

PARASITISATION AND LOCALISATION OF TICKS (ACARI: IXODIDA) ON EXOTIC REPTILES IMPORTED INTO POLAND

Magdalena Nowak

Department of Invertebrate Zoology and Parasitology, Institute of Biology, Pedagogical University of Cracow, Poland

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Abstract: As a result of examinations, the following species of ticks have been found parasitising on *Python regius* brought from Africa to Poland: *Amblyomma latum*, *Amblyomma transversale*, *Amblyomma* spp., on *Varanus exanthematicus*: *Amblyomma exornatum*, *Amblyomma flavomaculatum*, *Amblyomma latum*, *Amblyomma nuttalli*, *Amblyomma* spp., on *Varanus salvator* brought from Indonesia to Poland: *Amblyomma varanensis*. There were 58 specimens of monitor lizard (*V. salvator* and *V. exanthematicus*) and 92 specimens of python (*P. regius*) examined, with the selected locations of parasitisation by the ticks on the host's body described in detail. Among the 434 specimens of tick collected from the monitor lizards, the majority parasitised the host's limbs (40.5%), on the trunk (29.3%), the head (20.3%), and least on the tail (9.9%). There were 430 tick specimens collected from the bodies of the pythons. They chiefly parasitised the whole length of the back (54.4%) and on the abdominal side of the trunk (29.8%), less numerous in the neighbourhood of the cloaca (5.6%), around the eyes (3.7%), in the nasal openings (0.9%) and the remaining parts of the head (5.6%). Examination of the ticks' location on the reptiles' bodies enabled us to discover the specific parasitisation locations of ticks along the entire length of the host's body. Knowledge of the ticks' location on the bodies of specific reptile species, particularly at a time when the import of exotic animals is growing all over the world, will help in drawing up methods of fighting the parasites, and may give valuable clues to veterinary services and private breeders.

Address for correspondence: Dr Magdalena Nowak, Department of Invertebrate Zoology and Parasitology, Institute of Biology, Pedagogical University of Cracow, Podbrzezie 3, 31-054 Kraków, Poland. E-mail: mnowak@up.krakow.pl

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INTRODUCTION

Private collections of exotic reptiles have enjoyed great popularity in Poland for many years. The exotic animal trade has also developed, specialising in the import of reptiles from various corners of the world, including Southern Europe, Africa, South America, Canada, Australia, and the Malaysian Peninsula. In many Polish cities (Poznań, Wrocław, Łódź, Katowice, Rybnik, Świętochłowice, and Tarnów), there are cyclical terrarian trade fairs, where specialised breeders, professional traders, fans and amateur hobbyists exchange breeding experiences, but above all purchase or order new reptile specimens from wholesalers.

Important companies in the Polish reptile import market work in Upper Silesia and Warsaw. They respect Polish law on the trading of endangered species (CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; the Washington Convention).

Most frequently, these firms are used by pet shop owners, private collectors and zoos. Wholesalers always have popular species of tortoises, lizards and snakes on sale, and they also take special individual orders on specimens of rare species. The reptiles most frequently come from breeding farms and legal hunting in tropical countries. Organisations which sell these animals are required to possess and transfer documentation confirming the legality of

the specimen's origin to the owner; however, many reptiles kept in Polish homes also come from smuggling. The purchasers frequently know nothing of the animals' origin, and are also tempted by the cost of such specimens.

The international trade in living reptiles, which has grown dramatically in the last decade and is also developing strongly in Poland and Central Europe, is important for parasitological and epidemiological reasons. The majority of reptiles are attacked by ticks (Ixodida) – their external parasites. The import of exotic reptiles to Poland for breeding and trading has become a general phenomenon, the most numerous group being African reptiles, chiefly *Python regius* (Shaw, 1802) and *Varanus exanthematicus* (Bosc, 1792). The invasion prevalence of ticks on *P. regius* reaches as high as 81.2%, with 78.7% on *V. exanthematicus* [27]. The advanced construction of terrariums for keeping land animals in conditions maximally close to their natural habitats meet the environmental requirements of both the reptiles and their parasite ticks, and so the probability of growth in the tick population in terrarium conditions is likely.

