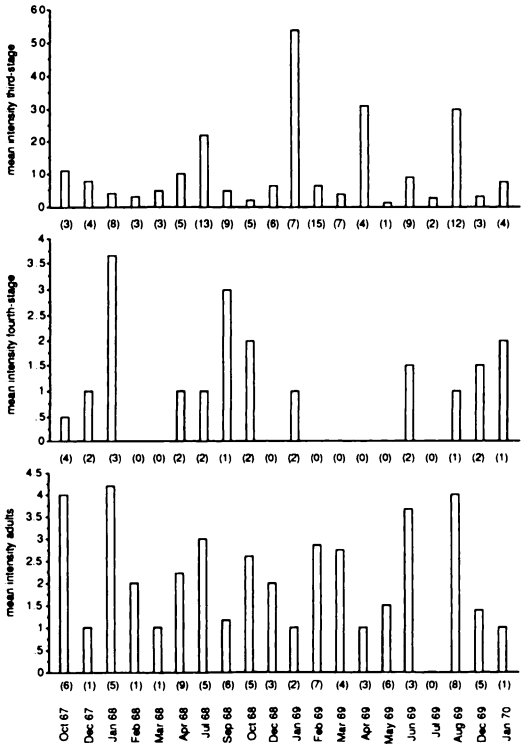


FIGURE 2. Monthly mean intensity of third-stage, fourth-stage and adult *Physaloptera retusa* in naturally infected *Sceloporus jarrovii jarrovii*. Numbers in parentheses are the number of lizards infected by the particular stage of *P. retusa*.

intensity for third-stage larvae, there was no corresponding high mean intensity for fourth-stage larvae (third-stage × fourth-stage correlation coefficient = −0.1). The highest mean intensity for third-stage larvae (47.2) occurred in January 1969; but, we collected no fourth-stage larvae that month and recorded mean intensities of 0.1 and 0 for February 1969 and March 1969, respectively. Likewise, there was no elevated mean intensity for adults in the 3 mo period immediately following January 1969 (third-stage × adult correlation coefficient = 0.3). Instead, there was a relatively constant mean intensity for adults in each of the 19 mo for which data were available (mean intensity ± SE = 2.2 ± 0.3).

The average monthly mean intensities of third-stage, fourth-stage and adult nematodes were 11.2, 1.0 and 2.2, respectively. When third and fourth-stage larvae are combined, 88 (18%) *S. jarrovii jarrovii* contained only larvae, 45 (9%) contained larvae and adults and 32 (7%) contained only adults. The larvae adult ratio was almost 8:1 (Table 1). More nematodes were collected from the stomach than from any other organ, 74% of third-stage larvae, 75% of fourth-stage larvae and 87% of the adults. Other locations for third and fourth-stage larvae and adults are listed in Table 1. We believe that all *P. retusa* found in the intestines were dead at the time of capture of the host. Internal vacuoles which we believe represented histolysis were present in these specimens. Our data suggested that about 88% of larvae failed to develop to the adult stage in this host.

When the data were analyzed by subsample (Table 2), significant differences were found in nematode prevalences between adult and juvenile lizards ($\chi^2 = 48.3$, 1 df, $P < 0.001$). No significant differences were found in nematode prevalences between adult male and female lizards ($\chi^2 = 2.76$, 1 df, $P > 0.05$) or between juvenile male and female lizards ($\chi^2 = 0.22$, 1 df, $P > 0.05$). The difference between adult and juvenile prevalences may be due to age, resulting from accumulative exposure over time to larval nematodes in food. The life span of *P. retusa* in lizards is unknown.

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TABLE 1. Frequency distribution of *Physaloptera retusa* by developmental stage in the alimentary tract of *Sceloporus jarrovii jarrovii*.

		Esophagus		Stomach		Small intestine		Large intestine	
Stage	*n*	*n*	%	*n*	%	*n*	%	*n*	%
Third	1,653	363	22	1,217	74	66	4	7	<1
Fourth	68	16	24	51	75	1	1	0	0
Adult	206	0	0	180	87	18	9	8	4
Total	1,927	379	20	1,448	75	85	4	15	1

However, it is possible that an adult lizard might be infected by parasites acquired more than 1 yr apart. Since *S. jarrovii jarrovii* lives for approximately 2 to 3 yr (Ballinger, 1973), older lizards would presumably have more opportunities for infection than younger hosts. Gray and Anderson (1982) collected adult physalopterans 360 days after experimentally infecting opossums. Thus, we attach no significance to the differences in mean intensities of nematodes in the age and sex subsamples (Table 2).

Sceloporus jarrovii jarrovii spends the winter in hibernacula but is unique in that it is active and feeds during the winter period (Ruby, 1977). Goldberg and Bursey (1990b) estimated that winter food intake of *S. jarrovii jarrovii* was approximately one fifth that of summer food intake; and, with the exception of Hemiptera and Hymenoptera, percentage composition of arthropod intake was approximately the same during both winter and summer.

The effects of *P. retusa* on *S. jarrovii jarrovii* are not known. Testes were enlarged, epididymes contained sperm and ovarian follicles were yolked in infected adult *S. jarrovii jarrovii* examined during the reproductive period indicating that the lizards were reproductively active. Furthermore, there were no significant differences in fat body weights between infected and uninfected summer males (Kruskal-Wallace statistic ($H = 0.9$, 1 df, $P > 0.05$), infected and uninfected summer females ($H = 2.8$, 1 df, $P > 0.05$), infected and uninfected winter males ($H = 2.95$, 1 df, $P > 0.05$) or infected and uninfected winter females ($H = 1.5$, 1 df, $P > 0.05$). Pearce and Tanner (1973) examined *P. retusa* infections in *Sceloporus magister, S. occidentalis* and *S. undulatus* and concluded that the effects of this parasite were negligible on lizard hosts. However, Gray and Anderson (1982) reported that gastric ulcers in the opossum were related to the stage of development of nematodes. In early experimental infections (40 days or less) in which only third and fourth-stage larvae were recovered, ulcers <1 mm in diameter were present at attachment sites. In older experimental infections where adult nematodes were present, ulcers were 2 to 10 mm in diameter.

