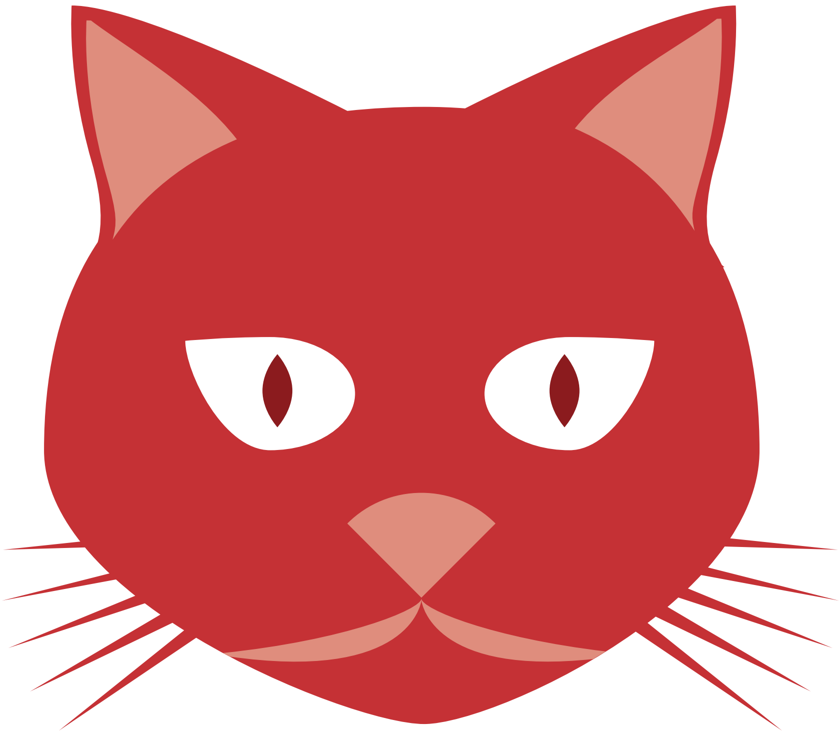
ImmunoCAP™

Epidermals & other animal proteins

Allergy - Which allergens?



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Contents

Epidermal and Animal Protein Allergens

The non-ingested allergens produced by mammals and birds comprise a large and complex group. Incidence of sensitisation appears to be increasing, and this is partly attributable to three factors. One is the long-standing but growing practice of keeping pets. Western ways are winning out, with record levels of Dog and Cat ownership, and with companion animals living within homes, sleeping on furniture or even with humans on their beds, and being handled and otherwise interacted with quite closely and frequently. With birth rates decreasing almost worldwide, pets help fill in for relationships that are rarer than previously: relationships with children, with younger siblings, and with grandchildren. For this reason and others, a pet allergy can be a particularly distressing one. In purely medical and practical terms, the treatment of choice is obvious: removal of the animal from the home. In emotional and social terms, things can be much more difficult, and this makes it crucial to begin with a correct diagnosis and a thorough understanding of the mechanisms of the allergy.

The second reason for the growth in allergy in this area is the increasing concentration and scale of agriculture and food manufacture. On the traditional farm of previous generations a variety of foodstuffs – meat, plant and dairy – were produced seasonally, usually limiting the exposure of farm workers to any one substance. With massive and monotonous exposure of workers to allergenic substances, it is not surprising that occupational allergy has risen dramatically. One of the predominant risks is allergy to epidermal and other animal proteins. Another important source of occupational animal allergies is laboratories. Rats, Mice, Guinea pigs and other animals are kept in large numbers for large-scale, statistically meaningful research, and workers who feed and handle them and clean their cages receive a high dose of their proteins.

The third important factor is growth in pest populations. Pigeons, Mice and Rats have found a solid ecological niche in the human urban environment, where they have ready food supplies and few predators. Rodents and some birds also infest agricultural environments, which are especially rich in food. Fabulous-sounding accounts are publicised of millions of pests living in certain districts. Modern sanitation and other hygiene measures have limited the infectious diseases pests and their parasites previously spread, but the problem of the presence of the animals and exposure to their various proteins remains. Animal pests are small enough to nest practically anywhere, and they live by foraging excursions, spreading their proteins efficiently wherever food might be found – which is almost everywhere. Rats are the chief offenders: they can pass through very tiny holes, and they can gnaw through concrete. They are also the most difficult to exterminate. As a complicating factor, certain strains of Rats, Mice and Pigeons are also kept as pets.

Animal allergen exposure is by several routes. In the case of birds, it is usually by their dried dung that becomes airborne as particulates, or by substances shed from their feathers. Mammals tend to shed allergens when proteins flake away from the outer layer of skin or epithelium; through serum albumin that is found in their saliva; or through dander, which comprises particles from their hair or fur. But these chemically distinct substances are very often combined, especially in the case of animals like Cats and rodents that wash themselves by licking, spreading saliva on both skin and fur. The urine of some mammals like Rats is a significant allergen and can be found either on the animal or in its environment. Bovine serum albumin occurs in meat and milk and so can act as a food allergen. It is also a substance very frequently employed in laboratories, for testing and for culturing cells and bacteria.

Common symptoms of bird allergy are asthma, allergic rhinitis and allergic conjunctivitis. A more severe syndrome, which can even result in death, is extrinsic allergic alveolitis (also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung), an inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Bird-Egg Syndrome is characterised by cross-reactivity between extrinsic bird proteins and ingested egg. Symptoms include rhinitis, urticaria, angioedema, and gastro-intestinal problems. Where exposure to bird proteins is intense, as in chicken farming and the feather processing industry, occupational allergies can occur.

Also where mammals are concerned, asthma, allergic rhinitis and allergic conjunctivitis are the most common symptoms. Dermatological symptoms can occur from exposure to some mammals (e.g., Cows), and angioedema and dyspnoea have also been reported after exposure to some (e.g., Deer). In farming, laboratories, and the fur industry, occupational allergies have been reported. Laboratory workers may experience anaphylactic reactions after bites, scratches and needle pricks (1-3). Swine Breeder's Lung, a form of extrinsic allergic alveolitus, is in rare cases associated with pig farming (4-5).

Cross-reactivity

Within this group of allergens, cross-reactivity must be viewed in the context of enormous genetic diversity. The animals in question have nothing universally in common but the fact that they are warm-blooded, terrestrial vertebrates, and in some cases their evolutionary divergence goes back more than a hundred million years. Nevertheless, broad cross-reactivity can be demonstrated.

Sub-groups such as the birds naturally display cross-reactive attributes. For example, Budgerigar and Chicken feather and egg yolk extracts have common epitopes, which may be important in the cross-sensitisation necessary for Bird-Egg Syndrome (6-8). There is an association between Horse, Cow and Deer (9-11), and between Ferret and Mink (12). Allergies to Dog and to Cat have been frequently linked (13-16), and the link has been extended to Fox and Mink.(17) In contrast, the Guinea pig and the Siberian Hamster appear distinctly un-cross-reactive (18-19).

But as indicated above, immunological relationships are not limited to the species among which they might be more or less expected. Cow's hair and Cow's milk represent one instance of cross-reactivity between a respiratory allergen and a food allergen (20-22). Cat and ingested Pork have a special immunological connection (23). Studies have demonstrated the potential for cross-reactivity to albumins from animals as different as Dog, Cat, Mouse, Chicken, Rat and even human (24-25). The lipocalin family of proteins is common to practically all respiratory animal allergens, including Horse, Cow, Dog, Mouse and even Cockroach, and also occurs in the beta-lactoalbumin of Cow's milk: a certain degree of cross-reactivity can therefore be expected (26).

ImmunoCAP™ epidermal and animal protein allergens available for IgE antibody testing

e204	BSA (bovine serum albumin) *Bos spp.*
e77	Budgerigar droppings *Melopsittacus undulatus*
e78	Budgerigar feathers *Melopsittacus undulatus*
e79	Budgerigar serum proteins *Melopsittacus undulatus*
e201	Canary bird feathers *Serinus canarius*
e1	Cat epithelium and dander *Felis domesticus*
e220	Cat serum albumin *Felis domesticus*
e218	Chicken droppings *Gallus domesticus*
e85	Chicken feathers *Gallus domesticus*
Re219	Chicken, serum proteins *Gallus domesticus*
Re 208	Chinchilla epithelium *Chinchilla laniger*
e4	Cow dander *Bos taurus*
Re216	Deer epithelium *Dama dama*
e5	Dog dander *Canis familiaris*
e2	Dog epithelium *Canis familiaris*
Re221	Dog serum albumin *Canis familiaris*
e86	Duck feathers *Anas platyrhynca*
Re217	Ferret epithelium *Mustela putorius*
Re214	Finch feathers *Lonchura domestrica*
Re210	Fox epithelium *Vulpes vulpes*
Re209	Gerbil epithelium *Meriones unguiculatus*
e80	Goat epithelium *Capra hircus*
e70	Goose feathers *Anser anser*
e6	Guinea pig epithelium *Cavia porcellus*
e84	Hamster epithelium *Cricetus cricetus*, *Phodopus sungorus*, *Mesocricetus auratus*
e3	Horse dander *Equus caballus*
Re205	Horse, serum proteins *Equus caballus*
Re203	Mink epithelium *Mustela spp.*
e88	Mouse epithelium, serum proteins and urine proteins *Mus spp.*
e71	Mouse epithelium *Mus spp.*
e76	Mouse serum proteins *Mus spp.*
e72	Mouse urine proteins *Mus spp.*
e213	Parrot feathers *Ara spp.*
e7	Pigeon droppings *Columba livia*
e215	Pigeon feathers *Columba livia*
e82	Rabbit epithelium *Oryctolagus cuniculus*
Re206	Rabbit, serum proteins *Oryctolagus cuniculus*
Re211	Rabbit, urine proteins *Oryctolagus cuniculus*
e87	Rat epithelium, serum, proteins and urine proteins *Rattus norvegicus*
e73	Rat epithelium *Rattus norvegicus*
e75	Rat serum proteins *Rattus norvegicus*
e74	Rat urine proteins *Rattus norvegicus*
Re202	Reindeer epithelium *Rangifer tarandus*
e81	Sheep epithelium *Ovis aries*
e83	Swine epithelium *Sus scrofa*
Re222	Swine serum albumin *Sus scrofa*
Re212	Swine, urine proteins *Sus scrofa*
e89	Turkey feathers *Meleagris gallopavo*
Mixes:	**ex1**
	ex2
	ex70
	ex71
	ex72
	ex73

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e204 BSA (bovine serum albumin)

Bos spp.

Family: *Bovidae*

Source material: Serum albumin

See also: Beef f27

Direct or indirect contact with Bovine serum albumin often causes sensitisation.

Allergen Exposure

Geographical distribution

Serum albumin is the main protein in mammalian blood tissue. It plays a very important role in the transport of nutritional substances into the system by virtue of its ability to bind with a large number of molecules.

Beef contains BSA and gamma globulin. These are heat-labile proteins found also in Cow's milk. BSA is a distinct milk allergen comprising approximately 1% of the total milk protein.

Environment

BSA is a protein found in Beef and in milk. It may be obtained from Bovine plasma, which is collected in slaughterhouses, highly purified, and used in biochemistry, immunochemistry, haematology and microbiology, in all countries where these sciences are practiced. It is most often employed in the production of diagnostic test systems, as a growth medium for bacteria, and as a cell culture.

Unexpected exposure

It is used in the manufacture of anti-wrinkle skin-tightener and is a basic protein for biological reactants. It may be used as a medium for *in vitro* fertilisation techniques.

Allergens

Bos d 6, a 67 kDa, heat-labile protein, is a major allergen in Beef and a minor allergen in milk (1-4).

Heat treatment and chemical denaturation are not able to decrease BSA's capacity to bind serum-specific IgE (5).

Potential cross-reactivity

Bovine serum albumin occurs as a major allergen in Beef, and a minor allergen in Cow's milk. Beef-allergic individuals are at risk of being allergic to Cow's milk and vice versa.

BSA and OSA (Ovine serum albumin) are important Beef and Lamb allergens. They have similar proteic sequences and allergenic properties (6).

Thiomucase (a mucopolysaccharidase obtained from Ovine tissues and used mainly to facilitate the diffusion of local anaesthetics and in the treatment of cellulitis) is partially cross-reactive with BSA, Cat dander and Sheep dander (7).

Clinical Experience

IgE mediated reactions

Food allergy (Beef/Milk), asthma, allergic rhinitis and anaphylaxis often occur following exposure to BSA (8). In Beef allergy, Bovine serum albumin (BSA) and actin have been reported to be the proteins most frequently involved in binding with the circulating IgE (9-10).

BSA can also be an occupational allergen. Recurrent rhinoconjunctivitis and wheezing following repeated exposure to purified lyophilised Bovine serum albumin (BSA) have been described in a laboratory technician (11).

Eosinophilic gastroenteritis is a disease characterised histologically by an eosinophilic infiltration of the gut. A study reports on a 22-year-old man in whom gastrointestinal symptoms first appeared in childhood. He had high IgE blood levels, and his skin-specific IgE test was positive to Bovine, Pig, and Lamb sera. The patient's serum contained specific IgE to Bovine serum albumin. The authors report that their data suggests a possible role for IgE-mediated hypersensitivity mechanisms in the pathogenesis of eosinophilic gastroenteritis (12).

The proliferative responses of peripheral blood mononuclear cells to Ovalbumin or Bovine serum albumin in children with atopic dermatitis who are sensitive to Hen's egg or Cow's milk have been reported to be significantly higher than the response of peripheral blood mononuclear cells of healthy children and Hen's egg- or Cow's milk-sensitive children with immediate symptoms (13-14).

A number of studies have reported severe allergic reactions during artificial insemination as a result of exposure to BSA present in the growth medium.

A 33-year-old woman without a history of atopic diseases or drug allergies developed a severe anaphylactic reaction with asthma, vomiting, itching, generalised urticaria, and angioedema during artificial insemination with her husband's sperm. The sperm-processing medium contained Bovine serum albumin (BSA). Bovine serum albumin is present in the follicle-rinsing fluid and in the medium used for embryo culture. The authors point out that artificial insemination with fluid containing potential allergens can represent an unnecessary risk for atopic females, even in the absence of prior clinical symptoms of allergic diseases (15-18).

