Evolutionary Ecology Research, 2019, **20:** 437–449

Neonates of the Mediterranean horseshoe bat, *Rhinolophus euryale*, pay no cost in body mass or length-adjusted body mass on account of the load of the ectoparasite *Eyndhovenia euryalis*

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ABSTRACT

Background: Bats are generally highly gregarious, forming large colonies known to favour the transmission and reproduction of ectoparasites. Exposure to parasites is responsible for the natural selection of very diverse behavioural and immune system adaptations that enable the hosts to survive and reproduce. A classic interaction between host and parasite is usually predicted, i.e. selection for more resistant hosts, which in turn leads to selection for more infective parasites. However, among bats and their ectoparasites, there are few examples of the host and parasite driving each other's evolution in this way.

Site of experiment: Kerend Cave, Kermanshah Province, western Iran.

Organisms: The Mediterranean horseshoe bat, *Rhinolophus euryale* and a mite, *Eyndhovenia euryalis*.

Question: Does the interaction of host and parasite (horseshoe bat and mite) result in a parasitism-induced cost manifested as reduced host body mass or reduced host body-condition index?

Methods: Simultaneous measurement of the percent prevalence, parasite load, and intensity of *E. euryalis*, and the body mass and body-condition index of neonates of *R. euryale* during the post-natal period in Kerend Cave.

Results: The parasite load of *R. euryale* neonates increases rapidly and peaks during the first three weeks of life, before decreasing steadily to its lowest value at the end of the post-natal period. We found no association between changes in parasite load and the body mass of *R. euryale*. This indicates that the interaction between the bat and the mite is regulated so that the bat hosts, during their post-natal growth, resist parasites without paying a cost of parasitism in terms either of reduced body mass or body-condition index.

Keywords: body-condition index, *Eyndhovenia euryalis*, nursing colony, parasite load, *Rhinolophus euryale*.

INTRODUCTION

Bat ectoparasites belong to diverse groups of arthropods. Some species are obligate parasites (e.g. mites), while others may be present temporarily on their bat hosts (e.g. cimicids).

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Ectoparasites live and feed on the surface of a host and the host's blood is normally their main food source. They also depend on their host to complete their own life cycle (Sharifi *et al.*, 2008, 2013).

The ectoparasites of bats have remarkably diverse life cycles, ecology, adaptations, and relationships with their hosts (Lourenço, 2008). Empirical research on various groups of vertebrates demonstrates that ectoparasites can cause mortality, morbidity, reduce fecundity, and regulate host population size and change demographic characteristics. So they sometimes influence host fitness indicators such as behaviour (Fenner and Bull, 2008), body condition, and reproductive success (Khokhlova *et al.*, 2002; Neuhaus, 2003; Lourenço and Palmeirim, 2007). However, exposure to parasites is responsible for the natural selection of very diverse behavioural and immune system adaptations that allow the hosts to survive and reproduce (Fitze *et al.*, 2004).

Traditional approaches to host–parasite interaction suggest that ectoparasites of bats act as vectors for diseases and cause physical damage to the bats (e.g. Marshall, 1982). In fact, many studies document that the patterns of parasite abundance and prevalence are associated with several biotic and environmental characteristics (Moura *et al.*, 2003). Some studies have reported the relationship between the number of parasites and body condition of bats (Christe *et al.*, 2000). In some bats, ectoparasitic reproduction events are synchronized with host reproduction – the number of ectoparasites peaks among pregnant and lactating bats. Once mothers cease lactating, parasite abundance rises in juveniles (Christe *et al.*, 2000; Bartonička and Gaisler, 2007; Lourenço and Palmeirim, 2007; Yousefi *et al.*, 2018). Other studies have shown that juvenile bats harbour more parasites than adults (Hawlena *et al.*, 2005; Lučan, 2006; Yousefi *et al.*, 2018). Variation in the intensity of a parasitic mite (*Spinturnix myoti*) in relation to the reproductive cycle and immunocompetence of its bat host (*Myotis myotis*) shows that pregnant females are less immunocompetent and harbour more parasites than non-reproductive females. As gestation progresses, parasites transfer vertically to juveniles from their lactating mothers (Christe *et al.*, 2000). Other studies demonstrate that differences in social behaviour between different segments of a species' population, as well as differences in roosting habits in different bat species, bat populations or sexes, can affect parasite load (Lourenço and Palmeirim, 2007; Sharifi *et al.*, 2008, 2013; Postawa and Szubert-Kruszyńska, 2014).

