

ALLERGY TO PIGEON TICK (*ARGAS REFLEXUS*) IN UPPER SILESIA, POLAND*Radosław Śpiwak¹, Maria Lundberg², S. Gunnar O. Johansson³, Alicja Buczek⁴¹Jagiellonian University Medical College, Faculty of Health Care, Institute of Public Health, Kraków, Poland²MIAB, Uppsala, Sweden³Karolinska Institute, Stockholm, Sweden⁴Medical Academy, Department of Medical Biology and Parasitology, Lublin, Poland

Śpiwak R, Lundberg M, Johansson SGO, Buczek A: Allergy to pigeon tick (*Argas reflexus*) in Upper Silesia, Poland. *Ann Agric Environ Med* 2006, **13**, 107–112.

Abstract: The pigeon tick *Argas reflexus* is avian ectoparasite that typically feeds on pigeons. When devoid of a natural host, the ticks can also attack humans. In Upper Silesia, southern Poland, people living in the vicinity of the birds' nesting sites are frequently bitten by *A. reflexus*. The bites can provoke serious allergic reactions, including fatal anaphylactic shock. In the present study, residents of 9 apartments invaded by pigeon ticks were invited to undergo medical examination, skin prick tests (SPT) and determination of specific IgE to *A. reflexus*. The test allergens were prepared of ticks collected on-site. Out of 18 residents living in the infested apartments, 15 accepted the invitation. In this group, 8 persons complained of tick-related health problems, positive SPT to *A. reflexus* were found in all of them, and specific IgE was detectable in 3 persons (range: 0.38–0.84 kUA/l; CAP class 1–2). Final clinical diagnoses were established of generalised urticaria with asthma in 1 person, generalised urticaria in another 1, and local allergic reactions to tick bites in the remaining 6. Among 7 symptom-free residents, all test results were negative. Besides the study group, the paper also describes the case of a person who developed hypersensitivity to *A. reflexus* as a child, after a few visits to an abandoned dovecote. 30 years later, positive SPT (++) and specific IgE (0.78 kUA/l; CAP class 2) were still present despite no further re-exposures. The article also discusses available pest control measures against *A. reflexus*.

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Key words: *Argas reflexus*, pigeon tick, soft tick, avian parasites, tick bites, allergic reactions, allergy.

Upper Silesia (Górny Śląsk) is a highly urbanised and densely populated area in southern Poland. For centuries pigeon breeding has been a popular pastime activity in this region. Many dovecotes were set up in attics of houses (Fig. 1) or in the courtyards, next to human dwellings. With time, many of the birds became feral, and nowadays pigeons provoke nuisance and public health concerns. In the present article, we describe the

development of allergy to pigeon ticks (*Argas reflexus*) among residents of 9 apartments invaded by ticks from neighbouring nesting sites of feral pigeons.

MATERIAL AND METHODS

Study sites. There were 9 apartments invaded by pigeon ticks, located in 6 separate multi-storey buildings

Received: 23 March 2006

Accepted: 20 May 2006

*This article is dedicated to the memory of 65 people killed on 28 January 2006 in the collapse of exposition hall at the VII International Fairs of Racing Pigeons "PIGEON 2006" in Katowice, Poland.

in 4 neighbouring towns of Bytom, Świętochłowice, Chorzów, and Katowice in Upper Silesia. Detailed description of the apartments and their surroundings is given in Table 1.

Collection of ticks for identification. The ticks are active during the night and spend the daytime hidden in crevices. Therefore, crevices of the walls and woodwork were examined for the presence of ticks by using a flashlight. Special attention was paid to faeces of the ticks, as tick habitats are marked by accumulation of excrements [4]. At each site, several specimens at different developmental stages were found, i.e. females, males, nymphs I and nymphs II. Collected ticks were preserved in 70% ethyl alcohol. Under laboratory conditions, the specimens were prepared according to [2], mounted in Faur's fluid and identified as *A. reflexus* based on their morphologic features (Fig. 2) [2, 29].