The life cycle of *Physaloptera retusa* has not been determined. However, the life cycle of several other species such as

TABLE 2. Characteristics of four subsamples of *Sceloporus jarrovii jarrovii* with corresponding prevalences and mean intensities of *Physaloptera retusa*.

Sceloporus jarrovii jarrovii	*n*	Mean SVL (mm)	Mean body weight (g)	Mean fat body weight (μg)	Prevalence (%)	Mean intensity (range)
Adult male	152	83.4	20.2	294.6	49	10 (1–149)
Adult female	179	77.9	16.8	311.7	40	11 (1–271)
Juvenile male	71	60.0	7.7	70.6	11	44 (1–214)
Juvenile female	87	59.5	7.6	84.9	14	5 (1–22)

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TABLE 3. Host and locality records for *Physaloptera retusa* in lizards from North America.

Host	Locality	*n*	Prevalence (%)	Reference
Physaloptera retusa				
Iguanidae				
Callisaurus draconoides	California	19	21	Telford, 1970
Gambelia wislizenii wislizenii	California	5	40	Telford, 1970
Sceloporus graciosus	California	292	28	Goldberg and Bursey, 1989a
S. graciosus graciosus	Utah	53	9	Woodbury, 1934
S. jarrovii jarrovii	Arizona	489	34	Goldberg and Bursey, 1990a
S. magister	Arizona	not given		Walker and Matthias, 1973
	Utah	11	18	Pearce and Tanner, 1973
S. occidentalis	Utah	11	45	Pearce and Tanner, 1973
S. occidentalis biseriatus	California	116	13	Telford, 1970
S. occidentalis longipes	Utah	7	100	Grundmann, 1959
S. orcutti orcutti	California	23	48	Telford, 1970
S. undulatus	Wis, Ill, NY	23	9	Morgan, 1943
	Utah	11	9	Pearce and Tanner, 1973
Uta stansburiana stejnegeri	California	639	3	Telford, 1970
Teiidae				
Cnemidophorus burti stictogrammus	Arizona	57	14	Goldberg and Bursey, 1989b
Scincidae				
Eumeces skiltonianus	California	14	7	Telford, 1970
Anguidae				
Gerrhonotus multicarinatus webbi	California	30	13	Telford, 1970

P. turgida by Alicata (1937), *P. hispida* by Schell (1952), *P. rara* and *P. praeputialis* by Petri and Ameel (1950), and *P. maxillaris* by Hobmaier (1941) and Lincoln and Anderson (1975) have been studied. Eggs contain first-stage larvae when laid and are passed in the host's feces. The eggs of *P. rara* remain viable for at least 2 mo at 4 C (Petri, 1950); whereas, the eggs of *P. hispida* remain viable for at least 8 mo at room temperature (Schell, 1952). Olsen (1974) reported that at room temperature eggs of *P. rara* hatch and larvae migrate into the wall of the arthropod host 36 hr after the eggs are swallowed. The first molt occurs between 11 and 12 days and the second molt takes place by day 15; third-stage larvae live up to 152 days in crickets. Third-stage larvae have been collected from earwigs (*Labidura reparia* and *Forficula auricularia*) (Basir, 1948; Schell, 1952), camel crickets (*Ceuthophilus* sp.) (Petri and Ameel, 1950), field crickets (*Gryllus assimilis* and *Acheta pennsylvanicus*) (Zago Filho, 1959; Cawthorn and Anderson, 1976a), grasshoppers (*Orphulella punctata*, *Eutryxalis filata* and *Dichroplus punctulatus*) (Zago Filho, 1959), German cockroaches (*Blatella germanica*) (Petri, 1950), flour beetles (*Tribolium confusum*) (Petri and Ameel, 1950), and ground beetles (*Harpalus* sp.) (Schell, 1952). Arthropods infected with third-stage larvae are the source of infection for lizards (Olsen, 1974).

Schell (1952) reported that egg production by *P. hispida* began 73 to 90 days after infection of cotton rats (*Sigmodon hispidus*) with infective larvae. Petri and Ameel (1950) reported egg production began between 56 and 83 days after infection of kittens with larvae of *P. rara*. Telford's (1970) data suggest that the development to the egg production stage might require as much as 210 days (October to April) in poikilothermic hosts.

Physaloptera retusa has been reported previously from 12 species of lizards in North America (Table 3). Only two of the papers in Table 3 report the presence of both larvae and adults. Goldberg and Bursey (1989a) found 41 third-stage larvae and

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106 adult worms in sagebrush lizards (*Sceloporus graciosus*) collected during May 1988. Telford (1970) pooled data from *Uta stansburiana*, *Sceloporus orcutti* and *S. occidentalis* and found immature nematodes were present from October through August and adult nematodes were present only from March through July. From these observations, he concluded that infection by *P. retusa* occurred at regular intervals throughout the year. We found immature nematodes during each month; adult nematodes were absent only during one month. Cawthorn and Anderson (1976b) reported that *Physaloptera maxillaris* in striped skunk exhibited annual population cycles in which the failure of third-stage larvae to develop was probably due to inadequate food consumption by the host. When skunks resumed feeding in spring, overwintering larvae developed into adults and initiated the next infection cycle. We believe that the lack of an annual infection cycle of *P. retusa* may reflect year-round ingestion of infected arthropods by *S. jarrovii jarrovii*.

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Received for publication 21 January 1991.

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