Other reactions

A 27-year-old woman with severe recurrent angioedema and urticaria since the age of 5 years was found to have high levels of circulating immune complexes in the peripheral blood. These immune complexes contained antibodies against Bovine serum albumin. Elimination of Bovine products from the diet resulted in the disappearance of immune complexes within 2 days. Reintroduction of Bovine products to the diet resulted in the reappearance of these immune complexes within 24 hours (19).

In an *in vitro* fertilization (IVF) program in which a medium containing Bovine serum albumin (Menezo's medium) was employed for rinsing follicles, 5 (15%) of 32 women involved developed a symptom complex compatible with serum sickness within 8-12 days after oocyte retrieval by echographic puncture. All the patients had specific IgG antibodies against BSA, and intradermal skin testing with BSA and Menezo's medium were positive. The presence of specific IgE against BSA in serum could not be demonstrated. The authors suggest that this is probably due to the presence of high levels of specific IgG antibodies, which can interfere in the RAST procedure (20).

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e77 Budgerigar droppings

Melopsittacus undulatus

Family: *Psittacidae*

Common names: Budgerigar, Budgie, Parakeet

Source material: Droppings

See also: Budgerigar – feathers e78 and Budgerigar – serum albumin e79

Direct or indirect contact with bird allergens frequently causes sensitisation. Bird allergens may be major components in house dust.

Allergen Exposure

Geographical distribution

Budgerigar and Parakeet are the common names for a widespread group of small Parrots, native to the Indo-Malayan-Australian region and now the most popular cage birds in the world. Parakeets have long, pointed tails, unlike the chunky Lovebirds with which they are sometimes confused. The wild Budgerigar of Australia is usually green or blue with black and yellow markings; as a cage bird, however, it has been bred in many color varieties.

Environment

Large flocks, sometimes in the tens of thousands, inhabit the open grasslands in central Australia, nesting in the spring and summer in the southern areas of the continent. In most of the world, however, Budgerigars are familiar only as pets.

Allergens

No allergens from this bird have yet been fully characterized.

Canary and Budgerigar feathers contain IgE-binding antigens that are not present in the corresponding bird sera and droppings (1).

Potential cross-reactivity

Cross-reactivity between Chicken and other phylogenetically related bird species may be expected, and in Chicken-allergic patients significant IgE titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (2-3), even in patients without known exposure (6).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result on exposure to Budgerigars (1,4).

In a prospective study, 258 adults were investigated for sensitisation against bird antigens (Budgerigar, Canary, Pigeon) using an intracutaneous test. Eighteen of 78 Budgerigar keepers reacted against Budgerigar feathers. Thirty (38%) showed a positive skin reaction with at least 1 of the 3 extracts tested. In non-bird-exposed persons a reaction was found in 18/96 (19%) against Budgerigar and in 24/96 (25%) against at least 1 of the 3 allergen extracts. Late reactions occurred in 5/70 (7%) Budgerigar keepers. The frequency of sensitization against Budgerigar antigens increased to 48% of bird keepers (24/50) if the birds could fly around in their homes instead of being always caged (4/22, 18%). Three of the 78 Budgerigar keepers (4%) had a positive nasal provocation with feather extract, and they were skin-positive against all 3 bird antigens tested (6).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulin antibodies including IgE (6), IgM (7), IgA and various IgG subclasses (8-10). The antibodies may be found in the sera and saliva of patients (11) as well as in the sera of asymptomatic but exposed subjects (12).

The allergenic proteins may be found in bird serum, droppings, skin scales, feathers and, in the case of Pigeons, Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). Contact may result from handling birds, cleaning their lofts, or exposure to the organic dust drifting down from a ceiling or roof where birds nest.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (13).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (14).

A woman with alveolitis due to her Budgerigar developed recurrent symptoms when exposed to dropping allergens left on her artificial Christmas tree (15).

Other reactions

See also: Budgerigar – feathers e78 and Budgerigar – serum albumin e79.

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e78 Budgerigar feathers

Melopsittacus undulatus

Family: *Psittacidae*

Common names: Budgerigar, Budgie, Parakeet

Source material: Feathers

See also: Budgerigar – serum proteins e79 and Budgerigar – droppings e77

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

Budgerigar and Parakeet are the common names for a widespread group of small Parrots, native to the Indo-Malayan-Australian region and now the most popular cage birds in the world. Parakeets have long, pointed tails, unlike the chunky Lovebirds with which they are sometimes confused. The wild Budgerigar of Australia is usually green or blue with black and yellow markings; as a cage bird, however, it has been bred in many color varieties.

Environment

Large flocks, sometimes in the tens of thousands, inhabit the open grasslands in central Australia, nesting in the spring and summer in the southern areas of the continent. In most of the world, however, Budgerigars are familiar only as pets.

Allergens

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1).

The allergens have not been fully characterized yet.

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1).

Cross-reactivity between Chicken and other phylogenetically related bird species may be expected, and in Chicken-allergic patients significant IgE antibody titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (2-3), even in patients without known exposure (1).

Budgerigar and Hen feather and egg yolk alpha-livetin have been shown to have common epitopes, and the authors of the study suggest that alpha-livetin (Chicken serum albumin) leads to a cross-sensitization and consequently to Bird-Egg Syndrome (4).

e78 Budgerigar feathers

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result on exposure to Budgerigars (5-6). The allergic manifestations may present as Bird Fancier´s Asthma and as the so-called Bird-Egg Syndrome, with symptoms such as rhinitis, urticaria and angioedema, and also as gastrointestinal problems (3,7).

In 212 sera from Budgerigar and Canary fanciers with symptoms of rhinitis and/or bronchial asthma, in 25 of 98 Canary feather-specific IgE antibody measurements, and in 28 of 154 Budgerigar feather-specific IgE antibody measurements, a significant level of specific IgE was found. In 3 sera, IgE antibodies against sera from both birds were present. IgE antibodies against Canary and/or Budgerigar feathers were present in about 20% of Canary and Budgerigar fanciers with symptoms of atopic disease. Canary and Budgerigar feathers contain IgE-binding antigens that are not present in the corresponding bird sera and droppings (6).

In a prospective study, 258 adults were investigated for sensitisation against bird antigens (Budgerigar, Canary, Pigeon) using an intracutaneous test. Eighteen of 78 Budgerigar keepers reacted against Budgerigar feathers. Thirty (38%) showed a positive skin reaction with at least 1 of the 3 extracts tested. In persons not exposed to birds, 18/96 (19%) were found to react to at least 1 of the 3 allergen extracts. Late reactions occurred in 5/70 (7%) Budgerigar keepers. The frequency of sensitization against Budgerigar antigens increased to 48% of bird keepers (24/50) if the birds could fly around in their homes instead of being always caged (4/22, 18%). Three of the 78 Budgerigar keepers (4%) had a positive nasal provocation with feather extract, and they were skin-positive against all 3 bird antigens tested (7).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulins including IgE (1), IgM (8), IgA and various IgG subclasses (9-11). The antibodies may be found in the sera and saliva of patients (12) as well as in the sera of asymptomatic but exposed subjects (13).

The allergenic proteins may be found in bird serum, droppings, skin scales, feathers and, in the case of Pigeons, Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). Contact may result from handling birds, cleaning their lofts, or exposure to the organic dust drifting down from a ceiling or roof where birds nest.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (14).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (15).

Other reactions

Feather Mites are a major source of soluble proteins derived from feathers, accounting for up to 10% of the total weight of the feather. RAST inhibition indicated feather Mites had species-specific epitopes as well as ones that cross-reacted with *Dermatophagoides pteronyssinus* (16-17).

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e79 Budgerigar serum proteins

Melopsittacus undulatus

Family: *Psittacidae*

Common names: Budgerigar, Budgie, Parakeet

Source material: Serum

See also: Budgerigar – feathers e78 and Budgerigar – droppings e77

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

Budgerigar and Parakeet are the common names for a widespread group of small Parrots, native to the Indo-Malayan-Australian region and now the most popular cage birds in the world. Parakeets have long, pointed tails, unlike the chunky Lovebirds with which they are sometimes confused. The wild Budgerigar of Australia is usually green or blue with black and yellow markings; as a cage bird, however, it has been bred in many color varieties.

Environment

Large flocks, sometimes in the tens of thousands, inhabit the open grasslands in central Australia, nesting in the spring and summer in the southern areas of the continent. In most of the world, however, Budgerigars are familiar only as pets.

Allergens

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1).

Canary and Budgerigar feathers contain IgE-binding antigens that are not present in the corresponding bird sera and droppings (2).

A 60 kDa allergen has been determined (3), but this and other allergens have not been fully characterised yet.

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1).

Budgerigar and Hen feather and egg yolk alpha-livetin have been shown to have common epitopes, and the authors of the study suggest that alpha-livetin (Chicken serum albumin) leads to a cross-sensitisation and consequently to Bird-Egg Syndrome (4).

e79 Budgerigar serum proteins

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result on exposure to Budgerigars (5,2). The allergic manifestations may present as Bird Fancier´s Asthma and as the so-called Bird-Egg Syndrome, with symptoms such as rhinitis, urticaria and angioedema, and also as gastro-intestinal problems (3,6).

In a prospective study, 258 adults were investigated for sensitisation against bird antigens (Budgerigar, Canary, Pigeon) using an intracutaneous test. Eighteen of 78 Budgerigar keepers reacted against Budgerigar feathers. Thirty (38%) showed a positive skin reaction with at least 1 of the 3 extracts tested. In persons not exposed to birds, 18/96 (19%) were found to react to at least 1 of the 3 allergen extracts. Late reactions occurred in 5/70 (7%) Budgerigar keepers. The frequency of sensitization against Budgerigar antigens increased to 48% of bird keepers (24/50) if the birds could fly around in their homes instead of being always caged (4/22, 18%). Three of the 78 Budgerigar keepers (4%) had a positive nasal provocation with feather extract, and they were skin-positive against all 3 bird antigens tested (6).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung' and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulins including IgE (1), IgM (7), IgA and various IgG subclasses (8-10). The antibodies may be found in the sera and saliva of patients (11) as well as in the sera of asymptomatic but exposed subjects (12).

The allergenic proteins may be found in bird serum, droppings, skin scales, feathers and, in the case of Pigeons, Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). Contact may result from handling birds, cleaning their lofts, or exposure to the organic dust drifting down from a ceiling or roof where birds nest.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (13).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (14).

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e201 Canary bird feathers

Serinus canarius

Family: *Fringillidae*

Common names: Canary

Source material: Feathers

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

The Canary is one of the most common domestic birds, together with Budgerigars and Parrots. In 1994, these birds were estimated at 25 million in US households, and more than 8 millions in German ones (1).

These birds descend from the wild Serin Finch or the very similar Wild canary, and their ancestors were brought from the Canary Islands, Madeira, or the Azores. The Wild canary, which still exists, is brownish green and looks like a Sparrow. Captive breeding has gone on for 500 years, during most of which time Canaries were the most popular cage birds in the world, because of their singing and mimicry and the ease with which they breed in captivity. The yellow mutation (with the bird remaining the size and shape of a Finch) has been the most popular, but Canaries are available in many colors and a range of sizes, shapes, patterns and songs. The German (or Hartz Mountain) roller is the classic song Canary and was the most numerous Canary breed in the world for many years. The American singer is a newer song breed that was developed in the United States. Usually somewhat aloof in nature, they do not typically bond with people.

Environment

See above.

Allergens

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1). The allergens have not been fully characterized yet.

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components which cross-react with serum allergens/ antigens of the same as well as of other bird species (1).

Cross-reactivity between Canary and other phylogenetically related bird species may be expected, and in Canary-allergic patients, significant IgE antibody titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (2-3), then in patients without known exposure (1). Moreover, cross-reactivity to Hen's egg, Bird-Egg Syndrome, should be considered,. Here the livetins present in egg yolk have been suggested as the major cross-reacting allergen (4-5). This adult type of egg intolerance must be distinguished from the common egg-white allergy of atopic children.

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Canary feathers, epithelial cells or droppings (6). The allergic manifestations may present as Bird Fancier´s Asthma and as Bird-Egg Syndrome, with symptoms such as rhinitis, urticaria and angioedema (2), and also as gastro-intestinal problems (3). Specific IgE has been found in patients exposed to Canary (1-3,6).

In a study, IgE antibodies to Canary were present in about 25% of the bird fanciers investigated (6). Among 212 sera from Budgerigar and Canary fanciers with symptoms of rhinitis and/or bronchial asthma, in 25 of 98 Canary feather-specific IgE antibody measurements, a significant level of specific IgE was found. In 3 sera, IgE antibodies against sera from both birds were present. Canary feathers were shown to contain IgE-binding antigens that were not present in the bird sera and droppings (6).

In a prospective study, 258 adults were investigated for sensitisation against bird antigens (Budgerigar, Canary, Pigeon) using an intracutaneous test. Thirty (38%) showed a positive skin reaction with at least 1 of the 3 extracts tested. In persons not exposed to birds, 24/96 (25%) were found to react to at least one of the three allergen extracts (7).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves and Finches. Exposure results in the development of immuno-globulin antibodies including IgE (1), IgM (8), IgA and various IgG subclasses (9-11). The antibodies may be found in the sera and saliva of patients (12) as well as in the sera of asymptomatic but exposed subjects (13).

The allergenic proteins may be found in bird serum, droppings, skin scales, feathers and, in the case of Pigeons, Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). Contact may result from handling birds, cleaning their lofts, or exposure to the organic dust drifting down from a ceiling or roof where birds nest.

This is typified in a report of a 54-year-old man who presented with features consistent with extrinsic allergic alveolitis occurring after contact with his pet birds (14).

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (15).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (16).

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e1 Cat epithelium and dander

Felis domesticus

Family: *Felidae*

Common names: Cat, Domestic cat

Source material: Epithelium and dander

See also: Cat serum albumin

Cat-allergic patients with IgE antibodies to Fel d 1 have been shown also to react to the corresponding protein of ocelot, puma, serval, Siberian tiger, lion, jaguar, and snow leopard (24).

