

Parasitic and commensal epibionts of the Chaco side-necked turtle (*Acanthochelys pallidipectoris*) and the scorpion mud turtle (*Kinosternon scorpioides scorpioides*) in Argentina

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Abstract. This study describes the algal coverage and commensal and parasitic epibionts in two species of freshwater turtles from the Chaco Ecoregion, Argentina, *Acanthochelys pallidipectoris* and *Kinosternon scorpioides scorpioides*. The leech family Glossiphoniidae (*Haementeria* and *Helobdella*) were the dominant animal epibionts for both species, constituting the first records of leech infestation for the species *A. pallidipectoris* and subspecies *K. s. scorpioides* (second record for the species). The tick *Amblyomma argentinae* was found attached to several *A. pallidipectoris* individuals—the second record for this host and a new geographic report for the province of Salta. Most turtles of both species presented a variable degree of algal coverage on the dorsum of the carapace. We analyzed how the type, prevalence and abundance of the epibionts found are a product of their distribution area and lifestyle, frequency of terrestrial excursions, and basking mode (documenting for the first time aerial basking for *A. pallidipectoris*) of the species studied herein.

Keywords. Algal coverage; Freshwater turtles; Leeches; Ticks.

INTRODUCTION

The composition of carapace-associated fauna can reflect the ecological habits of turtle species. For example, fully aquatic turtles are commonly ectoparasitized by leeches of the genus *Placobdella* Blanchard, 1893, among other lesser-known genera (Richardson, 1969, whereas semi-aquatic turtles may host ticks, leeches, or both (Dantas-Torres et al., 2009; Garcés-Restrepo et al., 2013). Studies on parasitic and commensal epibionts associated with turtle carapaces are well established for marine turtles (Caine, 1986; Barry et al., 1989; Frick and Slay, 2000; Greenblatt et al., 2003; Kitsos et al., 2005), but research on epibionts in freshwater turtles has primarily focused on ectoparasites, particularly leeches (Ernst and Barbour, 1972; Sawyer, 1972, 1986; Dodd, 1988). The ectocommensal epibiont fauna and filamentous chlorophytic algal coverage on turtle carapaces remain comparatively understudied (Hulse, 1976; Soyulu et al., 2006), especially in species from the Southern Hemisphere (Ferreira-Yuki et al., 1993; Marques et al., 2008; Novelli et al., 2009; Burgin and Betts, 2012; Huckembeck and Quintela, 2013; Seixas et al., 2014; Wu and Bergey, 2017; Mascarenhas et al., 2018).

Cagle (1950) and others (e.g., Boyer, 1965; Ernst, 1971; McAuliffe, 1977; Dodd, 1988) proposed the basking hypothesis as a mechanism by which turtles remove epibionts from their carapaces. This could help explain the observed reduction in leech intensity in species that bask

frequently. According to the basking hypothesis, aquatic basking species are expected to host a greater leech load than aerial basking species, as the latter spend more time exposed to air, potentially desiccating attached ectoparasites. However, in a study comparing populations of *Chelydra serpentina* Linnaeus, 1758 with differing basking frequencies, Brooks et al. (1990) found that populations that bask more frequently actually exhibited higher leech intensities—an observation that appears to contradict the basking hypothesis. The authors also noted that leeches were concentrated in the few areas of the carapace not exposed during basking (e.g., limb sockets), suggesting that basking could have a localized effect on leech behavior. They further proposed that host body size might be an alternative explanation, as larger turtles offer more surface area and refuge for ectoparasites.

Building on those findings, Ryan and Lambert (2005) offered an alternative perspective on the basking hypothesis, focusing on leech desiccation. Comparing leech intensity and prevalence in bottom-dwelling (*Sternotherus odoratus* [Latreille in Sonini and Latreille, 1801]) and aerial-basking (*Graptemys geographica* Le Sueur, 1817) turtles under both field and experimental conditions, they proposed that the desiccation hypothesis operates at an ultimate, evolutionary level. In this view, leeches of the genus *Placobdella* preferentially select hosts that are less likely to bask, thereby minimizing their risk of desiccation. In light of these findings, we suggest that the amount of

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time a turtle spends in and out of water may also influence the abundance and prevalence of various epibionts—including ticks—by shaping the environmental exposure and survival conditions of these organisms.

The present study describes algal coverage, as well as the abundance and prevalence of various parasitic and commensal animal epibionts, on two sympatric species of aquatic turtles: the Chaco side-necked turtle, *Acanthochelys pallidipectoris* (Freiberg, 1945), and the scorpion mud turtle, *Kinosternon scorpioides scorpioides* Linnaeus, 1766. *Acanthochelys pallidipectoris* is currently listed as Endangered internationally (IUCN Red List; Vinke and Vinke, 2022) and Threatened in Argentina (Prado et al., 2012). In contrast, *K. s. scorpioides* lacks an international conservation assessment and is considered Insufficiently Known in Argentina (Prado et al., 2012). In Argentina, as in other areas of the Chaco, both species spend most of the year buried or semi-buried, becoming active during the short but intense rainy periods of late spring and early autumn (Monguillot and Fabius, 1993; Vinke and Vinke, 2001; Vinke et al., 2011). During these periods, turtles move across the forest floor in search of suitable water bodies for feeding and breeding. The absence of confirmed basking observations suggests that *A. pallidipectoris* likely engages in aquatic basking (Yanosky et al., 2000), whereas anecdotal reports indicate that *K. s. scorpioides* bask aerially, although the behavior appears to be extremely rare (Buskirk, 2007; Berry and Iverson, 2011).

Based on these subtle ecological differences, we expected to observe differences in both algal coverage and the abundance and prevalence of epibiont fauna between *Kinosternon scorpioides scorpioides*—which presumably engages in aerial basking—and *Acanthochelys pallidipectoris*—which presumably engages in aquatic basking—across the Humid Chaco (characterized by greater water availability) and Dry Chaco (characterized by water scarcity) ecoregions.