Study group. We offered medical advice to all residents of the infested apartments. Of the 18 persons concerned, 15 agreed to participate in the study (Tab. 1). Among them, 8 persons complained of health problems related to tick bites ("Patients", 3 men and 5 women aged 25–78 years). The remaining 7 participants (4 men and 3 women aged 14–47 years) were symptom-free and asked for examinations because of their concerns regarding the

tick invasion. Their test results were used as reference in this article and they are further referred to as "Controls".

Preparation of *A. reflexus* extracts for allergy testing. Whole bodies of adult ticks collected in the infested apartments were air-dried, crushed and suspended (0.10 g/ml) in a mixture of glycerol and physiological saline (1:1 v/v). After overnight incubation at 4°C, the suspension was centrifuged, sterile filtered, and diluted to the final concentration of 5,000 PNU/ml according to [24]. 5 volunteers (members of laboratory staff or nurses) were skin prick-tested with this extract and none of them reacted. For the detection of *A. reflexus*-specific IgE (sIgE), ImmunoCAPs™ were produced according to [11] from crushed, air-dried bodies of ticks collected on-site. The extract was covalently coupled to the solid phase following the method described in [6].

Medical tests. Study participants underwent history taking using standardised questionnaire, skin prick tests (SPT), total IgE (tIgE) and *A. reflexus*-specific IgE (sIgE) determination. SPT were carried out on the anterior forearm surface using standard lancets (Allergopharma, Germany). The test site was observed after 20 min and the size of wheal reaction was recorded. The results were scored through comparing the diameter of wheals at test site with the diameter of the control wheal elicited by

Table 1. Apartments invaded by *Argas reflexus* and their residents participating in the study

Apartments infested by <i>A. reflexus</i>			Participants with tick-related symptoms ("Patients")			Participants without tick-related symptoms ("Controls")
Site	Town	Description	No. ⁽¹⁾	Sex, age ⁽²⁾	Symptoms since	
A	Bytom	Apartment on the top floor. Pigeon ticks first noticed 6 years ago, a few months after pigeons were removed from the loft and ventilation openings bricked up. Repeated invasions of pigeon ticks discontinued after installation of new windows.	1	M, 39	6 years	F, 47
B	Bytom	Apartment on the top floor. Ticks first noticed 5 years ago, a few months after pigeons were removed from the loft and ventilation openings were bricked up. Ticks found in spring/summer most frequently around windows.	2	M, 78	5 years	-
C	Bytom	Apartment on the top floor. Pigeon ticks first noticed in the apartment 5 years ago, new ticks found regularly since then.	3	F, 40	5 years	-
D	Świętochłowice	Apartment on the top floor invaded by pigeon ticks from the neighbouring loft, where pigeon nests were found. Ticks were first noticed 4 years ago.	4	M, 47 ⁽³⁾	20 years	-
E	Bytom	Apartment on the top floor. Pigeon ticks first noticed 2 years ago.	5	F, 25	5 months	M, 26
F	Bytom	Apartment on the top floor. The ticks first noticed 6 years ago, a few months after pigeons were removed from the loft and ventilation openings were bricked up.	6	F, 37	6 years	M, 39 M, 14 F, 16
G	Katowice	Apartment on the top floor. There was a dovecote in the loft above, which was liquidated 3 years ago. The site is still used by feral pigeons for nesting. Ticks first noticed 2 years ago.	7	F, 45	2 years	-
H	Chorzów	Since 6 years the apartment invaded by pigeon ticks through the window. Pigeons breeding sites on the building's facade.	8	F, 25	6 years	-
I	Bytom	Apartment in a converted loft that was previously inhabited by feral pigeons. Pigeon ticks first noticed 7 years ago. New ticks found each year despite repeated "disinfections".	-	-	-	M, 43 F, 43

¹Patient numbers are consistent with Table 2. ²M - male, F - female, age given in years. ³The patient was active as pigeon breeder since childhood.



Figure 1. Dovecotes in attics are typical habitats of *Argas reflexus*, and pose serious health risk to people living in the building.