Allergen Exposure

Sensitisation to Cat is strongly associated with asthma, especially in environments free of Mite and Cockroach (1). The presence of domestic pets increases the prevalence of respiratory symptoms in asthmatic children (2), and children sensitised to Cat allergen are more likely to develop a more severe asthma than children with negative tests to Cat (3).

Potential cross-reactivity

Cat-allergic patients with IgE antibodies to Fel d 1 have been shown also to react to the corresponding protein of ocelot, puma, serval, Siberian tiger, lion, jaguar, and snow leopard (24).

A subgroup of cat-allergic patients also react to Dogs and sometimes to other animals. Serum albumin is the main common component (25-26). Extensive cross-reactivity even occurs between albumins of distantly related species (27), and subjects with IgE antibodies to cat albumin may also react to Horse, Cattle, Pig, Rodents (28), and fur animals like Mink and Fox (29). However, great variability exists between patients, and selective sensitivity to limited numbers of species occurs (28), indicating shared and specific epitopes.

Common and species-restricted epitopes have also been observed on the major Cat and Dog allergens Fel d 1 and Can f 1 (30).

Allergy to Cat dander and Pork meat, also referred to as the Pork/Cat Syndrome (31), was shown to be mediated by IgE antibodies recognizing Cat and Pig serum albumin (32). In addition, other kinds of meat may be a risk for patients with this type of sensitivity, as indicated by a case with Cat-specific IgE antibodies and exercise-induced anaphylaxis after eating Pork or Beef (33).

Clinical Experience

IgE mediated reactions

IgE-mediated sensitisation to Cat is a risk factor for asthma attacks. Allergen exposure plays a causal role in the development of bronchial hyperreactivity and of the chronic inflammatory responses seen in patients with asthma (40). Infants exposed to Cats developed skin prick test sensitivity about 3 times more often than those without such exposure (41).

Review

Cat allergy

Sensitisation to Cat is strongly associated with asthma, especially in environments free of Mite and Cockroach (1). The presence of domestic pets increases the prevalence of respiratory symptoms in asthmatic children (2), and children sensitised to Cat allergen are more likely to develop a more severe asthma than children with negative tests to Cat (3).

e1 Cat epithelium and dander

Tobacco smoke, prenatal and postnatal, has been shown to have an adjuvant effect on Cat sensitisation in exposed children (4).

Allergic reactivity to pollens may be aggravated by environmental priming with ubiquitous animal dander (5). Allergy to Cats or Dogs also seems to be an important risk factor for the development of laboratory animal allergy (6).

Data strongly suggest that those with a predisposition for allergy should avoid having pets in the home (2).

Cat allergens

Several Cat-derived proteins are involved in allergy. An acidic glycoprotein and Cat serum albumin are common sensitisers (7-9).

The glycoprotein, now called Fel d 1, is a major allergen, and more than 80% of Cat-allergic patients have been reported to have IgE antibodies against this molecule (10).

Fel d 1 has an apparent molecular weight of about 36 kDa and is a dimer of a polypeptide comprised of two covalently bound chains called 1 and 2, or a and b (11). Chains 1 and 2 contain 70 and 92 amino acid recidues respectively (12). The IgE binding epitopes appear to be primarily conformational and do not involve carbohydrate residues, although chain 2 carries an oligosaccharide (13-16). Studies on recombinant chain 1 and chain 2 showed that both chains contain IgE-binding epitopes and contribute to the allergenicity of the protein (17).

Allergen localization

Fel d 1 is present on the skin surface and in the fur of the Cat. The protein has been demonstrated in, and may be produced by, salivary glands and lacrimal glands (18), skin sebaceous glands (19-20) and anal glands (21). The allergen production appears to be hormonally regulated, and male Cats produce more Fel d 1 than females and castrated males (22-23)

Cross-reactivity

Domestic cats and wild cats

Cat-allergic patients with IgE antibodies to Fel d 1 have been shown to also react to the corresponding protein of ocelot, puma, serval, Siberian tiger, lion, jaguar, and snow leopard (24).

Cat and dog and fur animals

A subgroup of Cat-allergic patients also react to Dogs and sometimes to other animals. Serum albumin is the main common component (25-26). Extensive cross-reactivity even occurs between albumins of distantly related species (27), and subjects with IgE antibodies to cat albumin may also react to Horse, Cattle, Pig, Rodents (28), and fur animals like Mink and Fox (29). However, great variability exists between patients, and selective sensitivity to limited numbers of species occurs (28), indicating shared and specific epitopes.

Common and species-restricted epitopes have also been observed on the major Cat and Dog allergens Fel d 1 and Can f 1 (30).

Cat and meat

Allergy to Cat dander and Pork meat, also referred to as the Pork/Cat Syndrome (31), was shown to be mediated by IgE antibodies recognizing Cat and Pig serum albumin (32). In addition, other kinds of meat may be a risk for patients with this type of sensitivity, as indicated by a case with Cat-specific IgE antibodies and exercise-induced anaphylaxis after eating pork or beef (33).

Cat parasites

It is also worth mentioning that Cats may carry exoparasites that could contribute allergens and possibly add confusion in the investigation of allergy related to animals.

The Cat flea is an example. Carried by the cat and occasionally biting humans, it is also an allergenic insect among many subjects, and may add to the allergen content of indoor dust (34-36).

Prevalence of cat allergy

Exposure to Cat allergens is one of the most common causes of respiratory allergic disease and is of worldwide importance. The prevalence varies because of cultural differences and environmental factors. Keeping Cats as pets in homes is an obvious risk, leading to prevalences up to 80% or above in atopics (1, 37-39). Cold climates may contribute to the risk because the cats spend more time indoors (38). Cat is the major cause of indoor asthma in dry, high-altitude areas like Los Alamos, New Mexico, USA, where Mites and Cockroaches are virtually absent (1) and it adds severely to the burden in more humid climates with high level Mite exposure (39).

Fel d 1 exposure

IgE-mediated sensitisation to Cat is a risk factor for asthma attacks. Allergen exposure plays a causal role in the development of bronchial hyperreactivity and of the chronic inflammatory responses seen in patients with asthma (40). Infants exposed to Cats developed skin prick test sensitivity about 3 times more often than those without such exposure (41).

The concentration of Cat allergen Fel d 1 is highest in homes with a Cat, but is usually also measurable in houses where Cats are not kept (42- 45). In many cases, the Fel d 1 level exceeds proposed threshold levels for Cat sensitisation (46). Furthermore, the low-level Cat exposure that occurs in many homes without Cats is capable of inducing symptoms in some patients who are sensitive to Cats (47).

In dry climates, Fel d 1 is a major cause of indoor allergy, e.g. in northern Sweden, where Mite and Cockroach allergens are undetectable in homes (48). Even in Japanese homes, the airborne Fel d 1 concentration is much higher (160 times) than those of the major Mite allergens (49).

Carpets, matresses and upholstered chairs are reservoirs of Cat allergens (50-52). Cat allergen is carried on human clothing into environments never visited by Cats (53-55). Transport of Fel d 1 on clothing from the domestic to the school environment is in fact a major source of classroom Cat allergen (56). The Cat allergen concentration in classes with many cat owners may be higher than that found in the homes of non-Cat owners (57).

Avoidance

Avoidance of Cat allergens is an important measure to take in the treatment of sensitised asthmatics, decreasing symptoms and the need for drugs (58). The Fel d 1 concentration in dust is significantly lower in homes from which the Cat has been removed than in homes keeping the pet (51,59).

Encasing covers and hot washing of linen reduce Cat allergens in matresses in the absence of Cats (60). Washing the clothes of Cat owners is an effective method for prevention of Cat allergen dispersal (61).

Dry heat up to 140 °C has little effect on the Fel d 1 content of house dust (62), and tannic acid treatment is not a reliable method for reduction of indoor Cat allergen (63). The effect of air cleaners in homes with Cat seems uncertain in terms of reducting symptoms (64-66). In addition, washing or spraying Cats does not lead to significant reduction of Fel d 1 shedding.

Only removal of the cat leads to a lasting decrease of the allergen exposure (67-69).

Diagnostic efficiency of IgE antibody measurements

The aggreement between IgE antibody and *in vivo* tests is generally high. A study of optimization of skin testing showed 94% concordance between Phadebas RAST and SPT (70). Pharmacia CAP System showed 91% efficiency relative to SPT in one study (71) and was considered superior to skin testing in another (72). A contributing factor to the variability of the degree of agreement may be the variability of the skin test extracts (73). Also, it has been shown that even low levels of naturally induced Fel d 1-specific IgG antibodies affect the skin reactivity (74).

e1 Cat epithelium and dander

Table 1

Region		Preval. %	Study group	n	Procedure	Reference
America						
USA	Chicago, Ill	29	Child asthma	138	SPT	75
		40	Asthma	592	SPT	76
	New York, NY	38	Adult asthma	73	SPT	77
	Morgantown, WV	14	Infantile asthma	196	SPT	78
	Los Alamos, NM	62	Child asthma	21	IgE Ab (PCS)	1
	San Diego, Cal	10	Child asthma	41	SPT	79
	California	39	Asthma and/ or rhinitis	141	SPT	80
Canada	Vancouver, BC	13	Asthma/asthma-like/bronchitis	504	SPT	81
	Sainte-Foy, Quebec	77	Atopic	2698	SPT	82
	Montreal, Quebec	84	Atopic	155	SPT	37
Mexico	Mexico Valley	13	Atopic children	247	SPT	83
Puerto Rico	Ponce	17	Asthma	576	SPT	84
Brasil	São Paulo	11	Child asthma	80	SPT	85
Europe						
Sweden	Uppsala	14	Random adults (34% atopic)	527	SPT	86
	Uppsala	15		472	IgE Ab (PCS)	
	Umeå (north)	73	Child asthma	41	IgE Ab (PCS)	38
	Linköping (center)	62		37		
	Helsingborg (south)	39		46		
United Kingdom	Birmingham	59	Asthma	54	SPT	87
Germany	Hamburg	12	Random adults	739	IgE Ab (PCS)	88
	Erfurt	8		718		
	Freiburg	18	Child, general population	583	SPT	89
Austria	Vienna	20	Random adults	191	SPT	90
	Vienna	40	Adult asthma	70		
	Vienna	44	Adult rhinitis	117		
Spain		21	Adult asthma	136	IgE Ab (PCS)	91
	Barcelona	16	Random adults	342	IgE Ab (PCS)	92
	Albacete	4		170		

Region		Preval. %	Study group	n	Procedure	Reference
East Mediterran.						
Turkey		16	Asthma and/ or rhinitis	614	SPT	93
Saudi Arabia	Dhahran	17	Atopic, Saudi Arabs	806	SPT	94
	Dhahran	32	Atopic, Expatriates	241		
South Atlantic						
Tristan da Cunha		20	General population	282	SPT	95
Tristan da Cunha		13	Born >1y after cat extermination	51		
South East Asia						
Thailand	Bangkok	10	Child asthma	100	SPT	96
	Bangkok	29	Adult rhinitis	100	SPT	97
Malaysia	Kuala Lumpur	73	Rhinitis	314	SPT	98
Japan						
	Sagamihara	78	Adult asthma	90	IgE Ab	99
	Sagamihara	31	Asthma and/ or rhinitis	458	SPT	100
	Tokyo	70	Child asthma, cat at home	44	IgE Ab (PCS)	39
	Tokyo	34	Child asthma, no cat at home	394		
Australia						
	Sydney	4	Child, general population	1217	SPT	101

PCS = Pharmacia CAP System®

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e220 Cat serum albumin

Felis domesticus

Family: *Felidae*

Common names: Cat, Domestic cat

Source material: Serum albumin

See also: Cat dander e1

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components in house dust.

Allergen Exposure

Geographical distribution

The Cat has been domesticated (probably from the small North African wildcat *Felis lybica*) for around 5,000 years. Cats have been greatly valued as destroyers of vermin, as well as for their ornamental qualities and their personalities as companion animals. Domestic Cats vary considerably in coat colour, quality and pattern, especially among the varieties bred for show. Cats occur in approximately 25% of Western households.

Environment

As well as in households and on farms, Cats are often found in a feral state in cities and rural environments. Rome has contained as many as a million feral Cats.

Allergens

Allergenic activity has been demonstrated in extracts of Cat dander and pelt (1-12), in serum (2-3,7,13) in urine, (8-9,11,13) and in saliva (9-13).

Various allergens have been isolated and characterised to date.

Fel d 1 (formerly Cat 1 or Ag 4) (14-15).

Fel d 1.1.

Fel d 1.2.

Fel d 1.3.

Fel d 2 (albumin) (16-17).

Fel d 3, Cystatin, 11 kDa, a cysteine protease inhibitor (18).

Albumin (Fel d 2), a 65-69 kDa protein, is found in serum, dander and saliva. About 15%-25% of Cat-allergic individuals are sensitive to Cat albumin, and for a few patients this may be the predominant allergen (1,19-23).

In a study that analysed sera from 43 individuals with a history of cat allergy, 39.5% were positive to Cat pelt, 37.5% to cat saliva, and 12% each to Cat urine and serum. The Cat pelt and saliva extracts contained allergen 1 (Fel d 1), but Cat serum and Cat urine collected by bladder puncture had no detectable levels of this allergen. A crossed immunoelectrophoresis/crossed radioimmunoelectrophoresis analysis failed to reveal any allergen in urine or serum that was not also present in the saliva or pelt preparations, although urine had two allergens not present in serum. When serum from a patient who had specific IgE antibodies to Cat pelt, serum, saliva, and urine was tested by crossed radioimmuno-electrophoresis, it was determined that a total of 6 allergens were detectable in Cat pelt, 3 in Cat urine, and 6 in Cat serum. Since Cat serum contains no detectable Cat allergen 1 (Fel d 1), it was concluded in this study that at least 7 allergens derived from the Cat are capable of binding to IgE antibodies in humans (24).

Although more than 12 allergens have been identified, Fel d 1 is the most important one. Fel d 1, a 38 kDa protein, is found in hair, dander and saliva.