In Poland, transfer and parasitisation of exotic reptiles imported from various parts of the world has been confirmed by ticks of the genera *Amblyomma* and *Hyalomma*: *Aponomma sphenodonti* (Dumbleton, 1943) (from New Zealand on the tuatara (*Sphenodon punctatus*)) [34]; *Amblyomma exornatum* Koch, 1844 (from Ghana on *V. exanthematicus*); *A. flavomaculatum* (Lucas, 1846) (from Ghana on *V. exanthematicus* and El Salvador on *Iguana iguana* Linnaeus, 1758); *A. latum* Koch, 1844 (from Ghana on *V. exanthematicus* and *P. regius*); *A. nuttalli* Dönitz, 1909 (from Ghana on *V. exanthematicus*); *A. quadricavum* (Schulze, 1941) (from El Salvador on *I. iguana*); *A. transversale* (Lucas, 1844) (from Ghana on *P. regius*); *A. varanensis* (Supino, 1897) (from Indonesia on *V. salvator* Laurenti, 1768); *Amblyomma* spp. Koch, 1844 (from Ghana on *V. exanthematicus* and *P. regius*) [27]; *Hyalomma aegyptium* (Linnaeus, 1758) (from Greece on *Testudo graeca* Linnaeus, 1758 and *Testudo marginata* Schoepf, 1792) [27, 35].

Knowledge of the ticks' location on the bodies of popularly-bred reptile species will help in drawing up methods of fighting the parasites, and may give valuable clues to veterinary services and private breeders.

MATERIALS AND METHODS

The location of ticks was examined on the following hosts: *V. exanthematicus* (66 specimens), *V. salvator* (1 specimen) and *P. regius* (133 specimens). The locations on the bodies of 58 monitor lizards and 92 pythons are presented in more detail. In total, 864 tick specimens were collected from 200 reptiles. Material gathering took place in animal wholesalers', at most two to three days after the reptiles were air freighted to Poland. The monitor lizards and pythons were alive and were thus examined. In searching for the ticks parasitising the host's body, the reptile's whole body was

carefully examined, and the ticks were removed using tweezers and then placed in test tubes with 70% ethyl alcohol. In order to determine the systematic affiliation of the ticks, keys and species descriptions were used [7, 14, 18, 25, 32, 33]. Because of damage to some tick specimens and the absence of a monographic work on world tick fauna of the *Amblyomma* genus, not all ticks of the *Amblyomma* genus could be strictly identified with a precise species affiliation.

Monitor lizards. There were 66 specimens of the savannah monitor *V. exanthematicus* examined, which were imported to Poland from a breeding farm in Ghana, Africa, and one specimen of the water monitor *V. salvator* imported to Poland from Indonesia. *V. exanthematicus* lives on land and inhabits South and Central Africa. It is a popular species held in captivity. *V. salvator* is a predatory lizard which inhabits boggy and swampy forested terrain and climbs trees. It occurs in South-East Asia from India to Sri Lanka, from the southern areas of China to Indonesia; it has also settled islands in the southern area of the China Sea. Owing to its large size, it is rarely seen in private collections.

A detailed location describing the place where the tick had bitten the lizard's body (head, trunk, limbs, tail) was examined in 58 monitor lizards, while a general location without a described specific place where the tick had bitten was examined in 9 lizards.

Pythons. There were 133 specimens of the royal python *P. regius* examined, mostly farmed reptiles imported from Ghana, Africa, to Poland. This is the most popular and long-lived snake with private breeders. In natural conditions it inhabits savannah, dense tropical forests, and is usually to be found on the ground; it occurs in Western and Central Africa.

A detailed location describing the place where the tick had bitten the snake's body (head, trunk, tail) was examined in 92 pythons, while a general location without a described specific place where the tick had bitten was examined in 41 pythons.