MATERIALS AND METHODS

The percentage of algal coverage, as well as the abundance and prevalence of commensal and parasitic epibionts, was recorded for *Acanthochelys pallidipectoris* and *Kinosternon scorpioides scorpioides*. Sampling took place during the southern spring and summer months (September–March) in 2016 and 2018–2020 across the Dry (eastern Salta, western Chaco and Formosa provinces) and Humid (northeastern Santa Fe province) Chaco ecoregions of northern Argentina, covering slightly more than 200 sampling locations. Turtles were captured using trawl nets or by muddling in two types of aquatic environments: (1) artificial ponds constructed to collect rainwater for livestock use near residences, and (2) naturally flooded areas surrounded by forest. Additionally, some specimens were opportunistically collected while crossing roads on rainy days. Each turtle was sexed, weighed (W), measured for straight-line carapace length (SCL), photographed, geolocated, and marked following Cagle (1939). Prior to release

at the point of capture, individuals were thoroughly examined for the presence of parasitic and commensal epibionts on the body surface. The specific body regions where ticks were found were recorded in detail, while leeches and other animal epibionts were recorded in aggregate. Samples were preserved in 70% ethanol and later examined in the laboratory under a stereoscopic microscope.

Ticks were identified to species using Nava et al. (2017), and total body length (both sexes) and scutum length (females only) were measured following Voltzit (2007). Juvenile leeches were excluded, and adult leeches were identified to genus following Ringuelet (1985), Sawyer (1986), and Marchese et al. (2020). Other epibionts were identified to at least family using regional keys for aquatic macroinvertebrates (Domínguez and Fernández, 2009; Núñez et al., 2010). For each epibiont category, two metrics were calculated: abundance (total number of individuals per turtle species) and prevalence (percentage of individuals of each species hosting the epibiont category). Algal coverage was estimated from field photographs and categorized into four coverage intervals (1–25%, 26–50%, 51–75%, and 76–100%) as proposed by Rodrigues and Silva (2015). Recaptured individuals were excluded from these analyses. Voucher specimens of representative animal epibionts were deposited in the Invertebrate Collection of the Museo de La Plata, Buenos Aires Province, Argentina (MLP-Ar. 20498; MLP-Oi. 4213–4217).

RESULTS

Acanthochelys pallidipectoris

Acanthochelys pallidipectoris was recorded at seven localities across two provinces. A total of 68 turtles were captured in Salta Province—specifically in the vicinity of Las Lajitas and Joaquín V. González—including 6 unsexed juveniles, 28 males, and 34 females. Among these, 9 individuals were recaptured once, with a one-year interval between captures. In Santa Fe Province, 22 turtles were recorded—1 hatchling, 3 unsexed juveniles, 6 males, and 12 females—across the areas of Vera, Garabato, Intiyaco, Toba, and Ogilvie; one individual was recaptured three years after the initial capture. Including recaptures, the total sample comprised 100 individuals.

The overall prevalence of epibiont fauna among these turtles was 25%, with the majority of records corresponding to leeches and ticks (in that order of frequency). Only three turtles from Salta hosted other types of epibionts: a non-biting midge larva, a coleopteran larva, and limpet snails (Table 1). Just five turtles carried two different categories of epibionts simultaneously.

Leeches and ticks on *Acanthochelys pallidipectoris* were found in both artificial ponds designed for livestock water storage near human dwellings (often shared with pigs and cattle; Fig. 1A) and in naturally flooded areas within a forest matrix, with or without cattle presence and varying degrees of surrounding forest cover (Figs. 1B–C). The midge larva, one of the limpets, and the coleopteran larva

Table 1. Abundance (A), prevalence (P%) and locality (L) for each commensal and parasitic epibiont associated with the freshwater turtle *Acanthochelys pallidipectoris* in Argentina. LL = Las Lajitas; JVG = Joaquín V. González; G = Garabato; SA = Salta province; SF = Santa Fe province.

Epibiont	<i>Acanthochelys pallidipectoris</i>		
	A	P (%)	L
Hirudinea Savigny, 1822			
Glossiphoniidae			
<i>Haementeria</i> spp.	2	2.0	LL, JVG (SA)
<i>Helobdella</i> spp.	150	17.0	LL, JVG (SA); G (SF)
Acari Leach, 1817			
Ixodidae Koch, 1844			
<i>Amblyomma argentineae</i>	11	6.0	LL, JVG (SA)
Diptera Linnaeus, 1758			
Chironomidae Newman, 1834			
<i>Chironomus</i> sp.	1	1.0	JVG (SA)
Coleoptera Linnaeus, 1858			
Hydrophilidae Latreille, 1802			
<i>Berosus</i> sp.	1	1.0	LL (SA)
Gastropoda Cuvier, 1795			
Ancyliidae Rafinesque, 1815			
<i>Hebetancylus</i> sp.	2	2.0	LL (SA)
Total	167		

were observed only on turtles captured in natural flooded habitats with variable forest cover (Figs. 1B–C). The remaining limpet was recorded on a turtle from an artificial pond.