Potential cross-reactivity

Albumins from Cat, Dog and Horse share some epitopes that account for the cross-reactivity observed in around a third of patients sensitised to Cat, Dog and Horse, but more than 50% of specific IgE that cross-reacts among these 3 animals is directed to allergens other than albumin (25-26). Significant cross-reactivity has been reported between Cat hair and Dog dander in specific IgE inhibition studies, whereas saliva and urine were more species-specific (27). Although a high degree of sequence homology exists among different animal albumins, a remarkable variability of IgE cross-reactivities has been observed, indicating that some patients are sensitized preferentially against certain albumins. Most of the patients allergic to albumins, however, reacted to Dog, Cat, and Horse albumin, which also bound a high percentage of albumin-specific IgE (28).

Some Cat-allergic individuals are likely to experience allergic symptoms following the consumption of Pork. Inhibition experiments showed that the spectrum of IgE reactivity to Cat serum albumin completely contained IgE reactivity to Porcine serum albumin. Sensitisation to Cat appears to be the primary event. Sensitisation to Cat serum albumin should be considered a useful marker of possible cross-sensitisation not only to Porcine serum albumin but also to other mammalian serum albumins (17).

Clinical Experience

IgE mediated reactions

Asthma, occupational asthma, allergic rhinitis and allergic conjunctivitis are commonly induced by Cat allergens (29-30). Domestic animals represent the second most important group of indoor air allergens after House Dust Mites (31). Sensitisation may occur even following unobserved exposure to Cat (32). Cat dander allergens have even been found in dust storms (33).

Studies throughout the world, wherever Cats are common domestic pets, report high sensitisation to Cat dander. Sensitisation to Cat serum albumin has not been investigated to the same degree.

In Quebec, Canada, skin-specific IgE in 3,371 consecutive patients revealed that the prevalence of sensitisation in atopic subjects to Cat hair epithelium was 76.5% (34).

In Vienna, Austria, skin- and serum-specific IgE determination led to the conclusion that Cat dander positivity was high in patients with respiratory allergy as well as normal individuals. The prevalence of sensitisation to Cat dander was highest in individuals with allergic rhinitis (44%) (35). In 512 adults in southeastern France, serum-specific IgE to Cat was surprisingly low, with 0.9% of the group shown to have these antibodies (36).

Pet dander is one of the most common allergic triggers (17%) in the UK (37). In Krakow, Poland, skin-specific IgE was positive for Cat dander in 11.4% of 311 children (38). Cat dander was also shown to be an important allergen in Turkey (39).

In Sweden, serum IgE antibody assays on 165 children with respiratory symptoms confirmed that there was a high degree of sensitisation to Cat, Dog, and Birch in Northern Sweden. Cat and Dog allergens were present in almost all of the school samples. By contrast, Dust mite and Cockroach allergens were generally unmeasurable (40).

Other reactions

See also: Cat dander e1.

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e218 Chicken droppings

Gallus domesticus

Family: *Phasianidae*

Common names: Chicken, Hen, Cock, Cockerel

Source material: Droppings

See also: Chicken f83 for allergy to Chicken meat, Chicken feathers e78, and Chicken serum albumin Re219

Direct or indirect contact with Chicken allergens may cause sensitisation.

Allergen Exposure

Geographical distribution

The Chicken (which probably originated as a jungle fowl in southwestern Asia) was one of the earliest animals to be domesticated, possibly as early as 4,000 BC. They were popular in China and among the Greeks and Romans, and are now distributed virtually throughout the world. They form by far the most important class of poultry, raised principally for their meat and eggs. The current trend is towards specialisation, with some Chicken raisers producing hatching eggs, others eggs for table use, and others raising Chickens to market as meat. Many distinct Chicken breeds have been combined through selective breeding into a few relatively standard types that are notably efficient converters of feed into meat or eggs. The dominant meat Chicken today is a cross between the fast-growing female White Plymouth Rock chicken and the deep-breasted male Cornish chicken. The predominant egg-laying type in the United States today is the White Leghorn chicken.

Environment

Breeders as well as workers in the Chicken food processing industry are examples of groups with high risk of exposure. Other means of exposure are pillows made of Chicken feathers, arts and crafts that include Chicken feathers, and wing feathers used in fletching arrows. A few breeds of Chicken are raised chiefly for their ornamental appearance or as pets.

Allergens

No allergens have yet been characterized.

Allergen exposure may occur from contact with Chicken feather, Chicken serum or Chicken droppings. Chicken droppings may contain, similarly to Pigeon droppings, excreted serum protein antigens, which may have been degraded, making identification difficult. Droppings may also include bacterial endotoxin and other non-species-specific biological substances.

Potential cross-reactivity

Positive IgE antibody reactions to sera and feathers from 5 bird species (Pigeon, Budgerigar, Parrot, Canary and Hen), and to Pigeon droppings, have been found in subjects with Bird Fancier's Asthma (10). Since antibodies of each of the patients also recognized antigens of birds with which they were not in contact, immunological cross-reactivity between different avian species was suggested.

e218 Chicken droppings

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Chicken feathers, epithelial cells or droppings. The allergic manifestations may present as Bird Fancier´s Asthma and as so-called Bird-Egg Syndrome with symptoms such as rhinitis, urticaria and angioedema (1), and also gastro-intestinal problems (2). Contact with Chicken has been reported as a common cause of occupational asthma and allergic rhinitis (3-5) .

Contact with Chicken is a significant cause of sensitisation in poultry workers. Asthma prevalence in farmers has been found by means of a questionnaire survey to be higher for Horse breeders/groomers, Pig farmers, poultry farmers, and those working with Oats. Up to 17.4% of poultry farmers reported symptoms of asthma (6). In an avian slaughterhouse, workers may be exposed to Chicken feathers, as well as to serum and droppings allergens (7). Sensitisation in these individuals may also occur to Chicken feed (8).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Chickens (8-9) or other birds such as Pigeons, Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulins including IgE (10), IgM (11), IgA and various IgG subclasses (12-14). The antibodies may be found in the sera and saliva of patients (15).

The allergenic proteins may be found in bird serum, droppings, and feathers. Contact may result from handling birds, cleaning their cages, or exposure to the organic dust drifting from where the birds reside.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (16).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (17).

Other reactions

Chicken droppings may contain *Histoplasma capsulatum*, resulting in the granulomatous disease histoplasmosis (18).

Mites may also be a major allergen in poultry farmers. Northern fowl mite (*Ornithonyssus sylviarum*) residing in Chicken feathers may be the predominant allergen causing occupational allergy in poultry farmers (4,19). The House dust mite *Dermatophagoides evansi* was documented in dust samples from poultry farms, as well as the House dust mite *Dermatophagoides farinae*, Mites of the *Tyroglyphidae* family and/or *Mucedine* family (20). Storage mites and other predatory Mites were also found in these samples (21). *Aleuroglyphus ovatus* is a Storage mite that has a worldwide distribution and has been found in stored bran, Wheat, Chicken meal, and dried fish products (22).

Farm workers handling animal feeds are exposed to a variety of chemicals, some of which may cause allergic contact dermatitis. A case of allergy to ethoxyquin (a preservative added to Chicken feed to inhibit vitamin degradation) in a Chicken farmer is reported (23).

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e85 Chicken feathers

Gallus domesticus

Family: *Phasianidae*

Common names: Chicken, Hen, Cock, Cockerel

Source material: Feathers

See also: Chicken f83 for allergy to Chicken meat, Chicken droppings e218, and Chicken serum albumin Re219

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

The Chicken (which probably originated as a jungle fowl in southwestern Asia) was one of the earliest animals to be domesticated, possibly as early as 4,000 BC. They were popular in China and among the Greeks and Romans, and are now distributed virtually throughout the world. They form by far the most important class of poultry, raised principally for their meat and eggs. The current trend is towards specialisation, with some Chicken raisers producing hatching eggs, others eggs for table use, and others raising Chickens to market as meat. Many distinct Chicken breeds have been combined through selective breeding into a few relatively standard types that are notably efficient converters of feed into meat or eggs. The dominant meat Chicken today is a cross between the fast-growing female White Plymouth Rock chicken and the deep-breasted male Cornish chicken. The predominant egg-laying type in the United States today is the White Leghorn chicken.

Environment

Breeders as well as workers in the Chicken food processing industry are examples of groups with high risk of exposure. Other means of exposure are pillows made of Chicken feathers, arts and crafts that include Chicken feathers, and wing feathers used in fletching arrows. A few breeds of Chicken are raised chiefly for their ornamental appearance or as pets.

Allergens

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components, which cross-react with serum allergens/antigens of the same as well as of other bird species (1). The allergens have not been fully characterized yet.

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components, which cross-react with serum allergens/antigens of the same as well as of other bird species (1).

Cross-reactivity between Chicken and other phylogenetically related bird species may be expected, and in Chicken-allergic patients, significant IgE antibody titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (2-3), even in patients without known exposure (1).

In Bird-Egg Syndrome, cross-reactivity to Hen's egg occurs (2-3). IgE from patients with Bird-Egg Syndrome was shown to recognise a 70 kDa protein in egg yolk and some major allergens in bird feather extract. Chicken serum albumin is the same protein as that designated alpha-livetin in egg yolk. The sera of patients with Bird-Egg Syndrome, pooled with Budgerigar or Hen feather extract and egg yolk extract, led to complete blocking of IgE binding to allergens in egg yolk and bird feather extract. However, IgE from patients with egg white allergy did not react with allergens in egg yolk and bird feather extract, despite strong IgE binding to egg white allergens. These results indicate common epitopes of Budgerigar and Hen feather and egg yolk alpha-livetin, and researchers suggest that alpha-livetin (Chicken serum albumin) leads to a cross-sensitisation and consequently to “Bird-Egg Syndrome” (4-6). This adult type of egg intolerance must be distinguished from the common egg white allergy of atopic children.

Cross-reactivity between Hen's feather and House dust mite allergen extract has been reported. However, the authors suggest that although this may result from cross-reacting allergens, the more probable explanation is that Chicken feather extract contained *Dermatophagoides pteronyssinus* allergens or at least allergens with epitopes common to *D. pteronyssinus* allergen (7) .

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Chicken feathers, epithelial cells or droppings. The allergic manifestations may present as Bird Fancier´s Asthma and as Bird-Egg Syndrome, with symptoms such as rhinitis, urticaria and angioedema (2); and also as gastro-intestinal problems (3). Specific IgE has been found in patients exposed to Chicken feathers, and contact with Chicken has been reported as a common cause of occupational asthma and allergic rhinitis (8-11,20).

Positive specific IgE tests with feather allergens have been reported in 20-60% of patients suspected to be allergic to feathers (12-14) . The clinical relevance of these results has not been fully established (20) .

Evidence of sensitisation to Chicken feathers is reported also in other studies. A Finnish study of 598 asthmatic children reported that 10% had specific IgE antibodies to Chicken feathers (7) .

Of 269 adult patients with suspected skin and respiratory allergies tested for feathers with skin-specific IgE tests, 9% of the whole group and 14% of those positive to inhalant allergens were positive to a feather allergen. Two reacted to Duck feathers, 12 to Goose and 15 to Chicken feathers. Symptoms were reported by 58% of feather skin-specific IgE-positive patients and by 55% of other skin-specific IgE-positive patients. Positive RAST-specific IgE test was surprisingly very low (20).

In a study of 507 asthmatic atopic children in the Chieti-Pescara area of Italy, specific IgE skin tests found that 5.9% were sensitised to feathers (15).

Chicken feathers are a significant cause of sensitisation in poultry workers. Asthma prevalence in farmers has been reported by means of a questionnaire survey to be higher for Horse breeders/groomers, Pig farmers, poultry farmers, and those working with oats. Up to 17.4% of poultry farmers reported symptoms of asthma (16). In an avian slaughterhouse, workers may be exposed to Chicken feathers, as well as to serum and droppings allergens (17). Sensitisation in these individuals may also occur to Chicken feed (18).

In a selected group of patients with known allergy to bird feathers, a high frequency (32%) of sensitisation to egg proteins, in particular egg yolk, suggests that in some patients feather sensitisation could trigger or somehow facilitate the later sensitisation to egg yolk proteins (Bird-Egg Syndrome) (19).

Clinical allergy to commercial feather products is less common than usually thought, as a result of the removal of dust, washing, and drying at 125 °C. The allergens derived from unrefined feathers include bird serum proteins, bird droppings, and feather mites.

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Chickens (18,21) or other birds such as Pigeons, Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves and Finches. Exposure results in the development of immunoglobulin antibodies including IgE (1), IgM (22), IgA and various IgG subclasses (23-25). The antibodies may be found in the sera and saliva of patients (26).

The allergenic proteins may be found in bird serum, droppings, and feathers. Contact may result from handling birds, cleaning their cages, or exposure to the organic dust drifting from where the birds reside.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (27).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (28).

Other reactions

Farm workers handling animal feeds are exposed to a variety of chemicals, some of which may cause allergic contact dermatitis. A case of allergy to ethoxyquin (a preservative added to Chicken feed to inhibit vitamin degradation) in a Chicken farmer is reported (29).

Mites may also be a major allergen in poultry farmers. Northern fowl mite (*Ornithonyssus sylviarum*) residing in Chicken feathers may be the predominant allergen causing occupational allergy in poultry farmers (10,30). The House dust mite, *Dermatophagoides evansi*, was documented in dust samples from poultry farms. Storage mites and other predatory Mites were also found in these samples (31). *Aleuroglyphus ovatus* is a Storage mite that has a worldwide distribution and has been found in stored bran, wheat, chicken meal, and dried fish products (32).

Polyester-filled pillows contain significantly more total weight of Der p 1 Mite allergen (*Dermatophagoides Pteronyssinus*) than feather-filled pillows (33).

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Re219 Chicken, serum proteins

Gallus domesticus

Family: *Phasianidae*

Common names: Chicken, Hen, Cock, Cockerel

Source material: Serum

See also: Chicken f83 for allergy to Chicken meat, Chicken droppings e218, and Chicken feathers e78

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

The Chicken (which probably originated as a jungle fowl in southwestern Asia) was one of the earliest animals to be domesticated, possibly as early as 4,000 BC. They were popular in China and among the Greeks and Romans, and are now distributed virtually throughout the world. They form by far the most important class of poultry, raised principally for their meat and eggs. The current trend is towards specialisation, with some Chicken raisers producing hatching eggs, others eggs for table use, and others raising Chickens to market as meat. Many distinct Chicken breeds have been combined through selective breeding into a few relatively standard types that are notably efficient converters of feed into meat or eggs. The dominant meat Chicken today is a cross between the fast-growing female White Plymouth Rock chicken and the deep-breasted male Cornish chicken. The predominant egg-laying type in the United States today is the White Leghorn chicken.