Analysis of the relationship between parasite load and the body condition of bats has revealed no common sex- or age-related trends. The strength of association between body condition and parasite load has been shown to vary widely (Neuhaus, 2003; Brown and Brown, 2004; Whiteman and Parker, 2004), while some recent studies have concluded that parasite load is independent of the body condition or 'wellbeing' of the bats (Johnson and Albrecht, 1993; Tompkins *et al.*, 1996; Zahn and Rupp, 2004; Perez-Orella and Schulte-Hostedde, 2005; Lučan, 2006; Sharifi *et al.*, 2008, 2013; Yousefi *et al.*, 2018). Although parasite load may have no significant impact on adult and subadult male body condition, it may do so in females. During the post-lactation period, adult and subadult females exhibit a positive relationship between parasite load and body condition (Lučan, 2006). Using the ratio of body mass to forearm length (*W*/*F*) as an index of body condition, Lučan (2006) found no significant correlation between parasite load and body condition among adult male or female *Myotis daubentonii*. Recent research by bat biologists provides a new evolutionary approach to the interaction between host and parasites, an approach that does not consider ectoparasites to be a health hazard. Several studies on parasite load in various species of bats have looked at the relationships between parasite load in adult bats (Zahn and Rupp, 2004; Lučan, 2006; Zhang *et al.*, 2010), body size (Theron *et al.*, 1998), gender (Zahn and Rupp, 2004; Lučan, 2006), immunocompetence (Christe *et al.*, 2000), and timing of reproduction (Sharifi *et al.*, 2008, 2013) of the host species.

To date, we have limited information on bat ectoparasites in Iran. While the ectoparasites of some bat species have been identified in Iran (Vatandoost *et al.*, 2010), few studies have addressed quantitative relationships between ectoparasites and their bat hosts or environmental factors.

Sharifi *et al.* (2008, 2013) investigated the parasite load of two bat species, *Myotis blythii* (Chiroptera: Vespertilionidae) and *Rhinolophus mehelyi* (Chiroptera: Rhinolophidae), in western Iran and found no relationship between parasite load and a body-condition index. Similar results have been obtained in studies conducted on *Pipistrellus kuhlii* (Sharifi *et al.*, 2012), *Miniopterus schreibersii* (Sharifi and Vaissi, 2013), and *Rhinolophus mehelyi* (Sharifi, 2004). Recently, Yousefi *et al.* (2018) studied post-natal variation in parasite load in neonates, lactating, pregnant and non-pregnant females in a free-ranging nursing colony of Geoffroy's bat (*Myotis emarginatus*) in Kerend Cave, western Iran, and found no association between body-condition index and parasite load in various stages of the life cycle.

Here, we hypothesize that the interaction between the host bat, *Rhinolophus euryale*, and its ectoparasite, *Eyndhovenia euryalis*, should not – at any stage of the bat's life cycle – result in a parasitism-induced cost that manifests as a reduced body mass or reduced body-condition index (Yousefi *et al.*, 2018). As a result, the aims of this study were to determine (1) how rapidly neonate bats acquire ectoparasites, (2) the pattern of post-natal variation in parasite load, and (3) the associations of parasite load with body mass and the body-condition index (*W*/*F*) during post-natal growth.

MATERIALS AND METHODS

Rhinolophus euryale is a medium-sized bat recorded at 27 sites in Iran (Benda *et al.*, 2012; Najafi *et al.*, 2019). It is a typical Mediterranean species and its range in Iran reflects this, as 19 out of the 27 sites are in the Zagros Mountains. *Rhinolophus euryale* was recorded in Iran almost exclusively in its roosts. There had been only one record of a maternity roost for this bat species – Dareze Cave in the mountains at the western edge of Khurramabad, Lorestan Province (DeBlase, 1980). However, when we conducted our study in Kerend Cave, we found it also to house a maternity roost for *R. euryale.* The conservation status of *R. euryale* is 'near threatened', according to the International Union for Conservation of Nature (Hutson *et al.*, 2001). Sharifi *et al.* (2000) tried to estimate the conservation status of Iranian species using an index of relative abundance that combined (1) the effect of the number of physiographic units a species is known to inhabit, (2) the number of sites at which it has been observed, and (3) the number of specimens reported at various observation sites. They concluded that *R. euryale* is 'rare' (in a ranking hierarchy of 'common', 'rare', 'very rare', and 'extremely rare').