All ticks were collected from the Dry Chaco region in Salta Province. Eleven specimens of *Amblyomma argentineae* Neumann, 1905 were recorded (Fig. 2), including four males (mean length = 5.1 mm; mean breadth = 4.2 mm) and seven females (mean length = 5.6 mm; mean breadth = 4.7 mm; mean scutum length = 2.6 mm; mean scutum breadth = 3.0 mm). These ticks were found on one male and five female turtles. Of the total ticks, two were collected from turtles captured in artificial ponds and 9 from those in natural ponds. Two turtles carried three ticks each—two females and one male in both cases. One of these turtles had ticks on the neck and both hind limbs, while the other had one tick in the right forelimb socket and two in the right hind limb socket. Another turtle carried two ticks on the skin of the right hind limb socket. Finally, three turtles carried a single tick each, with attachment sites differing among individuals: right hind limb, left hind limb, and neck. When combining *Acanthochelys pallidipectoris* specimens from both Santa

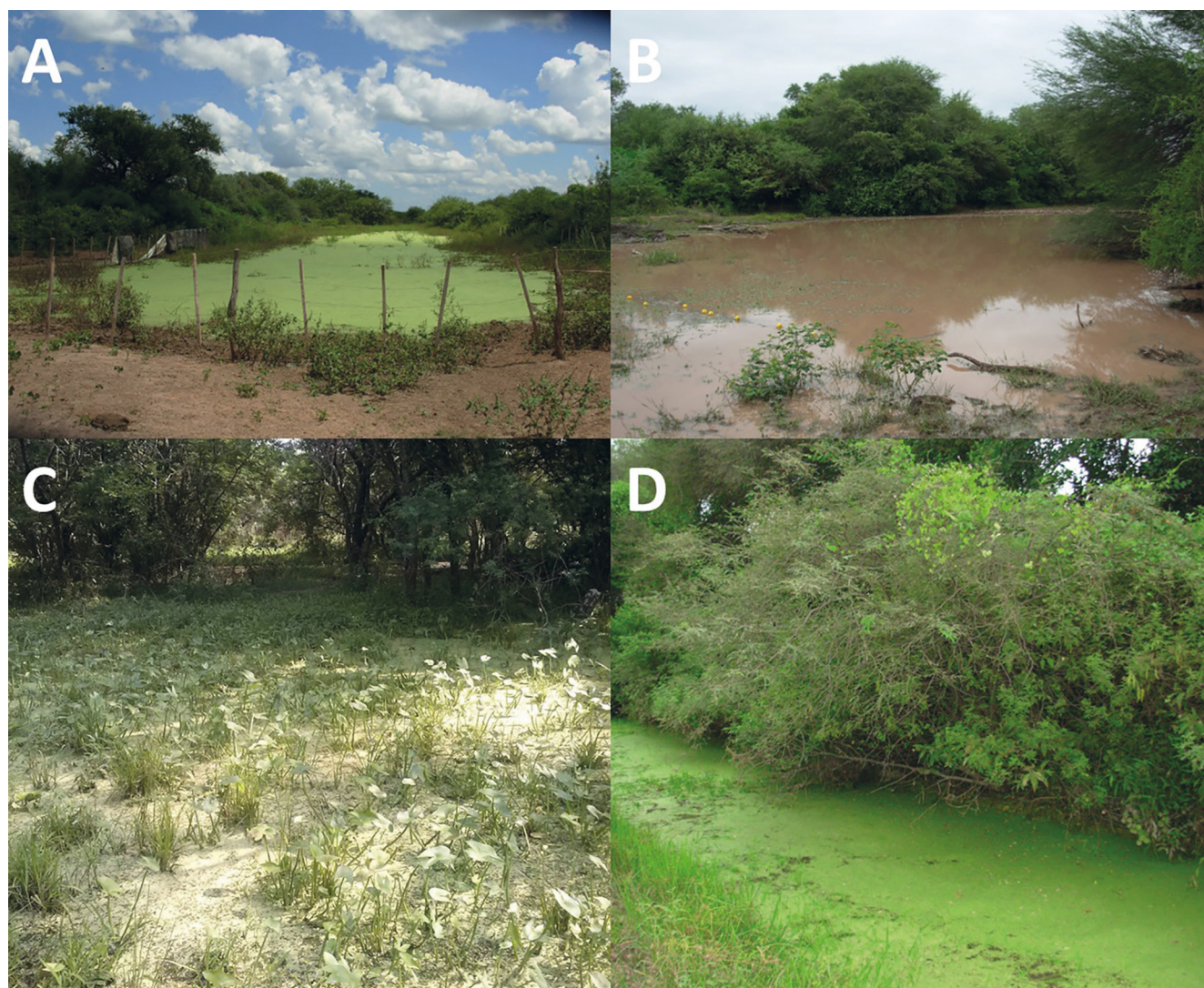


Figure 1. Types of environments where turtles were found in Argentina: (A) peridomestic water reservoirs in Salta province, (B) natural flooded soils in Salta and (C) Santa Fe provinces, (D) ditches alongside unpaved secondary roads in Salta province. Photos by MJC.