Environment

Breeders aswell as workers in the Chicken food processing industry are examples of group with high risk of exposure. Other means of exosure are pillows made with Chicken feathrs, arts and crafts that include Chicken feathers, and wing feathers used in fletching arrows. A few breeds of Chicken are raised chiefly for their ornamental appearance or as pets.

Allergens

Allergen exposure may occur from contact with Chicken feather, Chicken serum or Chicken droppings. Chicken serum may contain, similarly to Pigeon serum, the main source of clean soluble antigens. The major antigens are gamma-globulin proteins, e.g., IgA and IgA fragments. Serum also contains the major protein albumin, which is cross-reactive with albumin from other avian species, and with other serum proteins.

Gal d 5 (1) serum albumin (alpha-livetin) Mw 69 kDa.

Gal d 5 is a partially heat-labile allergen; IgE reactivity to Chicken albumin was reduced by 88% after heating at 90 °C for 30 min. This allergen can become airborne and was found in house dust (1).

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components, which cross-react with serum allergens/antigens of the same as well as of other bird species (2).

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components, which cross-react with serum allergens/antigens of the same as well as of other bird species (2).

Cross-reactivity between Chicken and other phylogenetically related bird species may be expected, and in Chicken-allergic patients, significant IgE titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (3-4), even in patients without known exposure (2).

In Bird-Egg Syndrome, cross-reactivity to Hen's egg occurs (3-4). IgE from patients with Bird-Egg Syndrome was shown to recognise a 70 kDa protein in egg yolk and some major allergens in bird feather extract. Chicken serum albumin is the same protein as that designated alpha-livetin in egg yolk. The sera of patients with Bird-Egg Syndrome, pooled with Budgerigar or Hen feather extract and egg yolk extract, led to complete blocking of IgE binding to allergens in egg yolk and bird feather extract. However, IgE from patients with egg white allergy did not react with allergens in egg yolk and bird feather extract, despite strong IgE binding to egg white allergens. These results indicate common epitopes of Budgerigar and Hen feather and egg yolk alpha-livetin, and researchers suggest that alpha-livetin leads to cross-sensitisation and consequently to Bird-Egg Syndrome (5-7). This adult type of egg intolerance must be distinguished from the common egg white allergy of atopic children.

ELISA inhibition demonstrated only partial cross-reactivity between Chicken albumin and conalbumin (1).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Chicken feathers, epithelial cells or droppings. The allergic manifestations may present as Bird Fancier´s Asthma and as so-called Bird-Egg Syndrome with symptoms such as rhinitis, urticaria and angioedema (3), and also gastro-intestinal problems (4). Contact with Chicken has been reported as a common cause of occupational asthma and allergic rhinitis (8-10).

Contact with Chicken is a significant cause of sensitisation in poultry workers. Asthma prevalence in farmers has been found by means of a questionnaire survey to be higher for Horse breeders/groomers, Pig farmers, poultry farmers, and those working with Oats. Up to 17.4% of poultry farmers reported symptoms of asthma (11). In an avian slaughterhouse, workers may be exposed to Chicken feathers, as well as to serum and droppings allergens (12). Sensitisation in these individuals may also occur to Chicken feed (13).

Chicken serum albumin (alpha-livetin) has been implicated as the causative allergen of Bird-Egg Syndrome. Specific bronchial challenge to Chicken albumin elicited early asthmatic responses in 6 patients with asthma. An oral challenge with Chicken albumin provoked digestive and systemic allergic symptoms in the 2 patients challenged, thus demonstrating that Chicken serum albumin may cause both respiratory and food-allergy symptoms in patients with Bird-Egg Syndrome (1).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Chickens (13-14) or other birds such as Pigeons, Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulin antibodies including IgE (2), IgM (15), IgA and various IgG subclasses (16-18). The antibodies may be found in the sera and saliva of patients (19).

The allergenic proteins may be found in bird serum, droppings, and feathers. Contact may result from handling birds, cleaning their cages, or exposure to the organic dust drifting from where the birds reside.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (20).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (21).

A case of allergy to Chicken intestines has been reported (22). (Whether the reaction was due to meat allergen or serum allergens was not determined.)

Other reactions

Contact urticaria from handling meat and fowl has been reported (23).

See also: Chicken f83 for allergy to Chicken meat, Chicken droppings e218, and Chicken feathers e78.

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Re208 Chinchilla epithelium

Chinchilla laniger

Family: *Chinchillidae*

Common names: Chinchilla

Source material: Epithelium

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

The Chinchilla, a medium-sized, round-eared rodent, lives in the Andes of Bolivia, Chile, and Peru, but is rare in the wild due to hunting and loss of habitat. It is bred in captivity for its extremely dense, bluish-gray fur, valued since the days of the Inca. For its size, the Chinchilla pelt is probably the most expensive in the world, though domestic pelts are not as costly as wild ones were. The animal is also kept as a pet. Chinchillas are raised on farms e.g. in South America and the United States.

Environment

Chinchillas are found in mountain shrub and grassland areas at elevations between 3,000 and 5,000 meters. They make their dens in rock crevices. See also under Geographical distribution.

Allergens

No allergens from this animal have yet been characterized. Allergens will likely be found, as in the case of other rodents, as serum proteins, in urine, and epithelia.

Clinical Experience

IgE mediated reactions

Chinchilla allergens may induce asthma, allergic rhinitis and allergic conjunctivitis in susceptible individuals (1-2).

One study documents positive reactions, upon nasal provocation challenge tests, to Chinchilla hair extract in 4 of 6 Chinchilla-sensitised patients (1 child and 3 adults) suffering with perennial rhinitis and/or asthma (2).

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Bos taurus

Family:	*Bovidae*
Common names:	Cow, Cattle, Steer, Ox, Bull
Source material:	Dander
See also:	Cow milk f2, Beef (meat) f27 and BSA (bovine serum albumin) e204

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

Cattle were among the first domesticated animals (descended from large wild oxen), and one of the earliest measures of wealth. Domestic Cattle were first brought to the Western Hemisphere by Columbus on his second voyage, and are now known almost throughout the world. Important breeds include Angus, Hereford, Brahman, Jersey, Guernsey and Ayrshire. Cows have traditionally been kept for a greater variety of purposes than any other domestic animal, but with industrialisation and specialisation in agriculture, multiple-purpose breeds are now more rare.

Environment

Cattle are usually born and raised on rangelands. Rangelands are unfertilized and uncultured, and must contain adequate areas for grazing; otherwise irreversible damage to natural ecosystems can occur. Cows are used primarily for dairy products (milk, cheese, etc.) and meat. They are also the sources of goods such as medicines, glue, soap, and leather. Males are used for pulling large loads or for plowing the soil because of their large size and their strength. The dung is a good source of fertilizer and fuel.

Allergens

Early studies of Cow hair and dander determined 17 antigens, of which 5 were serum proteins (1-6). The allergens are proteins 11, 15, 20, 22, 36, 50, 62.3 and >200 kDa in size (7-8). Four major allergens were initially shown to be predominantly associated with hair and dander, but they were also demonstrated in Cow saliva, urine, whey, amniotic fluid and Beef, as well as in Cow-hide products (4,9).

Of these allergens, a number have been characterized.

Bos d 1, a major allergen.

Bos d 2, Mw 20 kDa, a major allergen, a lipocalin (10).

Bos d 3, Mw 11 kDa, a major allergen, a Ca-binding S100 homologue.

Bos d 4, Mw 14 kDa, alpha-lactalbumin.

Bos d 5, Mw 18 kDa, beta-lactoglobulin.

Bos d 6, Mw 67 kDa, serum albumin.

Bos d 7, Mw 160 kDa, immunoglobulin.

Bos d 8, Mw 20-30 kDa, caseins.

The lipocalin Bos d 2 is the most allergenic and is found in Cow dander and urine (11). Research suggests that Bos d 2 is produced in sweat glands and transported to the skin surface as a carrier of the pheromone ligand. Because dander allergens of a number of mammalian species are lipocalins, the common biologic function of being pheromone carriers seems to be a common feature of an important group of aeroallergens (12).

Three Bos d 2 variants have been identified and named Bos d 2.0101 (previously sequenced Bos d 2), Bos d 2.0102 and Bos d 2.0103 (13).

Cow dander extract was shown to contain more allergenic activity than skin scrapings or whole skin extracts, which were needed in about 3-fold higher amounts than Cow dander extract to induce the same degree of inhibition in ELISA. Skin scrapings and whole skin extracts contained more high-molecular-weight components than dander extract. Using the sera of 49 Cow-asthmatic farmers, 2 major allergens were detected at 20 and 22 kDa in all 3 extracts. These results show that the highest amount of allergenic material and all the essential allergens are present in Cow dander extract. The study also reported that the normally non-allergenic high-molecular-weight components are detected in low concentrations in dander extract (14).

Although Cow dander contains a number of allergens, in asthmatic farmers IgE reactivity appeared to be directed to only a few components. Two main allergens were found in Cow dander, a 20 and 22 kDa protein; and a 20 kDa protein in Cow urine. The 20 kDa component was shown to be the most important allergen in Cow antigen extracts (15), later identified as a lipocalin.

Potential cross-reactivity

A study reported that approximately 20% of Cow dander-allergic sera displayed IgE reactivity with Cow's milk proteins and that inhibition studies revealed the cross-reactive nature of the IgE antibodies. Allergens with molecular weights of 69, 92 and >200 kDa were thought to be responsible (7). Earlier studies suggested that half of asthmatic children allergic to milk will react with bronchospasm if they are exposed to inhalation of Cow's hair (16).

Major Deer allergens with molecular weights of 22 and 25 kDa have been shown to be cross-reactive with the corresponding Cow allergens (17). Cross-reactivity between Fallow deer and Horse allergen extracts has been shown, but whether some cross-reactivity may exist between Cow dander and Horse dander has not been determined as yet (18).

Clinical Experience

IgE mediated reactions

Cow dander is a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis in farmers (7,19). Atopic dermatitis due to Cow hair and dander has also been reported (20-21). Atopic dermatitis has been described in a child due to Cow dander allergy (22). Cow dander may also result in protein contact dermatitis (23). Hand eczema due to Cow allergens has been reported to be common in Finnish farmers (24). Occupational allergy to Cows has also been described in veterinary surgeons (25) .

Bovine allergens have been reported to be the most prevalent causes of animal-induced allergic rhinitis in Finland, where about 1 in every 4 cases of occupational rhinitis is animal-induced. The largest patient group affected are dairy farmers. In a study of 106 farmers with allergic rhinitis, positive allergen challenges with Cow dander occurred in 20% (26). Similar results have been reported from similar studies of individuals allergic rhinitis, among whom the incidence with allergy to Cow was reported to be 15%. Of 32 patient sera, 23 were positive to Cow dander but only 2 were positive to Cow serum; patients who had IgE antibodies to Cow dander also had antibodies to Cow serum, but not the reverse (27).

Cow dander has also been reported to be the most common cause of occupational contact urticaria in Finland. In a case report, a patient was described with a combined type I and type IV allergy to Cow dander. She had complained of intense pruritus, whealing, and severe dermatitis, but no respiratory symptoms (28-30).

Cow dander has been recognised as an important aeroallergen in the aetiology of bronchial asthma in subjects from India (31) and Turkey (32). In Eastern Poland, sensitisation without the manifestation of symptoms has been reported. In 68 farmers from 17 randomly selected family farms, no farmer complained of symptoms when working with Cows or Pigs. Yet in 13 farmers (19.1%) either positive skin-specific IgE and/or the presence of serum-specific IgE to Cow dander and/or Pig epithelia was found. Seven farmers (10.3%) were positive to skin-specific IgE tests: 2 to Cow epithelium; 2 to Pig epithelium; and 3 to both allergens. Serum-specific IgE was also found in 7 farmers (10.3%): in 4 to Cow dander; in one to Cow epithelium; and in 2 to both allergens. Only one farmer showed a positive reaction to Cow allergens in both skin tests and IgE (33).

The same authors in another study concluded that detection of animal antigen-specific IgE may be a useful screening tool, although an exact assessment of sensitivity and specificity of the method in a larger population of exposed farmers will be required (20).

Veterinarians have developed contact urticaria (itching, swelling, and urticaria on hands and arms) after contact with amniotic fluid of Cows and/or Pigs. Skin- and serum-specific IgE tests done with self-prepared allergens were positive. The authors suggest that the allergen causing contact urticaria is a compound of amniotic fluid and serum but does not include the epithelia of these animals (34).

Among dairy farmers, Storage mites are reported to be as common as Cow dander as the cause of allergic occupational rhinitis (26).

Other reactions

A negative aspect of Domestic cattle husbandry is the disease Bovine Spongiform Encephalopathy, better known as Mad Cow Disease. Mad Cow Disease is a fatal degenerative brain disease, which is caused by a protein known as a prion. In humans, the equivalent disease is Creutzfeldt-Jakob Disease (CJD), which causes rapid dementia and neurological damage leading to death. The diseases are now believed to be linked to eating Beef from infected Cows.

See also: Cow's milk f2, Beef (meat) f27 and BSA (bovine serum albumin) e204.

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Re216 Deer epithelium

Dama dama

Family: *Cervidae*

Common names: See below

Source material: Epithelium

Direct or indirect contact with animal allergens may cause sensitisation.

Allergen Exposure

Geographical distribution

Deer are ruminant mammals of the family *Cervidae*, native to most areas of the world outside of Australia, Africa south of the Sahara, and Antarctica, and now introduced almost worldwide. Widely divergent types are the tiny Andean pudu, Elk, Caribou, Moose and Reindeer. Antlers, solid bony outgrowths of the skull, develop in the males of most species and are shed and renewed annually. Deer have a number of glands on their feet, legs, and faces; these are used in communication. The White-tailed deer that live in woodlands throughout the United States and in Central America and northern South America were a source of food, buckskin, and other necessities for Native Americans and white settlers. Slaughter through the years nearly exterminated this Deer, but it is now restored in large numbers in the Eastern United States and to a lesser extent in the West. Old World deer include the Red deer, the Fallow deer, and the Axis deer.

