BIOLOGICAL CYCLE OF *ARGAS (PERSICARGAS) KEIRANSI* FED ON HEN'S BLOOD UNDER LABORATORY CONDITIONS[1]

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A. keiransi Estrada-Peña, Venzal & González-Acuña (Acari: Argasidae) belong to the subgenus *Persicargas*, which includes soft bodied ticks distributed worldwide and commonly found parasitizing birds (Klompen, 1992). *Argas* (*Persicargas*) *keiransi* was described from engorged larvae of the Chimango Caracara (*Milvago chimango chimango* Vieillot (Aves: Falconiformes: Falconidae: Caracarinae)) from Chillán (Bío Bío Region), Chile (Estrada-Peña et al. 2003). Females of *A. keiransi* were later described by Estrada-Peña et al. (2006), also based on specimens from Chillán.

The objective of this study was to describe the biological cycle of *A. keiransi* under laboratory conditions and compare it with related species.

We collected eighteen females, three males, three nymphs and five larvae of *Argas keiransi* from Chillán (36° 36' S, 72° 02' W). Immature stages were collected from a wall in close proximity to a large roosting colony of Chimango Caracara (*Milvago chimango*). They were fed blood from domestic hens in plastic capsules (15 mm diameter and 17 mm high) attached to a wing (Kaiser, 1966). Adult ticks were placed in pairs and kept in ventilated plastic jars (30 mm diameter and 50 mm high) in an incubator at an average temperature of 24 ± 2°C and relative humidity (RH) of 75% ± 5 using a solution of sulfuric acid and water according to Solomon (1952), and a photoperiod of 12:12 L:D (Loomis, 1961; Kaiser, 1966; Guglielmone and Hadani, 1980; Khalil and Hoogstraal, 1981). A total of 11 female ticks were observed daily and data on length of preoviposition, oviposition, and incubation, as well as number of eggs laid and percent hatch were recorded. After a female finished laying eggs, it was retrieved and fed again as already described.

The life cycle of the tick was studied starting with ten-day-old larvae fed on chickens without prior exposure to ticks (Khalil, 1979; Khalil and Hoogstraal, 1981; Schumaker et al., 1997) to avoid the development of immunity in the host (Kaiser, 1966). Larvae that did not attach within 24 h from the first engorged lar-

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vae were discarded (Hoogstraal et al., 1975; Khalil, 1979; Khalil and Hoogstraal, 1981; Guglielmone et al., 1991; Schumaker et al., 1997). A total of 111 engorged larvae were collected and the number and success of each molt recorded. After each molt, tick larvae and nymphs were again fed blood from live hens with no previous tick exposures until ticks reached adult stage. Feeding ticks were observed for 3 h from their attachment and then daily.

Table 1 summarizes the length of the different life stages, as well as the percent of molt success. The average life cycle duration for *A. keiransi* was 213.4 d. The average number of molts per tick was 3.6, with a range of 2 to 5 molts. The shortest cycle recorded (140 d) resulted in a female and the longest cycle (347 d) was recorded from two ticks, both males. Over half the males (54.6%) emerged from nymph III, whereas 50% of the females emerged from nymph II. The number of eggs per female ranged between 16 and 122, with an average of 66.4 eggs (n = 730 eggs). Hatching rate averaged 80.7% (2.1 - 100%), resulting in the production of 632 larvae.

Table 1. Duration of the different life cycle periods of *Argas keiransi*.

Period	n	Average (d)	Range (d)	Molt Success (%)
Preoviposition	11	28.4	18 - 35	
Oviposition	11	7.0	3 - 12	
Incubation	9	18.7	13 - 26	
Larva to Nymph I	85	23.7	13 - 46	76.6
Nymph I to II	38	31.6	17 - 48	55.9
Nymph II to III	23	29.7	22 - 38	60.5
Nymph III to IV	11	31.9	24 - 38	73.3
Nymph IV to Adult	3	33.0	28 - 36	75.0

Table 2 summarizes the length of the different feeding periods. Since some larvae and nymphs I and II fed twice, the length of feeding could only be recorded exactly for the larvae, which on average lasted 82 d. Feeding in nymphs lasted for only a short period of time. For instance, feeding lasted < 24 h in 84%, 83%, 57%, and 100% of nymphs I, II, II, and IV, respectively. Adults also fed mostly for < 24 h (69% to 63% for females and males, respectively).

Table 2. Length of feeding periods for the differents stages of *A. keiransi*.

	Larva	Nymph I	Nymph II	Nymph III	Nymph IV	Female	Male
N	111	62	30	14	3	13	11
Range	7-17	10 min-8 d	8 min-6 d	30 min-6 d	24 h	24-72 h	24-72 h

In a recent study with a related tick species, *A. neghmei* Kohls & Hoogstraal, the life cycle was completed in a similar number of days (269 d, at 30°C and 35% RH) compared to *A. keiransi* (González-Acuña et al., 2010). However, most

studies with *A. (P.) persicus* report a shorter life cycle compared to our studies with *A. keiransi*. For instance, Micks (1951) reported a completed cycle in just 60 d at 25-28°C and 70-80% RH. Similarly, Loomis (1961) reported a completed cycle in 39 to 53 d, under similar temperature and humidity conditions (23-26.5°C, 72-80% RH) and El Kammah and Abdel Wahab (1979) reported a complete cycle in 63 to 178 d (30-32°C, 75% RH). In another study, the life cycle was completed in a maximum of 290 d at 28-29°C and 75% RH (still faster than our maximum of 347 d) (Khalil, 1979). The later study used temperatures 4 to 5°C higher than those used in our study. Differences in the length of *A. persicus* cycles may be due to some ticks experiencing diapause and/or to decreased feeding rates, resulting in longer developmental periods (El Kammah and Abdel Wahab, 1979).