On the basis of the data collected an analysis of the rate structure was performed, the ratios of tick appearance on various parts of the bodies of *V. exanthematicus* and *V. salvator* (head, trunk, limbs, tail) and the ratios of tick appearance on various parts of the bodies of *P. regius* (head, trunk, tail) were calculated. A statistical analysis of the data was performed on a specific number of reptiles: *V. salvator* and *V. exanthematicus* (n=58), *P. regius* (n=92). For all indicators of structure confidence limits were calculated assuming a confidence level of $1 - \alpha = 0.05$. All the calculations were performed using Microsoft Office Excel 2003.

RESULTS

As a result of the research, it was confirmed that the following tick species parasitised *P. regius*: *A. latum*,

Table 1. Location of ticks on the bodies of monitor lizards.

Location on the body of monitor lizards	Number of collected ticks	Average number of ticks on the examined part of the monitor lizard's body	
HEAD			
• around the eyes	1	1.33	
• nasal openings	54		
• ear openings	32		
• remaining parts of the head	1		
Total ticks on a head	88		
TRUNK			
• back of the trunk	87	1.92	
• abdominal side of the trunk	3		
• anal shield	37		
Total ticks on a trunk	127		
LIMBS			
• above toes	◦ forelimbs	51	2.67
	◦ hind limbs	72	
	◦ undefined	10	
• between toes	◦ forelimbs	10	
	◦ hind limbs	17	
	◦ undefined	16	
Total ticks on limbs	176		
TAIL			
• overall tail surface	43	0.65	
Number of examined monitor lizards	67		
Total number of ticks collected from monitor lizards	434		

A. transversale, *Amblyomma* spp., for *V. exanthematicus*: *A. exornatum*, *A. flavomaculatum*, *A. latum*, *A. nuttalli*, *Amblyomma* spp., for *V. salvator*: *A. varanensis*. The general invasion prevalence of ticks on hosts attacked equalled 77.6%.

Location of ticks on the bodies of *V. salvator* and *V. exanthematicus*. There were 434 tick specimens collected from the monitor lizards. Ticks were mostly located on the limbs – 176 tick specimens (40.5%) – and the trunk – 127 (29.3%); fewer on the head – 88 (20.3%) – and the tail – 43 (9.9%). Numerous ticks were observed between the toes and in the ear and nasal openings (Tab. 1). The monitor lizard most heavily infested by ticks had 68 parasite specimens; most of the ticks were located on its trunk, in the nasal openings and on its limbs. The ticks parasitised the entire body of the monitors, but there was a tendency to form larger groupings, chiefly in the areas of the nasal openings, the ear openings, and the anal shield. Parasites also appeared individually over the reptile's entire body.

Location of ticks on the bodies of *P. regius*. There were 430 specimens of parasitising ticks collected from the bodies of pythons. Ticks were found on the entire body of the pythons, although mostly on the back of the trunk – 234 tick

Table 2. Location of ticks on the bodies of pythons.

Location on the body of pythons	Number of collected ticks	Average number of ticks on the examined part of the python's body
HEAD		
• around the eyes	16	0.33
• nasal openings	4	
• remaining parts of the head	24	
Total ticks on a head	44	
TRUNK		
• back of the trunk	234	2.90
• abdominal side of the trunk	128	
• cloaca	24	
Total ticks on a trunk	386	
TAIL		
• overall tail surface	0	0.00
Number of examined pythons	133	
Total number of ticks collected from pythons	430	

specimens (54.4%) – and the abdominal side of the trunk – 128 (29.8%). There were fewer ticks collected from the cloaca – 24 (5.6%), around the eyes – 16 (3.7%), the nasal openings – 4 (0.9%), and the remaining parts of the head – 24 (5.6%). Individual ticks were collected from the nasal openings (Tab. 2). Among the pythons examined, the most infected specimen had 27 ticks, located mostly on the abdominal and back sides of the trunk and in the region of the cloaca. Ticks most frequently appeared individually or in groups of a few specimens close together on the reptile's body. Those hidden under the scales of the snakes' skin were difficult to locate.