Deer have considerable economic importance around the world. They are hunted for sport, for meat, and for their hides. Reindeer are important domestic animals in the far north. Several species have nearly been extirpated. A few others have been introduced far outside their natural ranges, often to the detriment of native species.

Environment

Deer occupy a wide range of habitats, from arctic tundras to tropical forests. Some Deer are solitary, but most live in herds that vary from a few individuals to many. Most species are browsers, but some include a substantial proportion of graze in their diets.

Allergens

Deer allergens with the molecular mass of 110, 72, 60, 59, 45, 25, 22 and 21 kDa have been identified. The 22 and 25 kDa proteins were determined to be major allergens (1-2). No allergens have been characterized to date.

In experiments using patient sera in specific IgE inhibition, IgE antibodies were directed to allergens common to pelt/hair/dander, urine, and serum. Pelt contained the most potent allergenic fractions (3).

Potential cross-reactivity

The 22 and 25 kDa allergens from Deer dander have been shown to be cross-reactive with the corresponding Cow allergens (1). Fallow deer allergens and Horse allergen extracts were shown to be cross-reactive (4).

Re216 Deer epithelium

Clinical Experience

IgE mediated reactions

Exposure to Deer dander may result in asthma, occupational asthma, allergic rhinitis, allergic conjunctivitis and anaphylaxis (1,4-5). Allergic reactions occur mostly in hunters, farmers and hunting guides.

A 25-year-old housewife in Mexico City developed rhinitis and asthma following exposure to Fallow deer in an animal park close to her home (4).

Urticaria, angioedema, and dyspnoea requiring epinephrine occurred in a 4-year-old boy following contact with Deer. He had had a mild reaction, after indirect exposure to the animal, 5 days prior to this episode of anaphylaxis. IgE-mediated tests were positive for Deer and Cow by both selective skin-prick method and RAST results (6).

Deer dander can induce occupational asthma through IgE-mediated mechanisms, as reported in a farmer raising Deer. Skin-specific IgE elicited positive reactions to dander extracts from Goat, Sheep, camel, and Cow as well as to Deer dander extract (1). Hunters are also susceptible to developing allergic symptoms following contact with these animals (3).

A postal questionnaire was sent to a random sample of 2,500 farmers throughout New Zealand. It was found that asthma prevalence was higher for Horse breeders/ groomers, Pig farmers, poultry farmers, and those working with Oats. Hay fever was significantly higher in Deer and crop farmers, and farmers working with Horses and Goats; eczema was higher for Goat and Deer farmers (7).

Other reactions

Contact urticaria from Roe deer meat and hair has been reported (8).

A boilermaker who engraved Deer bone (scrimshaw) as his artistic avocation developed recurrent anaphylaxis while scraping Deer bones (9).

Deer ked (*Lipoptena cervi L.*), a haematophagous louse fly of Deer, also attacks man and can cause persistent pruritic papules (10).

Lyme disease, from which severe neurological, muscular, cardiac and other damage can result, is carried by a spirochete transmitted by the Deer tick (*Ixodes sarcoptii*), which is prone to attaching to humans in grassy and woodland areas.

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Canis familiaris

Family: *Canidae*

Common names: Dog, Domestic dog, Hound

Source material: Dander/Epithelium/ Serum albumin

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house dust.

Because of the close interrelationships of Dog dander e5, Dog epithelium e2, and Dog serum albumin Re221, this single document will cover all of these allergens. The basic differences, to be described more fully further below, are the following:

Dander is the material shed by the Dog into the environment through hair and "dandruff". Dander is the "end product" and by far the most common source of Dog allergens and contains the highest proportion of Dog-specific allergens. It has naturally figured very prominently in clinical research, but all 3 allergen sources are important for an understanding of Dog allergy.

Epithelium is prepared by scraping off the epithelial layer from the skin.

Dog serum albumin is a protein mainly present in the serum. One exposure route is through saliva, but Dog serum albumin is also present in a fair amount in the skin (epithelium).

Allergen Exposure

Geographical distribution

The Dog, a relative of the wolf, the jackal, and the Fox, was one of the earliest domesticated animals, living in human communities as early as 12,000 years ago. Dogs remain pack animals and regard themselves as the lowest-ranking members of a human household. They are therefore very pliant in their behaviour and have been put to a great many uses, including herding, hunting, guarding, and pulling loads. More than 800 breeds have been developed according to human needs and preferences. Dogs are found in almost every human environment. In the industrialised world, they are nearly always companion animals, and because of their friendliness often live indoors and are frequently handled. There are around 68,000,000 owned Dogs in the United States alone.

Environment

Dogs are regularly found in households and on farms, but also in a feral state in cities and rural environments (though not in such large numbers as Cats). In the latter, they may form packs and become a danger to herd animals. Unvaccinated Dogs are also major spreaders of rabies.

Dog allergens have been found in serum, dander, pelt, hair and saliva, with the latter 4 being the most important, whereas Dog urine and faeces do not have any significant allergenic activity (1-3,38,44). (Extracts prepared from Dog liver, serum, salivary glands, and keratinocytes contain fewer IgE binding components (4).) Although allergen differences occur according to the origin of the allergen (e.g., epithelium or saliva), no breed-specific allergens occur (5-6,34,38-39). (This is contrary to much earlier studies (7-8).) But the concentration of allergens varies within breeds and among them (44).

Animal dander is extremely light-weight and tiny in size (approx. 2.5 microns; 1 micron = 1/25,000 inch) and can stay airborne for hours. Dog and Cat serum albumin are very common allergens present in house dust, whereas Horse serum albumin is present only in the near vicinity of the animal (9). But it is important to note that allergen levels in air do not always correlate with those found in dust (10). Older animals produce more dander than younger ones, because their skin is drier. The epidermal turnover is more rapid in Dog breeds that are prone to the various forms of dry and oily seborrhoea. Instead of the normal 21-day cycle, the epidermal turnover time of seborrhoeic Dogs is 3 to 4 days. Dog epithelia IgE antibody concentration has been reported to show a seasonal variation, although this might also be due to seasonal variation in testing routines (11).

Levels of Dog allergen in houses with Dogs may reach high levels, usually over 10,000 ng of Can f 1, the major Dog allergen, per gram of dust (12). Explained from another angle, exposure to Cat or Dog allergen airborne in homes with an animal can be up to 100 times higher than exposure to mite allergen (13-14). Levels in homes without Dogs are generally 10 to 100 times lower but can still be detected. Occasionally, high Dog allergen levels can be found in households without a pet, if the former occupants of the same household have had a pet, or if Dogs often visit the building (14). Similar findings have been reported from other studies. High levels of Can f 1 (> 10,000 ng) were found in dust in all but 1 of 50 homes with Dogs and in 8 of 50 homes without Dogs (28).

Airborne Can f 1 levels varied greatly among the homes with Dogs (range: 0.3 to 99 ng/m^3). Approximately 50% of Can f 1 was shown to be carried on large particles, > 10 µm in diameter, and similarly to Cat allergen, approximately 20% was carried on particles < 4.7 µm in diameter. Airborne Can f 1 carried on small particles may remain airborne for long periods of time, unlike Dust mite allergen, which is carried on larger particles that fall rapidly to the ground after a disturbance (28).

In houses with Dog allergen, the highest concentration appears to occur on the living-room floor, on furniture, and in bedrooms. Dog allergens are, however, also prevalent on walls, smooth floors, and finished furniture in homes with and without pets (15).

Washing the Dog achieves a modest reduction in the level of airborne Can f 1 in homes with a Dog. The Dog needs to be washed at least twice a week to maintain the reduction in recoverable Can f 1 from its hair (16).

Importantly, synthetic pillows have been reported to contain significantly more pet allergens than feather pillows, supporting the view that tightly woven encasements surrounding feather pillows act as a barrier against pet allergens (17).

Dog allergens can be detected not only in houses where Dogs are kept as pets, but also in other places such as schools and day-care centres where Dogs are not present on a regular basis (18-23). The allergens appear to be transported on clothes and may be present in relatively high concentrations (24). Furnishings and textiles in the classroom act as significant reservoirs of irritants and allergens and have an impact on the indoor air quality at school (25).

Concentrations of Can f 1 may be greater in dust collected in schools than in homes (26). In Sweden schools have been reported to be a major site of exposure to Cat and Dog allergens (27). In Swedish day-care centres, Dog allergen were shown to be present but usually at lower levels than in schools. In schools, the allergen levels ranged from 1,700 ng to 28,200 ng (Can f 1)/g dust on the chairs and 56 to 506 ng/g on floors (19). Lower levels in day-care centres were explained by the fact that their floors were cleaned daily by wet sweeping (22).

Furthermore, it has been shown that upholstered seats in public places constitute a reservoir for the accumulation of Dog allergen, and a source of exposure to Can f 1 inside public buildings and on public transport (29). In a study of Helsinki City Transport buses, trams, and underground trains, which carry 687,000 passengers on a weekday, the median concentration of Can f 1 in dust from seats and floors in the vehicles was determined to be 2,400 ng per g of dust (range 20 to 8,500 ng/g). Although these levels are not very high, they are high enough to cause symptoms in sensitive persons (30).

Even most automobile seats have been shown to have levels of Dog and Cat allergen that were well above the threshold levels considered to be risk factors for both sensitisation and symptoms, regardless of the presence of a pet in the home. The presence of live and dead mites and Mite, Cat, and Dog allergens in automobiles and on clothing suggests that both are means of dispersal of Mites and of Mite and pet allergens (31).

Upholstered chairs in hospitals constitute a significant reservoir of Cat and Dog allergen, and inhalation of airborne allergen by patients attending their hospital appointments may exacerbate asthma in those highly allergic to Cats or Dogs (32).

In facilities used for Dog shows, the Dog allergen prevalence may be exceptionally high, up to 2,100,000 ng Can f 1/g dust (33).

Unexpected exposure

Dog allergen particles can spread huge distances by many means, so that they can be found in practically any environment not specially sterilised. (See under Environment for examples.)

Allergens

As noted above, Dog allergens have long been detected in serum, dander, pelt, hair and saliva, with the latter 4 being the most important, whereas Dog urine and faeces seem to be less allergenic (1-3,38,44). (Extracts prepared from Dog liver, serum, salivary glands, and keratinocytes contain fewer IgE binding components (4)). Although allergen differences occur according to the origin of the allergen (e.g., dander, epithelium or saliva), no breed-specific allergens occur (5-6,34,38-39). (This is contrary to much earlier studies (7-8)). But the concentration of allergens varies within breeds and among them (44).

Animal dander is not the hair or fur of the animal, but the particles, comprising mainly old skin scales, that are constantly shed. However, the term "dander" is not well defined (34). Dog hair and dander are complex mixtures of components (35). However, clean pure hair does not contain allergens. Early studies reported that 2 allergens were present in dander: a Dog-specific one and another cross-reacting with Cat epithelium. Both were present in the dander of Dachshund, Airedale terrier, Poodle and Boxer (36). Since these early studies, over 24 antigens have been isolated from Dog dander extract, at least 7 of which are of allergenic importance. Some of these allergens have been identified as serum components such as albumin and gamma-globulin (37-39). The most important and specific allergen is the lipocalin Can f1.

Table 1. Dog allergens

Name	MW (kDa)	Main source	Function
Can f1	25	Dander, saliva	Lipocalin
Can f2	27	Dander, saliva	Lipocalin
Can f3	69	Serum, dander, epithelia, saliva, salivary gland, liver	Albumin
Can f4	18	Dander	

In Dog hair/dander extracts, 2 IgE-antibody-binding components with molecular masses of 23 kDa and 19 kDa have been isolated. These were designated Can d 1 and Can d 2, respectively, and were found in sera of approximately 74% of Dog-allergic individuals (39). These have since been renamed Can f 1 and Can f 2.

In another study, sera from 96% of patients with Dog allergy demonstrated specific IgE to these allergens. Can f 1 was preferentially detected in the (dander) extract and saliva, but not in skin, salivary gland, serum and liver extracts. Can f 2 was strongly expressed in skin, but not in dander, serum and liver (40-41).

Can f 1 is a major allergen and the most important Dog allergen, and Dog dander and saliva have a high content of it (38,42-44). The protein is produced in the canine Von Ebner's glands, which are small lingual salivary glands opening in the lingual epithelium. This protein actually ranges from 21 kDa to 25 kDa and is found in dander and saliva, but not in serum, and is a lipocalin (45-46). Dog urine and faeces contain very little of this allergen (44,47). More than 90% of Dog-allergic patients have been shown to have specific IgE directed to this allergen (42,44,48-49). Can f 1 was originally named Ag13 and found to be identical to Ag8 (44). It was also, as mentioned above, previously known as Can d 1. Can f 1 has demonstrated greater heat resistance than Mite allergens after 60 min at 140 °C (50). The protein is also relatively stable in house dust (49).

Can f 2, previously known as Can d 2, a protein with a molecular weight of 19 kDa (39) or 27 kDa (47), is found in dander and saliva (39,47). It is a lipocalin and has homology with Mouse urinary protein (MUP) (44,48) (51). Human IgE binding studies have confirmed the relevance of this allergen. It was found to react with IgE antibodies of 66% of Dog-allergic patients, and to bind 23% of the IgE antibodies directed against Dog dander extract, confirming its role as a minor allergen (44).

Can f 3, Dog serum albumin, a 69 kDa protein, is found in dander, hair, epithelia, saliva, and serum (52-53). It has also been found in salivary glands (parotid and submandibular) and liver (39). In one study, up to 90% of Dog-specific IgE antibodies were directed to Dog albumin in sensitised patients (4). This is in contrast with a study that reported that in 203 asthmatic children studied with regard to Dog serum albumin allergenicity, significant skin-specific IgE antibodies to Dog serum albumin were detected in only 9 of the 80 subjects who had significant skin-specific IgE to Dog dander and hair (54). Similarly, in 70 Dog-allergic subjects, serum-specific IgE to Dog serum albumin was found in approximately 40% (39). Dog serum albumin has also been reported to be an abundant allergen in Dog epithelia extracts (55). In 49 subjects hypersensitive to Cats and/or Dogs, serum albumin elicited intracutaneous reactions in most, but gave positive nasal provocation and RAST results in only a few and was, therefore, reported to be of limited clinical importance (1). Other studies have reported this allergen to be a minor allergen (39) (56).