Study area

We conducted our study in Kerend Cave (34°15′N, 46°17′E) in Kermanshah Province, western Iran. Kerend Cave lies on the outskirts of Kerend, a small city in western Kermanshah. The western edge of the Iranian plateau in the mid-Zagros Mountains is characterized by pronounced seasonal variation, including a long period of freezing temperatures in winter and a mild summer. The natural vegetation around the cave ranges from thin scrubland on steep rock outcrops to dense woodlands with diverse tree species. In areas where soil is well developed, open oak-pistachio woodlands can be found. These woodlands are dominated by Brant's Oak (*Quercus brantii*) and two species of pistachio (*Pistachio vera* and *P. khonchic*). Kerend Cave is small (about 50 m long) and oblique with a low passageway culminating in a small water-hole. The average temperature and relative humidity in the cave in the 15 visits during the post-natal study were 23°C and 56% respectively. Using several emergence counts in this cave, we estimated that approximately 750–800 bats of at least three species (*Rhinolophus ferrumequinum*, *R. euryale*, and *Myotis emarginatus*) roost in it.

Sampling

On 15 separate occasions during 2016 (20, 26, 30 May; 3, 7, 11, 15, 20, 23 June; 1, 8, 15, 25 July; and 5, 15 August), we sampled 189 *R. euryale* pups. We placed each pup in a cloth bag by itself after their mothers had emerged from the cave to forage. We recorded their sex, weight, forearm length, and the number of ectoparasites. We also assessed the reproductive status of females (pregnant or non-pregnant) by palpation of the foetus. We assessed lactation state by softly pressing the nipples to extract some milk. We determined developmental stage (juvenile or adult) based on the presence or absence of an epiphyseal gap. We recorded the number of ectoparasites on the pelage, ears, wings, and tail membrane. In addition, if the fur of a bat had already grown in, we spent about 20 seconds blowing on the fur in search of ectoparasites. Immediately after examination, we released adult bats at the entrance of the cave. We calculated the following variables: relative density of ectoparasites or parasite load (mean number of ectoparasites per bat), prevalence (percentage of infested bats), and mean intensity (mean number of ectoparasites per infested bat). We also used the ratio of body mass to forearm length (*W*/*F*: g/mm) as our body-condition index for *R. euryale.* We assessed the impact of parasite load using the slope of a regression line (correlation coefficient) between parasite load and the body-condition index (e.g. Lourenço, 2008; Sharifi *et al.*, 2008, 2013; Webber *et al.*, 2015).

The only bat ectoparasite species we report in this study is *Eyndhovenia euryalis*, a monotypic genus described by Rudnick (1960). We continue to study the ectoparasites of our bats to determine whether they are similar to one of the three known subspecies (Uchikawa and Dusbábek, 1985) of *E. euryalis* or if they should be granted a new status. Ectoparasites of the genus *Eyndhovenia* have been reported in various species of bats, including *Rhinolophus ferrumequinum*, *Miniopterus schreibersii*, and *Myotis emarginatus* (Imaz *et al.*, 1999; Krištofik and Danko, 2012), as well as *R. euryale* (Sachanowicz *et al.*, 2014) and *R. mehelyi* (Sharifi *et al.*, 2013). Identification of *E. euryalis* is based on the following features: large tritosternum; a completely dorsal peritreme; well-developed caruncles in females; and four or five pairs of dorsal propodosomal setae surrounding the dorsal shield anterior to the peritreme (Rudnick, 1960).

Using tweezers, we collected parasites manually, fixed them in 70% ethyl alcohol, and stored them in individual vials labelled with the host number for later identification. Before identification, the ectoparasites were cleared and mounted on microscope slides. To identify them, we used a compound light microscope and the descriptions of Rudnick (1960). All parasite specimens we collected are housed in the laboratory of Razi University Centre for Environmental Studies located in the Department of Biology, Razi University, Kermanshah, Iran.

Statistical analyses

Statistical analyses were undertaken using *Quantitative Parasitology* v.3.0 (Reiczigel and Rósza, 2005) and the software package *SPSS* v.16. We used non-parametric tests as the data are not normally distributed. To test for differences in mite abundance between host groupings, we used the Mann-Whitney *U*-test. We used Spearman's rank correlation coefficient to assess the strength of association between different factors. We considered all *P*-values < 0.05 to be statistically significant. We report all values as the mean ± standard error (SE), and all *P*-values are two-tailed.