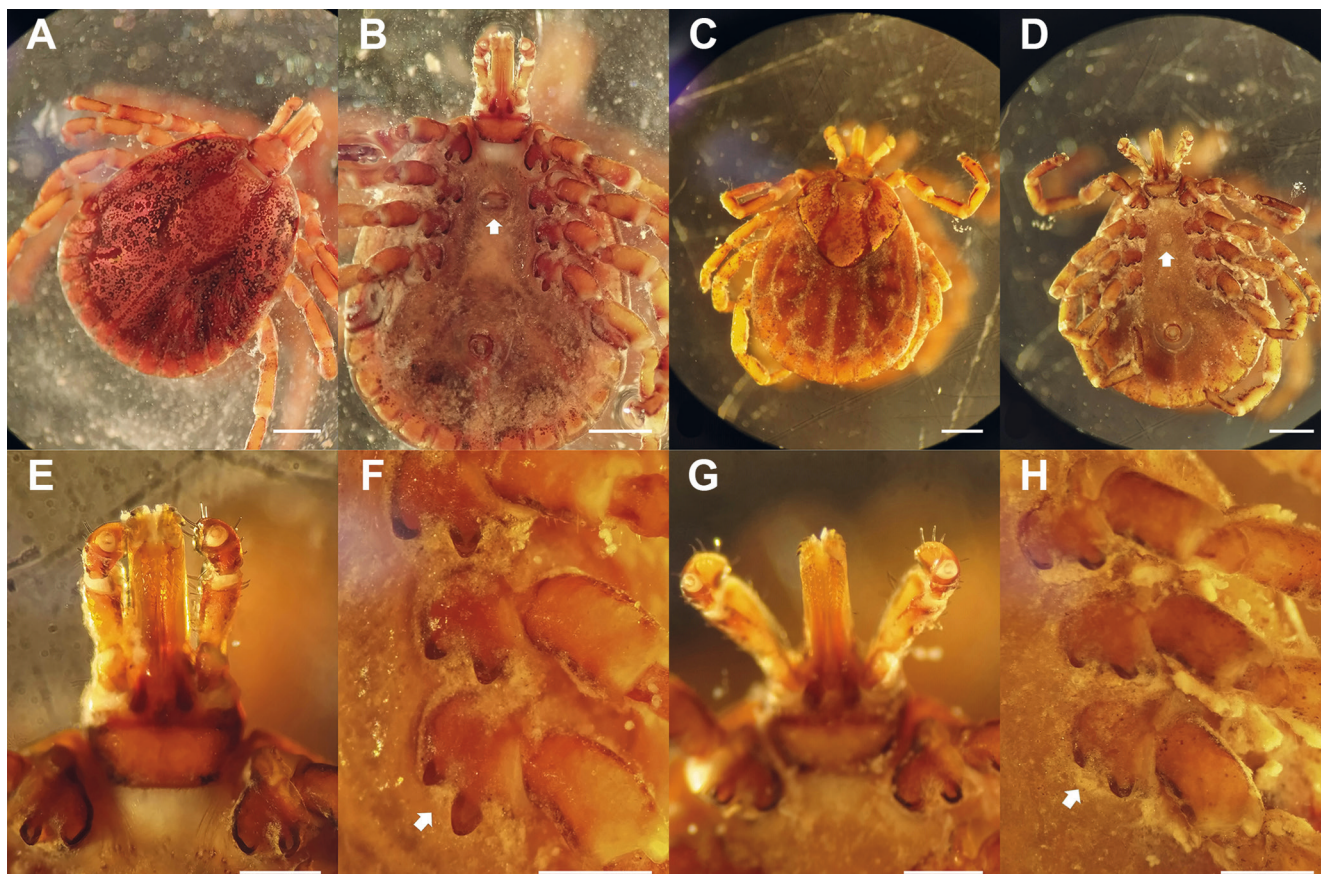


Figure 2. Male (A–B, E–F) and female (C–D, G–H) *Amblyomma argentiniae* showing dorsal (A, C) and ventral (B, D) views of the body, ventral views of the capitulum (E, G), and details of the coxae II–IV (F, H). Note the oval body size with ornate scutum (A, C) and the spatulate hypostome with dental formula 3/3 (E, G), as is typical of the species, the absence of marginal groove and carena in males (A), and the absence of chitinous tubercles on the postero-body in females (C). Arrows indicate the comma-shaped genital pore at the level of coxae II (B, D) and the external spurs of coxa IV, which are larger than the internal spurs (F, H). Scale bars: A–D (1 mm); E–H (0.5 mm). Photos by MJC.

Fe and Salta, tick prevalence was 6%. Considering only the Salta specimens, prevalence increased slightly to 7.79%. All ticks were attached to soft body parts of the turtles, including the neck, forelimbs, hind limbs, and corresponding limb sockets on both sides (Figs. 3A–B).

A total of 152 leeches of two genera of the family Glossiphoniidae Vaillant, 1890—*Haementeria* spp. and *Helobdella* spp. (Table 1)—were recorded on turtles from both the Humid Chaco (Santa Fe Province; *Helobdella* Blanchard, 1896 only) and the Dry Chaco (Salta Province; both genera), resulting in an overall leech prevalence of 20% across both regions (Figs. 3C–D). The highest abundance (136 individuals) and prevalence (22.1%) were observed in turtles from Salta, particularly those captured in peridomiciliary ponds used to store water for cattle. Of these, 127 leeches (approximately 57%) were found on just four turtles.

In Salta, leeches were found on 17 adult turtles—12 males (SCL = 147–169 mm; weight = 389–619 g) and 5 females (SCL = 146.5–159.5 mm; weight = 481–631 g). In most cases, leeches were located either exclusively on hard body parts (47.1%) or soft body parts (17.6%), while 35.3% of individuals hosted leeches on both regions simultaneously.

In Santa Fe, 20 *Helobdella* leeches were recorded, including individuals attached to the tail and limb

sockets of two juveniles (SCL = 72 mm, weight = 35 g; and SCL = 117 mm, weight = 188 g) and on the carapace of an adult male (SCL = 165 mm, weight = 564 g). Leech prevalence in Santa Fe was lower, at 12%. Most individuals ($n = 16$) were found on a single juvenile male encountered crossing a road on a rainy day. The remaining four leeches were collected from two turtles captured in natural flooded areas surrounded by typical Chaco forest.

Almost all turtles from both provinces exhibited some degree of filamentous algal coverage (95.6%, excluding recaptures). The only exceptions were three juveniles (70–77 mm SCL)—two from Salta and one from Santa Fe—and one hatchling from Santa Fe. The overall prevalence of algal coverage was similar between provinces: 97.1% of turtles from Salta (Dry Chaco ecoregion) and 90.9% from Santa Fe (Humid Chaco ecoregion) showed some level of algal growth. In more than 50% of turtles from both provinces, algal coverage fell within the highest categories (50–75% and 76–100%), a trend that was particularly pronounced in turtles from Santa Fe (85% of individuals) compared to those from Salta (53%; Figs. 4A–B).