Can f 4 is an allergen found in Dog dander.

Two serum proteins, alpha-1-antitrypsin and IgG, have been identified as minor allergens (2).

A distinct 19 kDa protein allergen has also been described (57).

Potential cross-reactivity

An extensive cross-reactivity among the different breeds of Dog could be expected.

Frequently, clinical observation has noted that many patients allergic to Cats are also allergic to Dogs. Many studies suggest evidence for cross-reactivity between some Cat and Dog allergens: in an early RAST inhibition study, significant cross-reactivity was observed between Cat hair and Dog dander, but saliva and urine were shown to be more species-specific (58).

Among 109 patients with animal allergy, allergens of similar molecular weight were detected in sera from 68 patients with both Cat and Dog allergy. Common as well as species-specific IgE epitopes of the major Cat and Dog allergens could be demonstrated by

IgE inhibition studies. The authors concluded that shared IgE epitopes of the major Cat and Dog allergens may provide an explanation for the clinical observation that allergies to Cats and Dogs are frequently associated (59).

However, several studies report an actual common allergen or allergens as responsible for the cross-reactivity, and these allergens appear to be serum albumin and lipocalin.

In a study reporting that Dog dander-specific IgE antibodies were inhibited by Cat epithelium allergens, 2 allergens were detected – one closely related to the major Cat epithelium allergen, the other Dog-specific. Both were present in the dander of Dachshund, Airedale terrier, Poodle and Boxer (36). Other studies have concurred, and attributed the cross-reactivity to a 69 kDa protein common to both (60). This protein was probably what is recognised today as serum albumin.

Albumins occur at high concentrations in animal hair/dander extracts and represent important cross-reactive allergens for up to 35% of patients with animal allergy (4,58). Albumins are minor allergens, i.e., few patients react to them. But sera from patients who are sensitised against albumins often contain a high percentage of albumin-specific IgE. Cat and Dog albumins are minor cross-reacting allergens that share a high degree of homology and cause sensitisation in 14% - 23% and 35% of Cat- and Dog-allergic patients respectively, and this may help explain the Cat-Dog cross-reactivity phenomenon (4,58). Significant sequence homologies of greater than 75% were found with albumins from different species: human, Pig, Cattle, Sheep, Mouse and Rat. The presence of common IgE-reactive epitopes among the major Cat and Dog allergens explains why many patients with animal allergies react to Cat and Dog hair/dander extracts (58).

In IgE immunoblot inhibition studies and histamine release tests, it has been demonstrated that patients who react to Dog albumin exhibit IgE reactivity with purified albumins from Cat, Mouse, Chicken, and Rat. The proportion of Dog-specific IgE directed against Dog albumin was determined for patients allergic to Dog albumin, and it was found to range from 70% to 90%. The deduced amino acid sequence of this protein was compared with the Swiss-Prot library, and significant sequence homologies were found with albumins from different species (human: 82.6%, Pig: 81.8%, Cattle: 77.3%, Sheep: 78.8%, Mouse: 75.8%, and Rat: 76.2%) (4).

Individuals clinically allergic to Horse could be sensitised to Horse serum albumin. These anti-horse albumin antibodies may cross-react with Dog serum albumin as well as other serum albumins from different origins (9). In a study assessing the importance of albumin as a cross-reactive allergen in patients sensitised to Cat, Dog and Horse, 117 patients sensitised to Cat were tested for IgE reactivity using skin-specific IgE determination and RAST assays with Cat, Dog and Horse hair/dander extracts and their purified albumin extracts. Twenty-two percent of patients exhibited specific IgE to Cat albumin; 41% of patients sensitised to Cat were also sensitised to Dog and Horse. Of these patients, 21% had IgE antibodies to 3 albumins and 17% to 2. IgE binding to Horse extract was inhibited to 30% by its homologous albumin, and IgE binding to Cat and Dog extracts almost to 15% by their respective albumins. The study concluded that albumins from these 3 animals share some epitopes that account for the cross-reactivity observed in around a third of patients sensitised to Cat, Dog and Horse. However, more than 50% of specific IgE that cross-reacted among these 3 animals was directed to allergens other than albumin (61). Other studies have investigated Horse-Dog cross-reactivity and concluded that there were extensive but variable degrees of cross-reactivity between serum albumins, including human albumin (53).

Cross-reactivity has been described between Pork and Cat epithelia and attributed to serum albumin. In that report, the authors described anaphylaxis in an individual following consumption of wild boar meat (62).

Major respiratory allergens of Dogs, Mice, Rats, Horses and Cows belong to the lipocalin group of proteins. The sequence identity of lipocalins is often less than 20%, but they contain between 1 and 3 structurally conserved regions, and their 3-dimensional structures are similar (46). The Cat allergen cystatin (Fel d 3), a cysteine protease inhibitor, was shown to have the cysteine protease inhibitor motif also partially conserved in the Dog allergen sequences Can f 1 and Can f 2, which are lipocalins (51).

Allergens with the same molecular weight have been determined in Mink, Blue fox, Silver fox, raccoon, Dog, and fitchew fur and urine extracts. Common IgE-binding epitopes, probably common allergens (especially the 62-67 kDa bands), have been suggested. IgE binding to the allergenic bands of these fur animal extracts was also observed in immunoblotting studies when Dog- and Cat-specific IgE-positive sera were used, and further inhibition studies of Dog-positive sera with fur animal extracts and fur-positive sera with Dog extract confirmed cross-reactivity of these IgE antibodies (63).

Clinical Experience

IgE mediated reactions

The association between pet exposure and asthma or sensitisation can be very confusing, and many conflicting findings have been published (64). Recent studies can be used to support just about any viewpoint on the issue: Dog exposure decreases (65-66), or has no effect (67) on the risk of sensitisation; asthma is negatively (67) or positively (68) associated with Dog exposure. Furthermore, Dog (and Cat) allergen is ubiquitous in human society and may affect sensitisation in predisposed individuals regardless of pet ownership (64,69-70). It has been suggested that exposure before birth or in early childhood is crucial in the process of sensitisation (71). In studies where early-life exposure to pets, or lifestyle factors associated with exposure to pets, were reported to reduce the risk of developing atopy-related diseases in early childhood, these findings may also be explained by selection for keeping pets (72).

Nevertheless, Dog dander clearly represents an important source of inhalant allergens, and many studies report that Dog may frequently induce symptoms in sensitised individuals (40-41,49,60). Symptoms include asthma, allergic rhinitis and allergic conjunctivitis. Thirty to 35% of atopic individuals display type I allergic symptoms on exposure to Cat and/or Dog allergens (4,73-74).

Fifteen percent of Finnish adolescents were reported to be sensitised to Dogs (75). In Los Alamos, New Mexico, 67% of asthmatic children were sensitised to Dog allergens (76). Specific IgE to Dog has been reportedly detected in up to 67% of asthmatic children (76), and among children with asthma, 40% were shown to have skin-specific IgE to Dog dander even though they had no direct contact with Dogs (75).

Importantly, symptoms can be caused by indirect exposure to Dog dander in schools, at work, and on public transport. Dog allergen can be transferred on a pet owner’s clothes and cause symptoms in an allergic person sitting nearby. In sensitised subjects, repeated exposure to allergens also contributes to subclinical inflammation, hyperresponsiveness, and general worsening of asthma (77-78).

Also importantly, Dog-allergic people may also be allergic to Cat: Cat allergen-specific serum IgE antibodies were detected in 71% of a group of 38 Dog dander-sensitive patients (36). Asthmatics sensitised to Cat and Dog have been shown to often also be sensitised to many other allergens (79).

Dermatitis following exposure to Dog allergens has been reported (80).

Occupational allergy to Dog allergens may also occur in animal workers, animal pelt workers, and laboratory workers. In a large epidemiological study of 5,000 laboratory workers, symptoms were reported in 26% exposed to Mice, 25% to Rats, 31% to Guinea pigs, 30% to Rabbits, 26% to Hamsters, 25% to Dogs, 30% to Cats and 24% to monkeys (81).

Interestingly, in Swedish farming households, in spite of the abundance of Can f 1, farmers were sensitised to Dogs only to a low degree (82).

Hand dermatitis in veterinarians has been reported (83).

Contamination of commercially available Dog dander skin-specific IgE preparations with the major allergens (Der p 1 and Der p 2) of the House Dust mite (*D. pteronyssinus*) has occurred, resulting in false-positive responses (84), showing the importance of using pure allergen source materials.

The effect of Dog avoidance on Dog dander-specific IgE antibody levels was studied from sera obtained from 24 subjects. Steadily high and even rising levels were observed in cases when a strict avoidance of

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Anas platyrhynea

Family: *Anatidae*

Common names: Duck; also see below

Source material: Feathers

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

Duck is the common name for wild and domestic waterfowl of the family Anatidae, which also includes Geese and Swans. It is the largest and most diverse group of waterfowl, and is hunted and bred for its meat, eggs, and feathers. Strictly speaking, Duck refers to the female and drake to the male. The ancestor of all domestic breeds (except the Muscovy of South American origin) is the Mallard, *Anas boscas*, which is found in Europe, Asia, and North America.

Environment

Ducks' environment usually depends on which of the 3 main groups they belong to: the surface-feeding Ducks such as the Mallard, Wood duck, Black duck, and Teal frequent ponds, marshes, and other quiet waters; the diving Ducks such as the Canvasback, Scaup, Scoter, Eider, and Red head are found on bays, rivers, and lakes; and the fish-eating Ducks, the Mergansers, with slender, serrated bills, also prefer open water. Ducks make long migratory flights. In northern countries a portion of the down with which the Eider ducks line their nests is systematically collected and used to stuff pillows and duvets. Large numbers of Ducks are raised in captivity and semi-captivity, especially in East Asia.

Allergens

No allergens have yet been characterized.

Potential cross-reactivity

Cross-reactivity between Chicken and other phylogenetically related bird species may be expected, and in Chicken-allergic patients, significant IgE titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (1-2).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Duck feathers, epithelial cells or droppings. The allergic manifestations may present as extrinsic allergic alveolitis (3).

Of 269 adult patients with suspected skin and respiratory allergies tested for feathers with skin-specific IgE tests, 9% of the whole group and 14% of those positive to inhalant allergens were positive to any feather allergen. Two reacted to Duck feathers, 12 to goose and 15 to chicken feathers. Symptoms were reported by 58% of patients who were skin-specific IgE positive to feather and 55% by other skin-specific IgE positive patients. Positive RAST specific IgE test was surprisingly very low (12).

e86 Duck feathers

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The allergenic proteins may be found in bird serum, droppings, and feathers. Contact may result from handling birds, cleaning their cages, or exposure to the organic dust drifting from where the birds reside.

Exposure to avian antigens results in the development of immunoglobulin antibodies including IgE (4), IgM (5), IgA and various IgG subclasses (6-8). The development of specific antibodies does not necessarily indicate disease. Forty-two workers from a poultry abattoir were examined for serum antibodies to Duck antigens and compared with healthy blood donors. The levels of IgG and IgA antibodies to Duck serum were significantly higher in poultry workers. In workers employed for less than 1 year the antibody levels were lower than in those who had been employed for a longer period of time. The IgA antibody level to a high-molecular-weight *Aspergillus* antigen was higher in poultry workers than blood donors, whereas the level of other Aspergillus antibodies were similar in the 2 groups. No cases of allergic alveolitis were found (9).

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (10).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (11).

Clinical allergy to commercial feather products is less common than usually thought, as a result of the removal of rough-dry dust, washing and drying at 125 °C. The allergens derived from unrefined feathers include bird serum proteins, bird droppings, and feather Mites (12).

Other reactions

Polyester-filled pillows contain significantly more total weight of Der p 1 Mite allergen (*Dermatophagoides pteronyssinus*) than feather-filled pillows (13).

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Re217 Ferret epithelium

Mustela putorius

Family: *Mustelidae*

Common names: Ferret, Household ferret, Polecat

Source material: Epithelium

The word Ferret is generally applied to the domesticated variety (*Mustela putorius furo*) of the Polecat.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

Common in the Old World, Ferrets have been used for centuries to hunt Rats, Mice, and Rabbits. They are ferocious, and may attack animals much larger than themselves. Domestic Ferrets are found in many colours, including albino, brown, and black. They are Weasel-shaped, and, like all mustelids, have well-developed anal scent glands. Polecats help to control rodent populations in the wild. They have also been hunted for their fur, which is considered valuable, though not as valuable as that of other mustelids such as Mink or Ermine.

Environment

Polecats prefer to live along bodies of fresh water, in wetlands, on the edge of forests, or in grasslands with islands of scrub trees. Ferrets, though domesticated, are generally kept outdoors because their odour may be very strong.

Allergens

Specific serum IgE from a patient with Ferret allergy was shown to bind to 4 protein bands (103, 81, 28.8 and 14.8 kDa) in the male and female urine but none in the hair. IgG-depleted serum bound to 2 additional bands (213 and 41.2 kDa) in the urine and to 2 bands (81 and 10.1 kDa) in the hair (1). No allergens have been characterized yet.

Potential cross-reactivity

In a report on Ferret allergy, the authors note that in a Mink-allergic subject, specific IgG to Ferret interfered with the specific IgE measurement; it is hypothesized that the Mink-allergic subject's serum contained similar competing antibodies (1). Mink is a mammal of the same family as Ferret.

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis, allergic conjunctivitis and contact dermatitis (1).

A 41-year-old male experienced a near-fatal asthma episode after washing his Ferret. He had experienced pruritis and erythema of the skin where he had been in contact with the animal (1).

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Re214 Finch feathers

Lonchura domestrica

Family: *Fringillidae*

Common names: Finch; also see below

Source material: Feathers

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

Finch is the common name for members of the *Fringillidae*, the largest family of birds (including over half the known species), found in most parts of the world except Australia. Finches are characterized by their stout, conical bills, used to crack open the seeds that form the bulk of their diet. They are valued as destroyers of weed seeds; many also eat harmful insects. Since seeds, unlike insects, are not influenced by weather, many Finches are year-round residents in colder areas. The Finches, which are considered the most highly developed of the birds, are widely diversified. In addition to birds whose names, such as Goldfinch, designate them as Finches: Sparrows, Buntings, Towhees, Juncos, Grosbeaks, Cardinals, Bramblings, Siskins, Linnets, Redpols, Canaries and Crossbills are all Finches.