RESULTS

The first *Rhinolophus euryale* pups were born on 20 May. They were born with no fur, their eyes closed and pinnae folded. By one week of age, their ears had become erect and a few sparse hairs could be seen on their bodies. Their eyes also opened during this time and they began to move. The short, soft hair of the pups was noticeable before age 10 days. Their hair colour gradually changed from dark grey to light grey during the post-natal period. Their ability to fly improved when they were about 21 days old. At this time, they began to fly independently in the cave. Young bats were able to make a straight line flight at about 40 days of age and flew freely inside the cave. We found no differences in body mass or forearm length between the sexes on any of the 16 sampling occasions. Following an early increase in ectoparasites, we observed a sudden reduction in parasite load; this reduction continued until the end of the post-natal period, when it was 5–6 parasites per individual (Fig. 1). The increase in parasite load in *R. euryale* neonates and its subsequent reduction were observed in both males and females (Table 1).

During the first 30 days of a bat's life, a significant, positive correlation was observed between age and parasite load ($r_S = 0.95$, $P = 0.000$, $n = 8$). From age 30 days until age 85 days, the relationship became negative and significant ($r_S = -1.00$, $P = 0.00$, $n = 70$).

Spearman's correlation coefficient did not reveal any significant relationship between parasite load and the body-condition index (W/F) in any bat grouping. Nor was there a significant relationship between parasite load and body mass (Fig. 2A) or the body-condition index (Fig. 2B). A positive, non-significant correlation was observed between parasite load and the

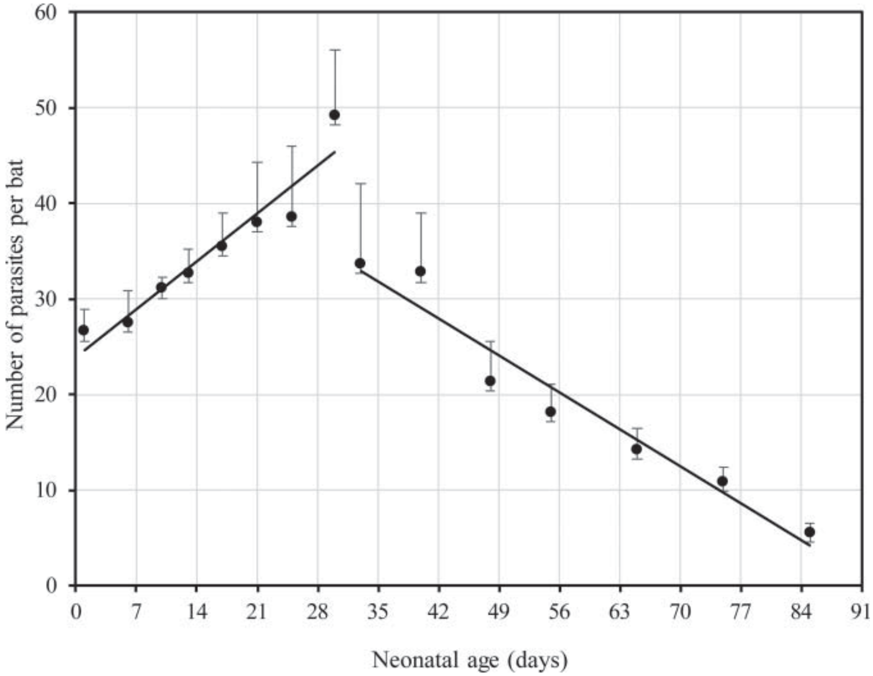

Fig. 1. Parasite load (number of parasites per individual) for male and female neonates of *Rhinolophus euryale* during the post-natal period in Kerend Cave, western Iran (values are means and standard errors).

Table 1. Numbers of ectoparasites (*Eyndhovenia euryalis*) and parasite loads for male and female neonates of the bat *Rhinolophus euryale* on 15 sampling occasions