In 2018, the landowner of one of the sampling sites in Salta Province reported regularly observing a turtle basking on a large log protruding from the water surface near the edge of a pond from 10:00–11:00. Subsequently, at 11:30 on 19 March 2019, we observed an individual of

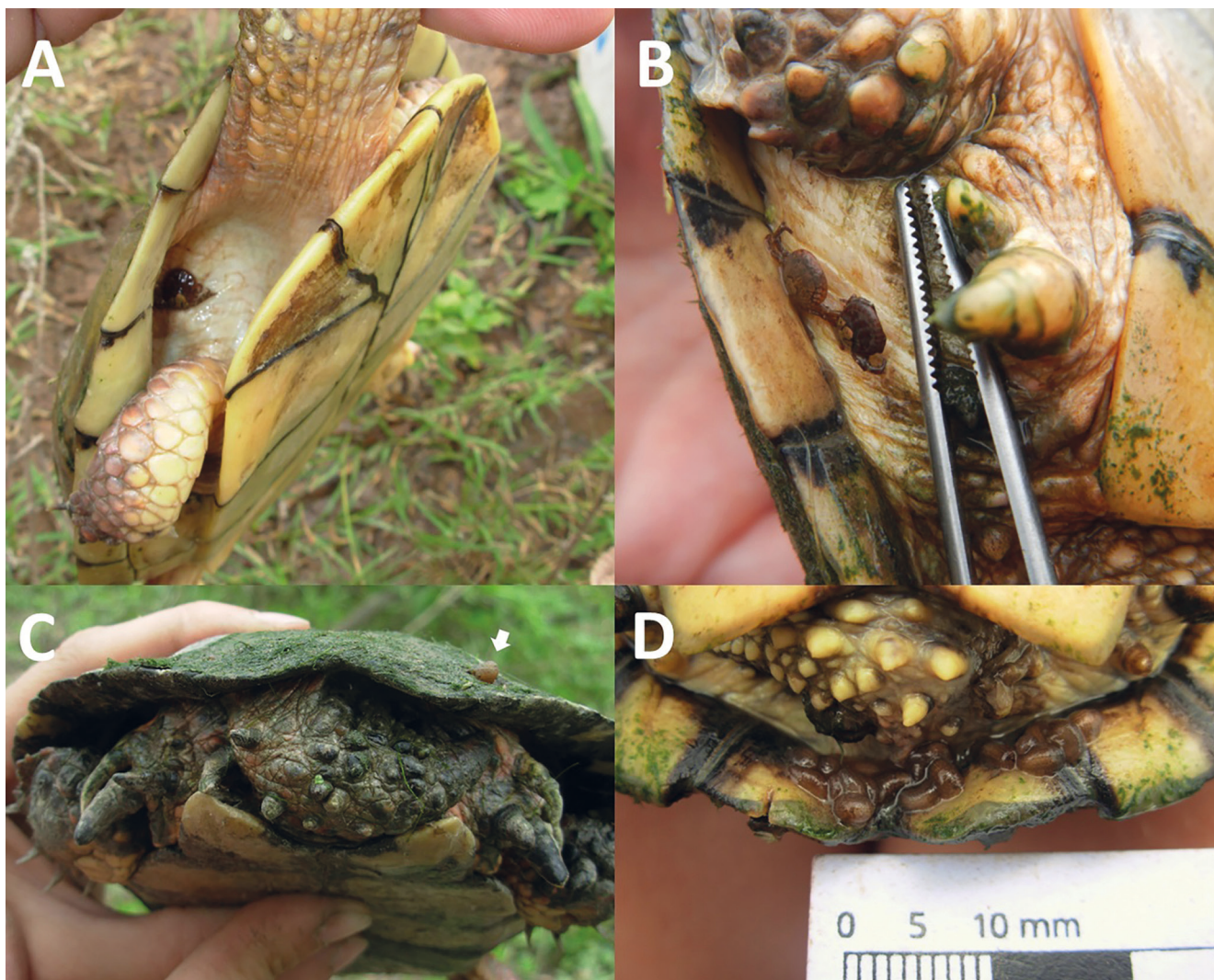


Figure 3. Specimens found on *Acanthochelys pallidipectoris*: *Amblyomma argentiniae* attached to (A) the right anterior limb socket and (B) the dorsal surface of the right thighs of two females in Salta. Leeches (Glossiphoniidae) attached to (C) the shell of a male and (D) the ventral side of the last marginal plates on the tail socket of a juvenile in Santa Fe. Photos: MJC.