Figure 2. *Argas reflexus* female, $\times 8$. Its length \times breadth ranges from 4.5-10.3 \times 3.9-7.2 mm.

histamine solution (1 mg/ml). Test wheal with diameter $<$ 50% of the control wheal's diameter was considered as a negative reaction (-), wheal with diameter from 50–99% was scored as (+), from 100–150% as (++) and above 150% as (+++). Blood samples were also taken from the study participants for IgE determination. Total IgE and *A. reflexus*-sIgE levels in serum were measured with the fluoro-enzymatic immunoassay (FEIA) using UniCAPTM 100E apparatus according to the manufacturer's instructions (Pharmacia Diagnostics AB, Uppsala, Sweden). Total IgE concentration was measured using standard reagents from Pharmacia, results below 120 kU/l were considered normal. For the determination of *A. reflexus*-sIgE, the above described, custom-made ImmunoCAPsTM were used. Results equal or higher than 0.35 kUA/l were regarded as positive.

RESULTS

All 8 patients with health complaints related to tick bites were diagnosed with allergy to *A. reflexus*. Six persons suffered from local allergic reactions of the skin. In the 2 remaining patients, there were systemic allergic reactions to the tick's bites manifesting as generalised urticaria in 1, and generalised urticaria with asthma in the other. The tick bites and bite-related symptoms were typically noted during the night or the following morning. Positive SPT to *A. reflexus* were recorded in all 8 patients, *A. reflexus*-sIgE was detected in 3 of them. Detailed information on tick bite-related symptoms and allergy test results are given in Table 2. Regarding the 7 "Controls", their reactions to tick bites did not exceed beyond transient pain and the development of a dark-red spot at the bite site. Neither positive SPT, nor sIgE to *A. reflexus* was detectable in this group.

A CASE REPORT

During preparations for the study, it was accidentally discovered that the first author of this paper was hypersensitive to *A. reflexus*. After some thought, he could recall the circumstances behind this sensitisation,

which occurred about 30 years earlier (mid 1970s) in Tarnów - a town located in southern Poland, 180 km east of the present study site. As a child of about 8 years, he attempted to clean an abandoned dovecote in the attic of a house. After several visits to the site, he could not continue with this activity due to intense itching of the skin, wheals, rhinorrhea and shortness of breath, which appeared within minutes after entering the dovecote. Altogether, there was no more than a 2-week time span between the first and the last visit in the dovecote, and he has had no further visits to pigeon nesting sites ever since. The whole story remained forgotten until the present study. SPT with *A. reflexus*-allergen gave a (++)-reaction, the sIgE level was 0.78 kUA/l (CAP class 2), total IgE was 490.3 kU/l. The person described here was atopic with confirmed Type I-hypersensitivity to multiple aero-allergens.

DISCUSSION

Feral pigeons are distributed worldwide and live close to human population, causing serious health problems. The birds may vector as many as 60 human pathogens - viruses, bacteria, fungi and protozoa [14, 31]. Also blood-sucking ectoparasites of pigeons can prey on humans, among these pigeon flea *Ceratophylus collumbae* [15], red blood mite *Dermanyssus gallinae* [12, 26], northern fowl mite *Ornithonyssus sylviarum* [32], and most frequently pigeon tick *Argas reflexus* [19, 21, 28, 33]. Severe allergic reaction of a person bitten by pigeon ticks was first reported from Upper Silesia in 1973 by Grzybek *et al.* (cited after [34]). Health concerns of the public were further stimulated by subsequent reports on the frequent appearance of *A. reflexus* in local pigeon nests [1]. Finally, a person died of anaphylactic shock after *A. reflexus* bite in 1993 [5]. Since then, pressure has been put on house owners to remove pigeon nests. When improperly carried out, however, such removals may cause more harm than benefit. If no sufficient pest control is carried out at the site, the ticks remain and eventually seek another host. In urban areas, people frequently act as such "makeshift" hosts. Typically, *A. reflexus*-invasions

on people start after removal of pigeon breeding sites in the neighbourhood, or take place in apartments converted from lofts previously inhabited by pigeons. This is true for the majority of apartments described in the present study (compare Table 1).