			Parasite load (mean ± SE)	
Sampling date	No. of ectoparasites	No. of bats (♀/♂)	♀	♂
20 May	266	10 (6/4)	27.16 ± 3.49	20.75 ± 3.32
26 May	303	11 (5/6)	30.40 ± 6.96	20.16 ± 2.70
30 May	373	12 (5/7)	30.42 ± 1.43	31.57 ± 1.83
3 June	327	10 (5/5)	32.20 ± 4.69	33.20 ± 2.24
7 June	426	12 (5/7)	38.60 ± 8.09	33.28 ± 2.61
11 June	495	13 (5/8)	36.60 ± 8.08	39.00 ± 9.09
15 June	540	14 (7/7)	46.00 ± 12.87	31.14 ± 7.29
20 June	625	12 (6/6)	55.16 ± 11.60	49.83 ± 7.46
23 June	370	11 (6/5)	35.50 ± 15.21	31.40 ± 6.70
1 July	295	9 (4/5)	33.25 ± 10.08	32.40 ± 8.87
8 July	214	10 (4/6)	20.75 ± 2.52	21.83 ± 7.12
15 July	271	15 (7/8)	19.14 ± 6.26	17.12 ± 2.07
25 July	156	11 (5/6)	15.60 ± 3.58	13.00 ± 2.95
5 August	130	12 (6/6)	12.83 ± 0.94	8.83 ± 1.07
15 August	103	12 (7/5)	9.80 ± 0.83	7.33 ± 1.05

Table 2. The percent prevalence (confidence interval), parasite load, and intensity of *E. euryalis* for male and female neonates, and pregnant and lactating females of the bat *R. euryale*

	No. of neonates			
	♀	♂	No. of pregnant females	No. of lactating females
No. of bats	99	89	20	21
No. of ectoparasites	2508	2563	167	445
Percent prevalence	100 (97–100)	100 (96–100)	100 (85–100)	100 (86–100)
Parasite load	28.17 ± 2.28	25.88 ± 1.67	8.35 ± 1.12	21.19 ± 2.81
Intensity	28.17 ± 2.28	25.88 ± 1.67	8.35 ± 1.12	21.19 ± 2.81

body-condition index in juveniles, both for females ($r_S = 0.183$, $P = 0.09$, $n = 89$) and males ($r_S = 0.10$, $P = 0.32$, $n = 99$). We also found a non-significant, negative correlation between parasite load and the body-condition index in pregnant ($r_S = -0.403$, $P = 0.10$, $n = 17$) and lactating ($r_S = -0.317$, $P = 0.16$, $n = 21$) females.

Table 2 shows the percent prevalence, parasite load, and intensity of *E. euryalis* for male and female neonates, and pregnant and lactating females. In pregnant and lactating females, as well as both male and female neonates, the prevalence of ectoparasites was 100%. The average parasite load for all *R. euryale* neonates was 26.97 ± 1.39; that for male (25.88 ± 1.67) and female (28.17 ± 2.28) neonates did not differ significantly ($P = 0.88$, $U = 4349$, $n = 188$).

The average parasite load for lactating bats (21.19 ± 2.81) was significantly smaller ($P = 0.000$, $U = 57$, $n = 41$) than for pregnant (8.35 ± 1.12) females. During the post-natal period, the parasite load of juveniles was significantly higher than for pregnant and lactating females. In the first 30 days following birth, ectoparasites on neonates of *R. euryale* increased rapidly to a peak of 49.25 ectoparasites per individual, 4.1 times the average parasite load observed in juvenile bats. Following this peak in parasite load, we observed a sudden decrease followed by a slower reduction (Fig. 1).

DISCUSSION

Our results are in line with our hypothesis that the interaction of the ectoparasite *Eyndhovenia euryalis* with its host *Rhinolophus euryale* does not result in a parasitism-induced cost in terms either of reduced body mass or reduced body-condition index (*W*/*F*). In both male and female neonates, we did not find any significant correlation between parasite load and either body mass (Fig. 2A) or the body-condition index (Fig. 2B). Similar results have been reported elsewhere.

During the first seven weeks of post-natal growth, we found significant positive relationships between the number of ectoparasites and body mass ($r = 0.86$, $P = 0.006$, Fig. 3A), and the number of ectoparasites and the body-condition index ($r = 0.97$, $P = 0.00$, Fig. 3B). After seven weeks, these two relationships became negative: $r = -0.95$, $P = 0.001$ (Fig. 3A) and $r = -0.98$, $P = 0.00$ (Fig. 3B) respectively. Differences in parasite load in *R. euryale* neonates during the early post-natal period not only reflect an inability to groom, but also imply rapid vertical transmission of *E. euryalis*.

Interactions between parasite and host are not usually lethal and concentrated on a small number of individuals, compared with other species interactions such as predation, competition, or herbivory (Begon *et al.*, 2006). In some cases, there may be an intimate relationship between parasite and host, an intimacy that is not seen in true predators, competitors, or grazers (Mouritsen and Poulin, 2002). Parasites might cause harm to their host but it may not be easy to demonstrate this (Toft and Karter, 1990). Instead, we see numerous examples of ectoparasites that feed on hosts of various taxa but appear to do no harm. Consider Australia's sleepy lizard, *Tiliqua rugosa*, whose longevity is not correlated with its parasite load of ticks (*Aponomma hydrosauri* and *Amblyomma limbatum*) (Bull and Burzacott, 1993).