Of the nineteen ticks that completed the cycle, one went through only two molts before differentiating into an adult female. This is in contrast to Argasidae with two to eight nymphal stages (with three to nine molts) (Oliver, 1989; Sonenshine, 1991). The fact that most males emerged from nymph III and most females emerged from nymph II is also in disagreement with previous studies which report that male ticks are most commonly produced in one less nymphal stage compared to females (Oliver, 1989).

Most argasid ticks feed for short periods ranging from minutes to a few hours (Endris et al., 1986, Sonenshine, 1991). Our results are overall consistent with this, with most *A. keiransi* requiring less than 24 h, but always greater than 1 hour. However, we also observed much longer feeding periods (of up to several days) for nymphs I, II, and III (16.1, 16.7 and 42.9% respectively) and adult females and males (30.77 and 36.36% respectively). El Kammah and Abdel Wahab (1979) did report longer feeding periods for *A. persicus* during the winter; however, there are no additional reports on length of feeding for the different *A. persicus* stages. We also observed several larval stages, with nymph I and nymph II feeding twice before molting. Oliver (1989) reported that immature stages usually feed only once during each development stage, but can feed up to two times if feeding is interrupted or amount of food ingested is less than required. The longer feeding period required by *A. keiransi* may be due to having used an unnatural host (*G. gallus* L.) for this species.

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LITERATURE CITED

El Kammah, K. M. and K. S. Abdel Wahab. 1979. *Argas (Persicagas) persicus* life cycle under controlled and outdoor conditions. Acarologia 21: 163-172.

Endris, R. G., T. M. Haslett, M. J. Monahan, W. R. Hess, and L. C. Rutledge. 1986. Techniques for mass rearing soft ticks (Acari: Argasidae). Journal of Medical Entomology 23: 224-229.

Estrada-Peña, A., J. M. Venzal, D. González-Acuña, and A. A. Guglielmone. 2003. *Argas* (*Persicargas*) *keiransi* n. sp. (Acari: Argasidae) a parasite of *Milvago chimango* (Aves: Falconiformes). Journal of Medical Entomology 40: 766-769.

Estrada-Peña A., J. M. Venzal, D. González-Acuña, A. J. Mangold, and A. A. Guglielmone. 2006. Notes on new world *Persicargas* ticks (Acari: Argasidae) with description of female *Argas* (*P.*) *keiransi*. Journal of Medical Entomology 43: 801-809.

González-Acuña, D., P. Vargas, K. Ardiles, L. Parra, and A. A. Guglielmone. 2010. Developmental biology of *Argas neghmei* Kohls & Hoogstraal (Acari: Argasidae) under laboratory conditions. Neotropical Entomology 39: 160-162.

Guglielmone, A. A. and A. Hadani. 1980. Ciclo biológico de "*Ornitodoros rostratus*". Aragao, 1911, bajo condiciones de laboratorio. Revista de Medicina Veterinaria (Buenos Aires) 61: 254-257.

Guglielmone, A. A., A. J. Mangold, and M. D. Garcia. 1991. The life cycle of *Amblyomma parvum* Aragao, 1908 (Acari: Ixodidae) under laboratory conditions. Experimental and Applied Acarology 13: 129-136.

Hoogstraal, H., S. S. Guirgis, G. M. Khalil, and M. N. Kaiser. 1975. The subgenus *Persicargas* (Ixodoidea: Argasidae: Argas): 27. The life cycle of *A. (P.) robertsi* population samples from Taiwan, Thailand, Indonesia, Australia, and Sri Lanka. Southeast Asian Journal of Tropical Medicine and Public Health 6: 532-539.

Kaiser, M. N. 1966. The subgenus *Persicargas* (Ixodoidea, Argasidae, Argas): 3. The life cycle of *A. (P.) arboreus*, and a standardized rearing method for argasid ticks. Annals of the Entomological Society of America 59: 496-502.

Khalil, G. M. 1979. The subgenus *Persicargas* (Ixodoidea: Argasidae: Argas): 31. The life cycle of *A. (P.) persicus* in the laboratory. Journal of Medical Entomology 16: 200-206.

Khalil, G. M. and H. Hoogstraal. 1981. The life cycle of *Ornithodoros (Alectobius) amblus* (Acari: Ixodidea: Argasidae) in the laboratory. Journal of Medical Entomology 18: 134-139.

Klompen, J. S. H. 1992. Comparative morphology of argasid larvae (Acari: Ixodida: Argasidae), with notes on phylogenetic relationships. Annals of the Entomological Society of America 54: 541-560.

Loomis, E. C. 1961. Life histories of ticks under laboratory conditions (Acarina: Ixodidae and Argasidae). Journal of Parasitology 47: 91-99.

Micks, D. W. 1951. The laboratory rearing of the common fowl tick *Argas persicus* (Oken). Journal of Parasitology 37: 102-105

Oliver, J. H. 1989. Biology and systematics of ticks (Acari: Ixodida). Annual Review of Ecology and Systematics 20: 397-430.

Schumaker, T. T. S., C. M. C. Mori, and C. S. Ferreira. 1997. Experimental infestation of *Gallus* with *Ornithodoros (Alectobius) amblus* (Ixodoidea: Argasidae). Journal of Medical Entomology 34: 521-526.

Solomon, M. E. 1952. Control of humidity with potassium hydroxide, sulphuric acid, or other solutions. Bulletin of Entomological Research 42: 543-554.

Sonenshine, D. E. 1991. Biology of ticks: Vol. 1 Oxford University Press. New York, USA. 488 pp.