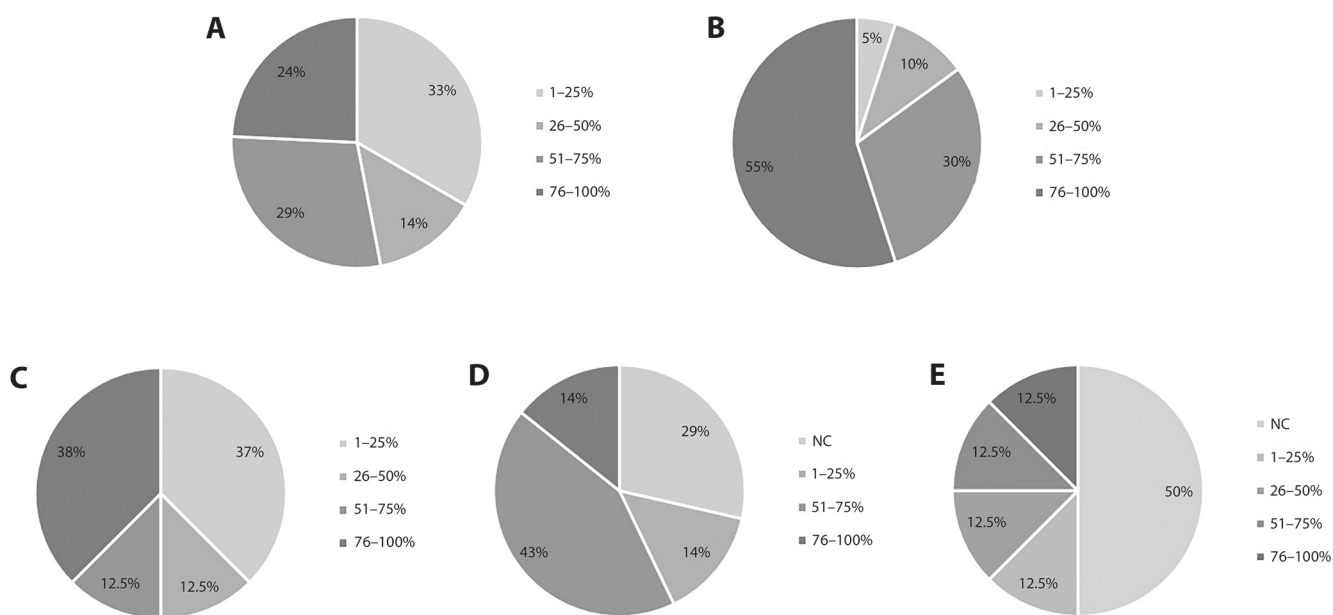


Figure 4. Percentage categories of algal coverage in *Acanthochelys pallidipectoris* from (A) Salta and (B) Santa Fe, and for *Kinosternon scorpioides scorpioides* from (C) Salta, (D) Formosa and (E) Chaco. NC = Not covered.

Acanthochelys pallidipectoris engaging in aerial basking on a log located in an artificial peridomiciliary pond in Salta. As we attempted to approach quietly through vegetation to take closer photographs, the turtle detected our presence at approximately 5 m and quickly dove into the water. Prior to retreating, the turtle was seen resting with its plastron against the log, limbs fully extended and hanging, and its head and neck raised and flexed upward—characteristic of aerial basking posture.

Kinosternon scorpioides scorpioides

Twenty-three individuals of *Kinosternon scorpioides scorpioides* were captured, including eight from Salta (four males and four females) in the surroundings of Las Lajitas, Joaquín V. González, and Misión Chaqueña, eight from Chaco (three males and five females) near Miraflores and Paraje Las Hacheras, and seven from Formosa (two unsexed juveniles, two males, and three females) near Laguna Yema. The only epibionts recorded on these turtles were leeches of the family Glossiphoniidae (*Haementeria* spp. and *Helobdella* spp.). Overall leech abundance and prevalence across the three provinces were three individuals and 8.7%, respectively. Two leeches (one of each genus) were found on the carapace of a single female (SCL = 140 mm; weight = 400 g) captured in a ditch near Misión Chaqueña, Salta (prevalence = 12.5%; Fig. 1D). Another leech—unidentified due to damage during collection—was found attached to the right hind limb of a female (SCL = 164 mm; weight = 626 g) captured in a peridomiciliary pond near Miraflores, Chaco (prevalence = 12.5%).

Across all turtles from the three provinces, 73.9% showed some degree of filamentous algal coverage. Turtles from Salta had the highest incidence, with 100% presenting algal growth. In contrast, prevalence was slightly lower in Formosa (71.4%) and considerably lower in Chaco (50%).

Patterns of algal coverage also varied by province. In Salta, turtles predominantly showed either low (1–25%) or high (76–100%) algal coverage (three turtles in each category), with intermediate categories (26–50% and 51–75%) represented by only one individual each (Fig. 4C). In contrast, turtles from Formosa were mostly in the intermediate category (51–75%, 3 individuals), while the extreme categories (1–25% and 76–100%) each had only one individual (Fig. 4D). In Chaco, each algal coverage category was represented by a single turtle (Fig. 4E).

DISCUSSION

This study provides new insights into freshwater turtle epibionts by examining two phylogenetically distant species with similar habitat use and behavior—both bottom-dwelling and exhibiting a semi-aquatic lifestyle imposed by the seasonal drying of water bodies. As a result of our research, we report a new geographic record and describe epibiont assemblages that vary in species

composition, prevalence, and abundance among turtle populations. These aspects are addressed in greater detail in the following sections.

Despite the genus *Amblyomma* being relatively diverse in the Southern Cone (25 species) and known to parasitize reptiles (Nava et al., 2017; Guglielmo et al., 2021, 2023), reports of *Amblyomma* ticks parasitizing freshwater turtles in Argentina remain scarce (Estrada-Peña et al., 2019). The first such record in the country was by Ivancovich and Luciani (1992), who reported two females of *Amblyomma argentinae* parasitizing a single individual of *Phrynops hilarii* (Duméril and Bibron, 1835) in northwestern Formosa Province. This record was likely cited in a later distributional account by Guglielmo et al. (2001), though it only referenced the host at the genus level (*Phrynops* sp.) and gave a vague locality (“Chaco region”). Attempts to retrieve more detailed information from the original authors and from relevant collections (e.g., INTA Rafaela, Santa Fe Province) were unsuccessful.

Until recently, the only additional record of *Amblyomma argentinae* parasitizing *Acanthochelys pallidipectoris* in Argentina was provided by García et al. (2023a), published during the review process of the present study and referring to a locality in Chaco Province. All other reports of *Amblyomma* spp. parasitism on freshwater turtles distributed in Argentina refer to populations outside the country (Table 2). Moreover, only a subset of these records is based on field observations of wild animals actively searched for ticks (Ivancovich and Luciani, 1992; Guerra et al., 2000; Pereira et al., 2007; Witter et al., 2016; Martins et al., 2020; García et al., 2023a). Others are based on captive individuals (Amorim et al., 1999; Burridge and Simmons, 2003; Teixeira et al., 2003), or wild specimens examined under uncertain conditions (Martins et al., 2015), raising questions about the reliability of host-parasite associations under natural conditions. There are also records of unidentified ticks lacking further details (Table 2).