Consider also feather mites, among the most common avian ectoparasites. Galván *et al.* (2012) used a large dataset comprising 83 species of birds collected in 151 localities to explore the correlation between feather mite abundance and the body condition of their hosts. They found that although a negative relationship between feather mite abundance and host body condition occurred in a few species of birds, in most species the sign of the correlation was positive (69%). Similarly, several bat biologists using body mass and the body-condition index (*W*/*F*) to assess body condition, found no significant correlation between parasite load and body condition (Lourenço and Palmeirim, 2007; Sharifi *et al.*, 2008, 2013; Postawa and Szubert-Kruszyńska, 2014).

Some host–parasite interactions have yielded contrasting results. Lourenço and Palmeirim (2007) found *Spinturnix* to have a detrimental effect on its host's body-condition index. On the other hand, Zahn and Rupp (2004) and Lučan (2006) found no significant correlation between mite abundance and the body-condition index of bats. Lučan (2006) found no common trend in the relationship between parasite load and body-condition index in sex- and age-related groups. Finding some bats in poor condition and with large parasite loads, Zahn and Rupp (2004) interpreted this combination as a consequence rather than a cause of the host's condition.

In addition to mites and bats, multiple studies in other vertebrates (e.g. birds and rodents) have shown a relationship between body condition and ectoparasites (e.g. Brown and Brown, 2004; Møller and Saino, 2004).