The number of tick specimens collected from pythons and monitors lizards were comparable, with the greatest number of ticks being collected from the trunks of both host groups (Tab. 1, 2).

The calculation of tick localisation on the surface of the host reptile, confirmed by statistical analysis, may serve as an estimate of tick location on the host body for an entire population of a given species. This is particularly important information for veterinary services which are required to monitor external parasites on the bodies of exotic reptiles imported into Poland.

During the examinations, individual reptiles were observed on which an exceptionally large number of ticks parasitised (from a dozen or so to tens of tick specimens). The apathetic and slow behaviour of *P. regius* and *V. exanthematicus*, and the observably weakened activity of the reptiles indicated the direct effects of parasitisation by a large number of ticks. It was observed that ticks parasitised in groups were plugging the nasal and ear openings of *V. exanthematicus*. In the eye and its close surroundings several well-fed ticks occurred, blocking the field of view

of *P. regius* and *V. exanthematicus*. During the removal of firmly attached ticks from the host's skin with tweezers, it was noticed that the tick's hypostome, anchored in the reptile's body, damaged the skin and made a hole in the host's tissues.

During the investigation, it was observed that ticks may fall off the host's body unnoticed by the breeder and move around the terrarium or the place where they were kept. This would presumably bring with it the possible consequence of change of host for another (such a case probably occurred on an *I. iguana* imported from Central America, from which an African tick, *A. flavomaculatum* was collected) [27].

DISCUSSION

Information on the location of ticks on the bodies of reptiles popular in Polish domestic terrariums is valuable for reptile sellers and the veterinary services, as well as for breeders when purchasing animals. During the research, it was particularly noted that the ticks parasitising the reptiles aroused no interest in the sellers, chiefly because they are relatively imperceptible to the naked eye, especially on the bodies of snakes. Knowledge of the place where ticks attach themselves to the reptile's body is particularly important because the tick's long mouthparts are introduced into fragments of thin skin, most often under or between scales and shields, and the parasite is not always visible at once, or even noticeable under the fingers.

The species of tick influences the parasitisation site on the host body, as well as the developmental stage and the size of the host attacked and its habitation. A crucial role is played by the aggregation and attachment pheromones secreted by the male ticks, especially ticks of the *Amblyomma* genus. Hungry ticks of the same species sensitive to the aggregation and attachment pheromones cling to the parasitisation locations and most frequently site themselves near males which are already feeding. Usually, these are locations which have a strong blood supply and thin skin, with more or less stable temperature and humidity conditions as well as shaded from the sun. The observed differences in the number of parasitising ticks on the host may also be the result of dynamic changes in abiotic factors among which the most crucial role is played by humidity and temperature [35].

On the bodies of *V. exanthematicus* and *V. salvator*, the ticks parasitised the entire body length of the reptile, and ticks were most frequently localised on the limbs above and between the toes, as well as on the trunk, particularly on the back. Ticks were also observed in the ear and nasal openings. Similar research results on the location of *Ixodes ricinus* (Linnaeus, 1758) on *Lacerta agilis* Linnaeus, 1758 has been provided by Kurczewski [23]. The author showed that the ticks were decidedly more frequently located around the forelimbs, but also in the ear openings and the abdominal part of the trunk. Haitlinger [12] has confirmed

that ticks on Lacertidae are most frequently found at the root of the forelimbs and the neck. King and Keirans [21] discovered that ticks on *Varanus indicus* (Daudin, 1802) were located on all parts of the reptile's body, and on *Varanus timorensis* (Gray, 1831) they were mostly concentrated on the neck and tail. In research on the Caucasian agama *Laudakia caucasia* (Eichwald, 1831) in the mountains of Turkmenistan, it was shown that ticks of *Haemaphysalis sulcata* Canestrini & Fanzago, 1878 were sited most numerous around the neck, and then at the roots of the lizard's forelimbs [1]. The phenomenon of tick location on limbs or their surroundings and the lower parts of the body is justified by the way in which the lizards move and gather food.