The 1992 record of two female ticks on *Phrynops hilarii* lacks a voucher specimen and contains no host verification, making taxonomic confirmation impossible. We attempted to verify the identity of the host by contacting one of the original authors (C.A. Luciani) and the curator of the collection at INTA Colonia Benítez, Chaco Province, but were unsuccessful. Therefore, our record of *Amblyomma argentinae* parasitizing *Acanthochelys pallidipectoris* constitutes the second confirmed case of this host-parasite association for the species and represents a new geographic record for Salta Province.

Amblyomma argentinae is known to parasitize various reptiles, including snakes, lizards, and turtles, and has even been recorded on an amphibian (Debárbora et al., 2015; Nava et al., 2017; Guglielmo et al., 2021; García et al., 2023b). However, tick abundance and prevalence on *Acanthochelys pallidipectoris* were low compared to levels reported for its primary host, *Chelonoidis chilensis* (Gray, 1870), on which up to 71 ticks have been found on a single individual (Richard and Guglielmo, 1988). This suggests that *Ac. pallidipectoris* likely plays a minor

Table 2. Bibliographic records of ticks and leeches in freshwater turtle species present in Argentina. NI = Not Identified.

Epibiont	Host	Country	Reference
Acari			
Ixodidae			
<i>Amblyomma argentinae</i>	<i>Phrynops hilarii</i>	Argentina	Ivancovich and Luciani, 1992
<i>A. argentinae</i>	<i>Acanthochelys pallidipectoris</i>	Argentina	García et al., 2023a
<i>Amblyomma dissimile</i> Koch, 1844	<i>P. Geoffroanus</i>	Brazil	Witter et al., 2016
<i>A. dissimile</i>	<i>Kinosternon scorpioides</i>	Brazil; Colombia; Guatemala	Amorim et al., 1999; Burrige and Simmons, 2003; Teixeira et al., 2003; Bedoya-Cañón et al., 2018
<i>Amblyomma rotundatum</i> Koch, 1844	<i>Hydromedusa tectifera</i>	Brazil	Martins et al., 2015
<i>A. rotundatum</i>	<i>Mesoclemmys vanderhaegei</i> (Bour, 1973)	Brazil	Witter et al., 2016
<i>A. rotundatum</i>	<i>Trachemys dorbigni</i> (Duméril and Bibron, 1835)	Brazil	Martins et al., 2020
<i>A. rotundatum</i>	<i>K. s. scorpioides</i>	Brazil	Amorim et al., 1999; Guerra et al., 2000; Pereira et al., 2007
Ixodidae NI	<i>K. s. scorpioides</i>	Paraguay	Buskirk, 2007
Ixodidae NI	<i>A. pallidipectoris</i>	Argentina	Vinke et al., 2011
Hirudinea			
Glossiphoniidae			
<i>Haementeria cheloniae</i>	<i>P. hilarii</i>	Uruguay; Argentina	Ringuelet, 1985
<i>H. cheloniae</i>	<i>Hydromedusa tectifera</i>	Uruguay	Ringuelet, 1985
<i>H. brasiliensis</i> (Weber, 1915)	<i>P. Geoffroanus</i>	Brazil	Ringuelet, 1985
<i>Haementeria</i> sp.	<i>P. Geoffroanus</i>	Brazil	Santana et al., 2020
<i>Placobdella bistrata</i> Pinto, 1920	<i>P. Geoffroanus</i>	Brazil	Brites and Rantin, 2004
Rhynchobdellida NI	<i>H. tectifera</i>	Brazil	Huckembeck and Quintela, 2013

role in maintaining tick populations and may represent a case of spillover to an ecologically associated host—similar to other instances of low-prevalence tick parasitism (Guglielmone et al., 2001). Further studies are needed to clarify the role of this turtle species in the life cycle of *Amblyomma* ticks.

Leeches were the most abundant and prevalent organisms among the aquatic fraction of animal epibionts. The genus *Helobdella* constituted the majority of aquatic epibionts on both turtle species, while leeches of the genus *Haementeria* de Filippi, 1849, immature midges of the genus *Chironomus* Meigen, 1803 (previously reported on *Phrynops Geoffroanus* Schweigger, 1812 in Brazil by Marques et al., 2008, and *Hydromedusa tectifera* Cope, 1870 by Huckembeck and Quintela, 2013), limpets, and aquatic coleopteran larvae—both reported here for the first time on South American turtles—represented a minor fraction.

Leeches of the genus *Helobdella* are known to feed on hemolymph and soft tissues of invertebrates (Christoffersen, 2009; Ocegüera-Figueroa, 2012), while only species of *Haementeria* are described as hematophagous (Ocegüera-Figueroa, 2012). A summary of leech species recorded parasitizing freshwater turtles in Argentina is presented in Table 2.

Unfortunately, we were unable to confirm whether the *Haementeria* specimens found on *Acanthochelys pallidipectoris* and *Kinosternon scorpioides scorpioides* from Salta correspond to *H. cheloniae* Ringuelet, 1985 or another species. Nonetheless, irrespective of species identification, our records represent novel findings: (1) the leeches recorded on *K. s. scorpioides* constitute the first case of leech infestation on this subspecies and the second for the species—the first being *Placobdella*

ringueleti López-Jiménez and Ocegüera-Figueroa, 2009 on *K. s. albogulare* Duméril and Bocourt, 1870 in Costa Rica (Ocegüera-Figueroa and Pacheco-Chavez, 2012), and (2) the leeches found on *A. pallidipectoris* represent the first record of leech infestation for the species.