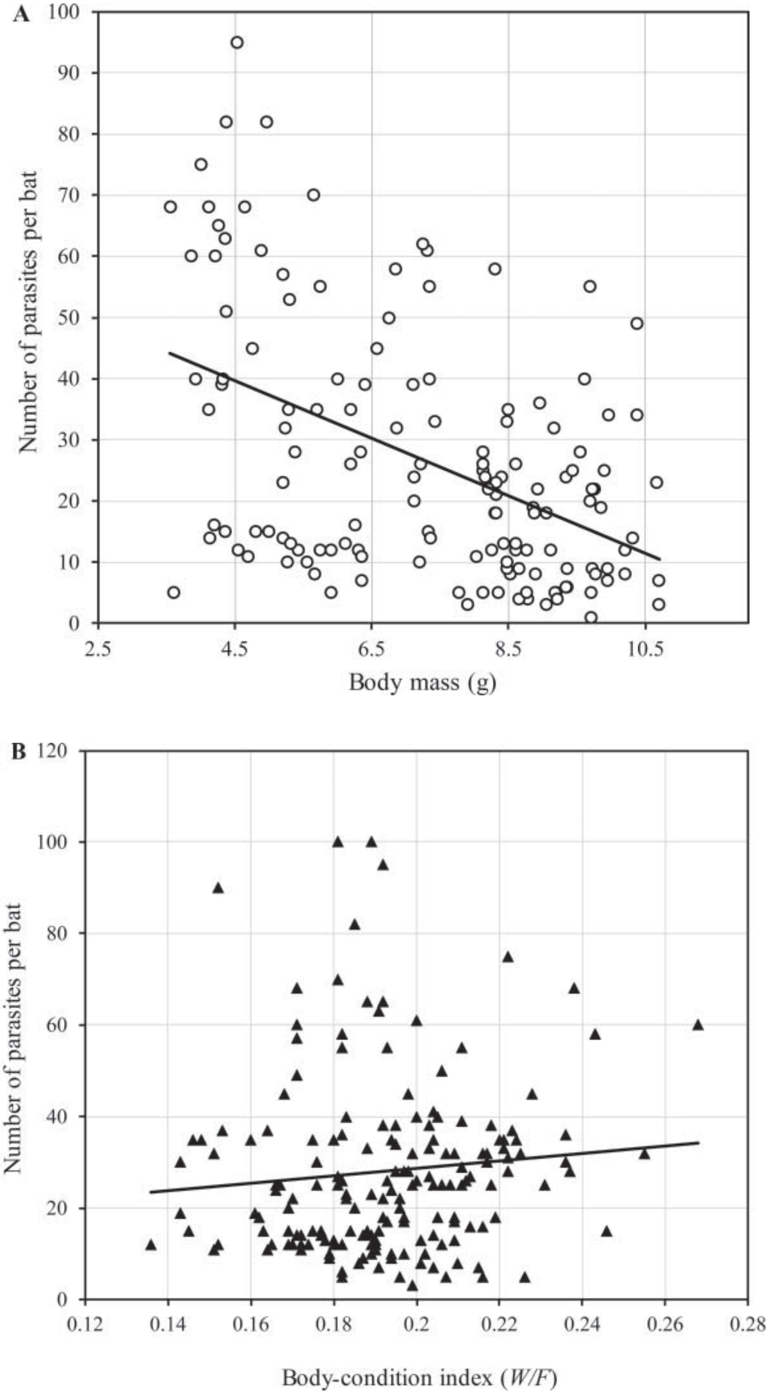

Fig. 2. Relationship between parasite load and (A) body mass and (B) body-condition index (*W*/*F*) in neonates of *Rhinolophus euryale* in Kerend Cave, western Iran.

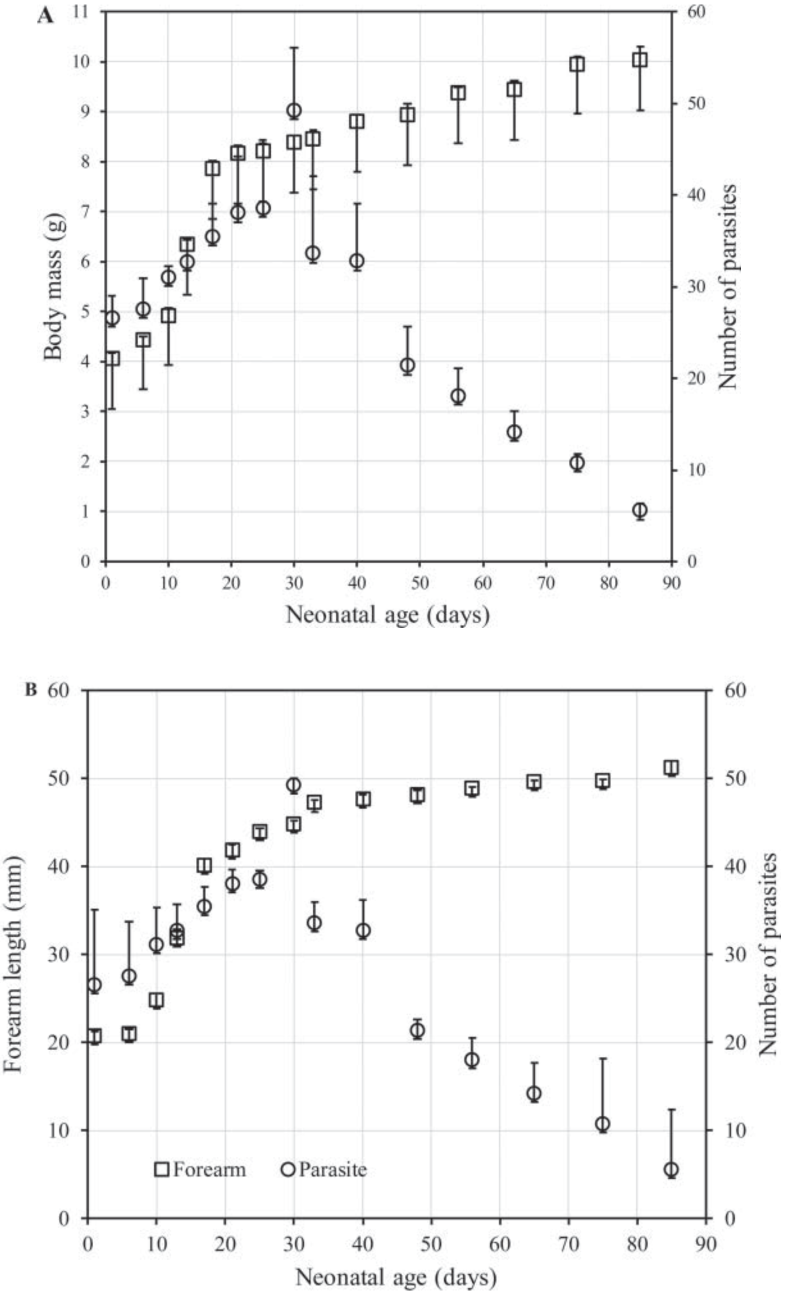

Fig. 3. Changes in parasite load of *R. euryale* neonates during post-natal growth. Growth is represented by changes in body mass (A) or forearm length (B).