Successful removal of blood-sucking parasites from pigeon nesting sites is a key measure to prevent allergic reactions to *A. reflexus* in people. Unfortunately, the tick possesses a range of biological features that make it difficult to eradicate. Adult *A. reflexus* can survive 5 or more years without feeding [9]. Anecdotal reports were published of people first invaded by pigeon ticks after as many as 13 years after removal of neighbouring dovecotes [23]. The larvae of *A. reflexus* can survive 1 year without feeding, whereas unfed nymphs can stay alive for 3 years or more [8]. Pigeon ticks hide in the deepest cracks, which are difficult to penetrate for pesticides; moreover, the tick can halt respiration for a few hours, which makes short-acting pesticides ineffective [3, 7]. Even when using long-term residual pesticides, *A. reflexus* is difficult to exterminate due to its long life cycle. Finally, thousands of ticks can be found in one pigeon nest (Mayer 1954, cited after [13]) - such vast numbers make *A. reflexus* very difficult to eradicate

completely. Repeated treatments by a pest control professional are necessary [17]. Until successful eradication of the tick, a provisional measure can be implemented that prevents *A. reflexus* from entering human dwellings: Double-sided adhesive tape should be stuck to windowsills and around other openings used by the parasite for entering the apartment. When crawling over the tape, *A. reflexus* sticks to it and cannot proceed (Haag-Wackernagel, personal communication). This simple measure helps to control the invasion before professional pest control is carried out.

Dautel and Kahl [7] have proposed the following steps for eradication of *A. reflexus*:

- 1) complete uncovering of all potential tick hides (in some instances, plaster must be removed from the walls),
- 2) application of a pyrethroid spray in order to expel the ticks from cracks and crevices, and finally,
- 3) application of propoxur-based contact pesticide to kill the ticks.

When this scheme is not applicable or not effective, other pesticides could be tried, which were reported to be effective against ticks of *Argas* family. These include permethrin [10], ivermectin [25], and *Bacillus thuringiensis* [16]. Finally, repellents could be tried in order to keep

Table 2. Medical data of people with *Argas reflexus*-related health problems, ordered according to allergy test results

No.	Sex, age	Complaints related to <i>A. reflexus</i> bites	<i>A. reflexus</i> -sIgE (kUA/l)	<i>A. reflexus</i> -SPT	Interpretation of <i>A. reflexus</i> bite reaction	Other allergies	Other SPT ⁽¹⁾	tIgE ⁽²⁾ (kU/l)
1.	M, 39	Pruritus and wheals on the whole body and dyspnoea after pigeon tick bites. Symptoms always during night-time, each time tick found in/around bed.	0.84 (CAP 2)	++ ⁽³⁾	Generalised urticaria and asthma	-	-	69.1
2.	M, 78	Pruritus, erythema and oedema of the bite sites persisting for 1-2 days. Ticks found many times in the apartment, esp. around windows.	0.79 (CAP 2)	+++	Local allergic reaction	-	-	6.9
3.	F, 40	Pruritus and oedema at the bite site with subsequent infiltration and necrosis that healed after 1 month. Live ticks found many times.	0.38 (CAP 1)	+++	Local allergic reaction	-	-	826.4
4.	M, 47	Pruritus and oedema of the face persisting for 1-2 days. Only when at home.	<0.35 (CAP 0)	++	Local allergic reaction	-	-	72.6
5.	F, 25	Pruritus, erythema, papules and vesicles at biting sites that persist for 1-2 weeks.	<0.35 (CAP 0)	+	Local allergic reaction	-	-	18.0
6.	F, 37	Pruritus and oedema at bite site persisting for 1-2 weeks.	<0.35 (CAP 0)	+	Local allergic reaction	Seasonal rhinitis	weed pollen +	24.8
7.	F, 45	Pruritus and wheals on the whole body, persisting 1-2 days.	<0.35 (CAP 0)	+	Generalised urticaria	Perennial rhinitis	<i>D. pteronyssinus</i> +	229.4
8.	F, 25	Pruritus and oedema of the legs after <i>A. reflexus</i> bites, for 3-4 weeks.	<0.35 (CAP 0)	+	Local allergic reaction	Perennial rhinitis	<i>D. pteronyssinus</i> ++	56.5