The turtle carapace could be considered analogous to a coral reef—albeit a mobile one—where the assemblages of animal epibionts and colonies of chlorophytic algae form an ecosystem in themselves (Tracchia, 2018). As such, these epibiotic communities might serve as ecological indicators. The dominance of certain epibiont species over others, along with variation in algal coverage, could reflect differences in turtle behavior and habitat use. Current knowledge indicates that *Acanthochelys pallidipectoris* and *Kinosternon scorpioides* are highly adapted to the pronounced dry season and extended droughts characteristic of the Chaco region (Berry and Iverson, 2011; Vinke et al., 2011). Both species exhibit similar habits: they undergo terrestrial dormancy during dry periods, dwell on the bottom of shallow water bodies, and presumably perform aquatic basking (*A. pallidipectoris*) or, in the case of *K. s. scorpioides*, rarely engage in aerial basking.

Given these ecological similarities, we were surprised to observe marked differences between the two species in terms of algal coverage and epibiont assemblages—even among individuals sharing the same pond. These differences were also evident among populations of the same species, particularly *Acanthochelys pallidipectoris*, between the Dry Chaco (presence of ticks, higher leech abundance and prevalence, greater epibiont diversity) and the Humid Chaco (absence of ticks, lower leech abundance and prevalence, reduced epibiont diversity).

As an initial interpretation, we suggest that the degree of terrestrial activity can be inferred from the type

and quantity of epibionts present on different body regions. Accordingly, the absence of ticks on *Kinosternon scorpioides scorpioides*, even in environments where *Acanthochelys pallidipectoris* harbored ticks, could indicate lower terrestrial activity in the former species—or, conversely, to higher terrestrial exposure in *A. pallidipectoris*, especially among females. Notably, among the eight ticks recorded, five were found on females and only three on a single male.

Tick prevalence in tortoises has been reported to be higher in degraded environments than in more pristine habitats (Ehlers et al., 2016). However, in our study, the opposite pattern was observed for *Acanthochelys pallidipectoris* in Salta, where tick prevalence was higher (10%) in individuals from natural flooded soils surrounded by forest than those from artificial peridomestic ponds (4%). In contrast, the pattern of leech infestation aligned more closely with the findings of Ehlers et al. (2016), with higher prevalence (50% vs. 8%) and abundance in turtles from cattle-impacted ponds.

For *Kinosternon scorpioides scorpioides*, leech infestation was recorded in two individuals—one from a cattle-impacted pond in Chaco and another from a ditch in Salta. Similarly, in Santa Fe, three *A. pallidipectoris* individuals showed leech infestations, although most of the leeches were found on a single juvenile observed crossing a road, making the relationship between habitat and infestation less clear in these cases.

The marked differences in tick prevalence observed between eastern and western populations of *Acanthochelys pallidipectoris* warrant further investigation. As noted above, *Amblyomma argentiniae* is primarily associated with terrestrial reptiles and amphibians exhibiting a strong terrestrial tendency, such as toads of the genus *Rhinella* Fitzinger, 1826, with the highest abundance and prevalence reported in Dry Chaco populations of the tortoise *Chelonoidis chilensis* (Ivancovich and Luciani, 1992; Guglielmone et al., 2001). All known collections of *A. argentiniae* originate from dry areas within the Chaco domain (according to the classification used by Guglielmone et al., 2001), and its abundance decreases toward the southern and eastern parts of this region, mirroring the distributional limits of *C. chilensis*. This pattern could explain the absence of *A. argentiniae* in our Humid Chaco samples of *A. pallidipectoris* from northeastern Santa Fe, where *C. chilensis* is rare and the tick is considered scarce (Estrada-Peña et al., 2019).

In contrast to findings from the northern hemisphere, where mud and musk turtles often host high leech loads (Ernst, 1986), we observed an extremely low leech load in *Kinosternon scorpioides scorpioides*: only three leeches were found on two of the 23 individuals examined. This low infestation rate, along with the absence of other epibionts, calls for additional explanations beyond those proposed for the absence of ticks in this species. The “desiccating leech hypothesis” (Ernst, 1971) remains a plausible explanation, although its validity has been challenged by experimental data (Ryan and Lambert, 2005) and evidence suggesting leeches might be more desiccation-resistant

than previously believed (Vogt, 1979). Alternatively, interspecific or conspecific cleaning interactions could influence epibiont prevalence. Previous studies have documented bird–turtle cleaning associations (Vogt, 1979) and turtle–turtle cleaning behaviors (Krawchuk et al., 1997), which might also play a role. Supporting this hypothesis, preliminary data from fecal and stomach content analyses (Cassano and Alcalde, 2022) of *K. s. scorpioides* individuals included in this study indicate occasional ingestion of leeches and terrestrial mites (species identification pending), suggesting the possibility of conspecific cleaning through incidental or intentional consumption.

Additionally, our direct observation of *Acanthochelys pallidipectoris* engaging in aerial basking challenges the prevailing assumption that the species exclusively basks underwater—an idea likely influenced by the absence of previous basking records. Our sighting, combined with anecdotal reports from local residents who observed turtles basking alone on logs at midday in ponds inhabited solely by *A. pallidipectoris*, suggests that aerial basking may occur, albeit infrequently. This pattern mirrors that observed in *Kinosternon scorpioides scorpioides*, for which aerial basking is also considered rare. Aerial basking is hypothesized to serve several functions, including drying of the shell and skin and reducing the algal load (Cagle, 1950; Boyer, 1965; Shealy, 1976). Although *K. s. scorpioides* exhibited a lower overall percentage of individuals with algal coverage than *A. pallidipectoris* (73.9% vs. 95.6%), both species showed a high degree of coverage, consistent with the infrequent observation of aerial basking.

In conclusion, our findings highlight the value of epibiont communities as indicators of host ecology and underscore the complexity of host–epibiont relationships in freshwater turtles. We emphasize the need for further research to clarify these relationships and to address other factors—such as reproductive behavior, sex-based differences, and the physicochemical properties of aquatic habitats—that may influence epibiont diversity and dynamics. Expanding our understanding of these associations will contribute not only to the ecological knowledge of these turtle species but also to broader questions concerning freshwater ecosystem interactions and health.

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