Some have questioned the validity of body mass and the body-condition index (*W*/*F*) as good indicators of body condition. These authors believe that in each sex and age category of bats, parasite abundance and, in particular, host body condition, may be influenced by different underlying causal mechanisms.

Large parasite loads in *R. euryale* neonates in the early post-natal period reflect both vertical transmission of *E. euryalis* and the inability of young bats to groom themselves. In the early post-natal period, some offspring with a body mass below 5 g received up to 100 individuals of *E. euryalis* from their host mothers. The rate of increase in parasite load during post-natal growth is linear and rapid (0.66 per day). The peak in parasite load occurs at a body mass of 9 g (Fig. 3A) and a forearm length of 50 mm (Fig. 3B), both of which are attained at an age of 30 days when juvenile bats are already roosting separately in the cave (Eghbali *et al.*, 2018).

We know that *E. euryalis* spend their entire life cycle on the host, and tend to remain on the same individual for long periods (Rudnick, 1960). Two reports indicate that *E. euryalis* adjust their reproductive cycle to that of their host, thus achieving vertical transmission to the neonates (Christe *et al.*, 2000; Lourenco, 2008). Clayton and Tompkins (1994) hypothesize that ectoparasites transmitted vertically can move more easily among host individuals, but are less harmful to their hosts than parasites transmitted horizontally because the fitness of vertically transmitted parasites depends on the successful reproduction of their hosts (see also ter Hofstede and Fenton, 2005).

In contrast to some bat species, in *R. euryale* there is no difference in parasite load between the sexes. Similar results have been reported for juveniles of *Myotis myotis*, *M. blythii*, and *M. daubentonii* (Lučan, 2006; Christe *et al.*, 2007). However, other authors have demonstrated varying degrees of difference in parasite load between adult male and female bats (Zahn and Rupp, 2004; Lučan, 2006; Christe *et al.*, 2007). These authors found that female bats are more exposed to the parasites because of their colonial reproductive groupings compared with the more isolated males. Also, sex bias in parasite load most likely results from sex-specific differences in host social behaviour – again males are more isolated than females (Christe *et al.*, 2007; Patterson *et al.*, 2008). And males experience immunosuppressive effects (Christe *et al.*, 2000), which are influenced by androgens (Klein, 2004).

Several studies have demonstrated that the reproductive status of adult bats is associated with parasite load and prevalence, which may be due to a reduction in immune defence against parasites in reproducing females (Deerenberg *et al.*, 1997; Moshkin *et al.*, 1998), and endocrine changes related to reproduction (Zuk, 1996). Pregnant and lactating females show no significant difference in parasite load (Hogarth, 1982; Haig, 1993). Christe *et al.* (2000) found that pregnant female *M. myotis* have a particularly low immune response to antigenic phytohemagglutinin in early pregnancy, and parasite load is higher in reproductive females than in non-reproductive females because the former have weaker cell-mediated immunity.

Most studies of the impact of ectoparasites on bat species have been conducted with adult bats. As a result, information related to the parasite load of neonate and juvenile bats is very scarce. Bats at these developmental stages cannot groom themselves and so cannot defend themselves against ectoparasites. Compared with adult bats, they are also more fragile and vulnerable because they have no fur and are in the early stages of immunological development. However, Yousefi *et al.* (2018) studied post-natal variation in parasite load in neonates, lactating, pregnant and non-pregnant females in a free-ranging nursing colony of Geoffroy's bat (*Myotis emarginatus*). In this colony, the density of ectoparasites increased up to an average of 21.3 ectoparasites per individual during the first two weeks following the birth of pups. This was followed by a sudden reduction in parasite load, which stabilized after 80 days at 8.6 ectoparasites per individual – the same density as for adults.

In conclusion, our study of variation in parasite load did not reveal any negative impact of *E. euryalis* on the body condition of bat neonates. This was true despite the marked variation in parasite load during the early growth of the neonates. We observed significantly higher numbers of mites on neonates during the first three weeks of the post-natal period compared with the numbers of mites on lactating and pregnant females. Soon after the neonates experienced this early increase in parasite load, the load suddenly decreased. This pattern is consistent with other findings such as those on the intensity and prevalence of ectoparasite infestation in neonates and juveniles reported by Eckstein and Hart (2000). Such a difference may be attributable to the inability of bat neonates to groom themselves in the early post-natal period as well as the rapid vertical transmission of the ectoparasites from parent to offspring. The very low intensity of infestation of ectoparasites in non-pregnant females may also be related to their isolation from reproducing females.

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