¹SPT - skin prick tests; Beside *A. reflexus* allergen, the patients were tested with Animal Danders I, Trees I, Trees II, Grasses/Cereals, Weeds, Fungi I, *Dermatophagoides pteronyssinus*, *Blattella germanica* (Allergopharma, Reinbeck, Germany). ²tIgE - total immunoglobulin E in serum; normal range is below 120 kUA/l. ³Due to the patient's history of severe systemic reactions, skin tests were performed with *A. reflexus* allergen extract diluted to 20% of the original concentration.

the ticks away from people. Permethrin and DEET (N,N-diethyl-3-methyl benzamide) were shown to be effective against *Argas persicus* (a relative of *A. reflexus*) [10, 20, 22]. After successful eradication of pigeon ticks, measures should also be undertaken to prevent possible reinvasions: All openings that could be used by feral pigeons for entering the building should be permanently obstructed (e.g. by mounting wire netting or bricking up) and external breeding sites protected with pigeon deterrent systems [13].

In the present study, most persons with allergy to tick bites were non-atopic. This indicates that *A. reflexus*-allergen is strong enough to induce hypersensitivity also in people without an individual tendency to developing allergies. Similar observations were made previously [19, 27]. Out of 18 persons living in the infested apartments (including those who declined to participate in the study), 8 (44%) were diagnosed with allergy to tick bites. Residents of 6 out of 9 infested apartments, experienced their first allergic symptoms to tick bites in the same year when *A. reflexus* appeared in the apartment (A, B, C, F, G, and H in Table 1). This suggests a rapid sensitisation; thus, again strong sensitising properties (though it cannot be excluded that the symptoms only turned the residents' attention to the ticks that were present previously). The case description included in this article provides yet another clue to the strong allergising potential of *A. reflexus* and a rapid development of hypersensitivity to pigeon tick bites: The sensitisation developed after a few visits to an abandoned dovecote, and within less than 2 weeks. Once induced, the allergy to pigeon tick persisted for 3 decades without known re-exposure.

Previous studies suggest that diagnosis of *A. reflexus*-allergy may sometimes be hampered by false-negative and irrelevant positive results when using whole-body extracts of *A. reflexus* for skin prick tests (SPT) and specific IgE [19]. In our study, all 8 persons with tick-related symptoms had positive SPT to *A. reflexus* and all "Controls" remained negative. This means that we did not see either false positive nor false negative results while using whole-body extract of *A. reflexus* for SPT. However, the determination of sIgE appeared in our hands less sensitive than SPT, as it was detectable only in 3 out of 8 people with tick-related symptoms. Therefore, whole-body extract of pigeon tick seems indeed not to be the best substrate for sIgE determination. An improvement can be hoped in the future when the recently cloned major allergen of *A. reflexus* saliva, Arg r 1 finds its way into diagnosis [18].

CONCLUSIONS

1. The presence of nesting sites of feral pigeons in the vicinity of human dwellings is an important risk factor for invasions of people by *A. reflexus*.

2. Removal of pigeons without proper eradication of pigeon ticks further increases the risk of *A. reflexus* attacks on humans.

3. A considerable portion (>40%) of people bitten by *A. reflexus* develop hypersensitivity manifesting as local or systemic allergic reactions.

4. Once acquired, allergy to *A. reflexus* bites can persist over decades without further re-exposures.

Acknowledgements

This study was partly financed from the grant 501/PKL/43/P of the Jagiellonian University Medical College in Krakow, Poland. We thank Dr Krystyna Kubicka and Dr Dariusz Ciura (Katowice) for their on-site help while performing the study, and Prof. Daniel Haag-Wackernagel (Basel) for critical reading and comments on the article. Initial results of this study were presented at the XXIII EAACI Meeting in Amsterdam, 2004 [30].

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