On *P. regius*, ticks were also found along the entire body, although they were most numerous on the back and abdominal sections of the trunk, less so around the cloaca, on the head, and directly near the eyes, and individual ticks were collected from the nasal openings. Stenos *et al.* [36] report that during hunting of lizards and snakes in Australia, ticks were gathered numerous in the ear openings. Lehmann *et al.* [24] have observed in experimental research that female ticks of *Amblyomma dissimile* Koch, 1844 attached to the head or near the spine of a snake required less time to paralyse the host, which breathed more rapidly, than ticks parasitising other parts of the reptile's body.

Skilled removal of parasitising ticks from reptiles, particularly parasites which are partially fed and therefore aroused to feed more, is a very important activity which requires knowledge, hygiene and precision from the breeder. Insufficiently fed ticks which are irritated by mechanical removal from the host's skin may be a danger to human health because they will rapidly attack a substitute host [35], which may be the breeders or their domestic pets. Reptiles also attempt to defend themselves against invasion by external parasites. There are examples known of biting parasitising ticks from their own skin, but it is also suggested that some lizards, such as those of the *Cnemidophorus* genus Wagler, 1830, feed on ticks by digging them out of the soil or biting them off dead hosts. Such cases have been described in Africa, the USA and Mexico [26].

There is no data on economic losses caused by tick parasitisation of reptiles. Comparing the situations observed in farm mammals (weight loss in the bodies of cattle, reduction in milk and meat production, death as a result of tick-borne diseases) [16, 17], these should also not be excluded in the case of reptile breeding. Skin which is damaged by the long mouthparts of ticks of genera *Amblyomma* and *Hyalomma* and wounds from secondary bites which cause festering skin changes are an obstacle to the use of the host's skin for industrial purposes.

Direct consequences of tick parasitisation on reptiles are very varied, from mild effects: weakness, slow movements, apathy, lack of appetite and thinning of the reptiles [13, 22, 23, 27] to drastic, for example host death as a result of tick paralysis [13].

The international trade in live animals is a cause for concern and fear in many countries which import animals together with transferred ticks, including: the USA, the United Kingdom, Argentina, Chile, and Poland [2, 3, 4, 5, 10, 19, 28, 30]. If there are optimal conditions for the development of a given tick species in the new living place together with the host, the ticks will usually form a population. The acclimatisation of certain tick species is assisted by the artificial conditions created by humans (e.g., in a terrarium or economic buildings for animals). Many tick species of world fauna have been lucky in establishing populations in new living places far from their natural environments. Examples include ticks of the Argasidae families: *Argas persicus* (Oken, 1818) from Central Asia transferred on poultry to all continents of the world in the temperate and tropical zones [15], as well as ticks of the Amblyomidae family: *Amblyomma variegatum* (Fabricius, 1794) from Senegal in Africa transferred together with farm animals to India [8], *Hyalomma aegyptium* (Linnaeus, 1758) from Mediterranean areas and Central Asia transferred on tortoises to Europe [35], *Rhipicephalus sanguineus* (Latreille, 1806) from Africa and Mediterranean areas transferred on domestic dogs to all continents of the world and many islands in the tropical and sub-tropical zones [9, 14, 29], as well as to Germany [6], Denmark [11] and Poland [37]. The import and propagation of exotic animals brings with it the potential risk of spread of ticks and tick-borne diseases in regions previously free from the parasites, which is a dangerous epidemiological problem [3, 15, 20, 27, 31]. Ticks moving on their hosts may introduce pathogens hitherto unregistered in Polish, or even European fauna, regardless of whether the ticks establish populations in artificial or natural environments or not.

Exotic reptiles are thus a further host group which, alongside migratory birds, bring alien tick species to Poland in equally large numbers, and therefore this phenomenon is ever more general and requires appropriate monitoring.

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