Environment

Finches' wild environments are extremely diverse; Canaries are known mostly through captivity.

Allergens

No allergens from this bird have yet been characterized.

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to bird allergens (1). The allergenic proteins may be found in bird serum, droppings, skin scales, feathers and, in the case of Pigeons, Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). Contact may result from handling birds, cleaning their lofts, or exposure to the organic dust drifting down from a ceiling or roof where birds nest.

Extrinsic allergic alveolitis, also known as Hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulins, including IgE (1), IgM (2), IgA and various IgG subclasses (3-5). The antibodies may be found in the sera and saliva of patients (6) as well as in the sera of asymptomatic but exposed subjects (7).

Hypersensitivity pneumonitis due to Finch feathers has been reported. Serum-precipitating antibodies to Finch extract were positive, and the patient improved after removal of Finches (8).

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (9).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of Extrinsic Allergic Alveolitis (10).

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Re210 Fox epithelium

Vulpes vulpes

Family: *Canidae*

Common names: Fox, Red fox, Common red fox, Tod

Source material: Epithelium

Most Fox species belong to the Red fox group, genus *Vulpes*.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens may be major contributors to allergy in occupational settings, e.g., furriers' premises.

Allergen Exposure

Geographical distribution

The Common red fox is found in Eurasia, North Africa, and North America. Foxes live almost throughout the world, but are particularly numerous in the Northern Hemisphere. They are known for their raids on poultry but are nonetheless very beneficial to farmers as destroyers of rodents. Despite extensive killing of Foxes – for sport, for their fur, and to reduce predation of livestock-most species continue to flourish, as they are semi-omnivorous, intelligent and adaptable. Foxes are also bred in captivity for their fur.

The Fox has a pointed face, short legs, long, thick fur, and a tail about one half to two thirds as long as the head and body, depending on the species. Colours vary widely, but as the name suggests, in Red foxes reddish colours predominate.

Environment

Foxes usually inhabit areas of forest mixed with open country, in many kinds of climate. Although most active at night, they are also seen by day.

Allergens

Urine extracts of Blue fox and Silver fox contained more protein bands than the fur extracts did. Allergenic bands of 62-67 kDa, 23-25 kDa and 18-19 kDa have been detected in fur and urine extracts, but the allergens have yet to be characterized (1).

Potential cross-reactivity

Allergens with the same molecular weight were found in Mink, Blue fox, Silver fox, Raccoon, Dog and fitchew fur and urine extracts. With cross-reacting sera the reciprocal RAST inhibition with all 5 animal extracts indicated common IgE-binding epitopes, probably common allergens (especially the 62-67 kDa bands). Urine and fur contain common allergens, since urine allergens strongly inhibited IgE binding to fur allergens. The IgE binding to allergenic bands of fur animal (Fox, Mink, raccoon) extracts was also observed in immunoblotting when Dog and Cat specific IgE containing sera were used. RAST inhibition of Dog-positive sera with fur animal extracts and fur-animal-positive sera with Dog extract confirmed the cross-reactivity of these IgE antibodies. No such inhibition was seen with Cow extract. These results suggest that fur animals have IgE binding epitopes or allergens – possibly albumin – in common with Cat and Dog; but not with Cow (1).

Re210 Fox epithelium

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result from occupational exposure to Fox epithelium, and may occur in hunters (1-2).

In 42 women occupationally exposed in the fur manufacturing industry, the highest prevalence of positive immediate skin reactions to antigen of animal hair was found for marten (10%), followed by Fox and Lamb (7%), Mink (5%), and Chinese lamb, domestic Fox, and Chinese calf (2%). Precipitating antibodies were demonstrated for Lamb (17%), astrakhan (14%), Mink, domestic Fox and skunk (12%), Chinese lamb (10%), and Chinese calf (7%). Increased total IgE was found in 9.5% of subjects. A high prevalence of acute symptoms during the work shift was found among furriers. In general, greater drops in respiratory parameters occurred in individuals with positive precipitins as opposed to those with positive skin tests. This study suggests that workers in the fur manufacturing industry develop acute and chronic respiratory problems often associated with specific indicators of atopy (2).

One hundred and eighty-eight fur farmers and fur garment workers and a control group were given a self-administered questionnaire, lung function tests, and skin-specific IgE tests to common environmental allergens, and epithelium and urine of fur animals. Symptoms of rhinitis and conjunctivitis were significantly more common among the fur garment workers than among the control group, but were not associated with atopy (3).

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Re209 Gerbil epithelium

Meriones unguiculatus

Family: *Cricetidae*

Common names: Gerbil, Mongolian gerbil, Sand rat

Source material: Epithelium

The Mongolian gerbil is the species commonly kept as a pet in homes and classrooms, but there are around 90 species of Gerbils and Jirds (Gerbils' relatives in the genus *Meriones*).

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components in house and animal laboratory dust.

Allergen Exposure

Geographical distribution

This small rodent is found throughout the hot arid regions of Africa and Asia. Gerbils have large eyes, powerful, elongated hind limbs, and, unlike Rats and Mice, a fully furred tail, with a tuft at the end. Gerbils are 7.6 to 12.7 cm long, excluding the tail, and are sandy, gray, brown, or reddish in color with white underparts. In recent years Gerbils have become popular as house pets. They are odorless, easy to raise, and usually gentle. Females may bear as many as 15 litters in a lifetime; each litter may contain up to 10 young. Because of the threat of escaped Gerbils breeding prolifically and becoming serious crop pests in a congenial climate with large food sources, their keeping is banned in some parts of the US.

Environment

They live in dry grasslands and desert fringes, or are kept as pets or laboratory animals.

Allergens

No allergens from this animal have yet been characterized.

Clinical Experience

IgE mediated reactions

Asthma and allergic rhinitis may occur from exposure to Gerbils (1-2) .

Nine cases of Gerbil allergy have been described in 2 publications, but the authors warn that allergy to Gerbil may be more common than is apparent. Typically, patients present with a persistent cough, intermittent dyspnoea and/or nocturnal wheezing. Symptoms of allergic conjunctivitis may be present. Rhinitis and sneezing may be prominent symptoms. Onset of allergic illness may occur some years after a Gerbil is acquired as a pet, but once the illness is developed, symptoms occur rapidly following contact with the animal (1) .

Other reactions

Allergic alveolitis has been described (3).

Re209 Gerbil epithelium

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e80 Goat epithelium

Capra hircus

Family: *Bovidae*

Common names: Goat

Source material: Epithelium

See also: Goat's milk Rf300

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

Goats are among the most common domesticated animals. They are managed for the production of milk, meat and wool, particularly in arid, semitropical or mountainous countries (where their numbers and extremely wide grazing range result in serious ecological problems). A large variety of Goat breeds serves different purposes. Breeds of Swiss origin are distinguished for milk, which is often used to make cheese; those of Asian origin are prized for their fibre; and meat Goats are associated especially with Spain, South America, Africa, and India. However, most breeds are highly adaptable and widely distributed. The Pygmy Goats of Western Africa are of increasing interest as laboratory and pet animals in the West. There are more than 460 million Goats worldwide, yielding more than 4.5 million tons of milk and 1.2 million tons of meat, besides mohair, cashmere, leather and dung; and more people consume milk and milk products from Goats worldwide than from any other animal. Goats rapidly revert to a feral state, and feral populations are found in areas as remote as the Galapagos Islands.

Environment

Goats are encountered in agricultural settings, in mainly mountainous regions of the wild, and through their consumer products (see under Geographical distribution).

Allergens

The epidermal allergens from this animal have not yet been characterized.

Clinical Experience

IgE mediated reactions

Exposure to epidermal allergens from Goat may result in asthma and allergic rhinitis (1-2).

Animal danders, e.g., Cow Dander, Guinea pig whole pelt, Dog dander, and Horse and Goat dander, play an important role in the aetiology of bronchial asthma in Indian subjects (1).

Two hundred and sixty-three United Arab Emirates nationals with a respiratory disease suspected of being of allergic origin were submitted to SPT and RAST. It was shown that 8.3% were sensitised to Cat fur, 4.9% to Goat hair, and 0.7% to Rat hair and Mouse hair (2).

A postal questionnaire was sent to a random sample of 2,500 farmers throughout New Zealand. The results showed that that asthma prevalence was higher for Horse breeders/groomers (16.5%), Pig farmers (18.2%), poultry farmers (17.4%), and those working with Oats (17.4%). Hay fever was significantly higher in Deer and crop farmers, and farmers working with Horses and Goats; eczema was higher for Goat and Deer farmers (3).

Other reactions

See also: Goat's milk Rf300.

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Anser anser

Family: *Anatidae*

Common names: Goose, Toulouse goose, Grey goose, Greylag

Source material: Feathers

The genera *Anser* and *Branta* should both be considered. *Anser* includes many wild Geese with well-known domestic relatives. This group includes *Anser anser* (European) and species of Africa and Asia. *Branta* includes wild Geese like the Canada goose (*Branta Canadensis*) and the Brants (most notably *Branta bernicla*).

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

Goose is the common name for large wild and domesticated swimming birds related to the Duck and the Swan. (Strictly speaking, the term Goose is applied to the female and gander to the male.) Wild Geese tend to be seasonally migratory, moving in large flocks over great distances between continents.

Environment

Geese are found in agricultural settings, and in aquatic and semi-aquatic environments in the wild. Their meat is eaten roasted and broiled, and served in the form of pâté de foie gras, a paste made from the enlarged livers of force-fed Geese.

Unexpected exposure

Goose down is widely used for stuffing pillows, duvets and jackets.

Allergens

No allergens have yet been characterized.

Potential cross-reactivity

Cross-reactivity between Goose and other phylogenetically related bird species may be expected, and in Chicken-allergic patients, significant IgE titers to Parrot, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (1-2).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Duck feathers, epithelial cells or droppings. The allergic manifestations may present as Extrinsic allergic alveolitis (3).

Of 269 adult patients with suspected skin and respiratory allergies tested for feathers with skin-specific IgE tests, 9% of the whole group and 14% of those positive to inhalant allergens were positive to any feather allergen. Two reacted to Duck feathers, 12 to Goose and 15 to Chicken feathers. Symptoms were reported by 58% of feather skin-specific IgE positive patients and 55% by other skin-specific IgE positive patients. Positive RAST specific IgE tests were surprisingly few, which may be explained by possible contamination of the skin extracts by Mite allergens (12).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The allergenic proteins may be found in bird serum, droppings, and feathers. Contact may result from handling birds, cleaning their cages, or exposure to the organic dust drifting from where the birds reside.

Exposure to avian antigens results in the development of immunoglobulins including IgE (4), IgM (5), IgA and various IgG subclasses (6-8). The development of specific IgG and IgA antibodies to avian proteins does not necessarily indicate disease (9).

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (10).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of Extrinsic allergic alveolitis (11).

Clinical allergy to commercial feather products is less common than usually thought, as a result of the removal of rough dry dust, washing and drying at 125 °C. The allergens derived from unrefined feathers include bird serum proteins, bird droppings, and feather mites (12).

Other reactions

Polyester-filled pillows contain significantly more total weight of Der p 1 Mite allergen (*Dermatophagoides pteronyssinus*) than feather-filled pillows (13).

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e6 Guinea pig epithelium

Cavia porcellus

Family: *Caviidae*

Common names: Guinea pig, Cavy

Source material: Epithelium

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house dust and laboratory dust.

Allergen Exposure

Geographical distribution

The Guinea pig (unrelated to Pigs – the name may be due to this rodent's shrill squeal), native to South America, has been used as a domesticated food source for hundreds of years in Ecuador, Peru and Bolivia. Guinea pigs have also been invaluable in research laboratories, where they have been used in fields such as nutrition, pathology, genetics, and toxicology. The Guinea pig is also an excellent pet, much handled by children due to its gentleness and sociability. *Cavia porcellus* are not known in the wild (unless in a feral state), but domesticated Guinea pigs are now found worldwide in captivity.

There is a number of varieties, some with short, smooth hair and others with longer hair; and a great range of color combinations, including mixtures of black and white and many shades of brown. They have rounded bodies, large heads and blunt noses and reach a length of 15 to 25 cm and a weight of 450 to 900 g.

Environment

Guinea pigs as a food source can be kept in specialised huts or allowed to run free and scavenge. It is believed that feral colonies of Guinea pigs may be present in some South American countries, living in grasslands or forests. See also under Geographical distribution.

Allergens

Guinea pig allergens are derived from the urine, saliva, and pelts of Guinea pigs (1-2). In sera from patients with Guinea pig allergy, 3 major allergens have been identified with molecular weights of 8 kDa, 17 kDa and 20 kDa (2). Three have been characterized to date:

Cav p 1, a 20 kDa protein, found in hair, dander and urine (2-5).

Cav p 2, found in hair, dander and urine (3-5).

Serum albumin, which binds significant amounts of IgE (2).

Cav p 1 is a member of the lipocalin family (6).

Guinea pig dust, dander, fur, urine and saliva have been reported to be the more potent extracts; while whole pelt, faeces and serum were considerably less active. There appears to be no appreciable difference in the potency of the allergens between the sexes. The results of skin- and serum-specific IgE, and of inhibition studies, suggest cross-allergenicity between the various extracts (2).

Guinea pig allergen particles may be as small as 0.8 micrometre in size, and would be capable of remaining airborne for long periods after disturbance. In one study urine was said to be the major airborne allergen as well as the allergen to which the greatest percentage of the subjects studied reacted (4).

Potential cross-reactivity

The cross-reactivity of Guinea pig urine, pelt, and albumin has been studied in RAST inhibition assays. Guinea pig pelt extract and urine produced dose-related inhibition in all 3 assays, i.e., were cross-reactive, but Guinea pig albumin was inhibitory in only the homologous assay (4).

Cav p 1, from Guinea pig hair, has been shown to have 57% identity with a sub-sequence of MUP (major urinary protein), a member of the lipocalin superfamily. Allergenic relationships among Guinea pig allergens derived from hair and urine of different animal species (Mouse, Rat, Cat) were studied by ELISA inhibition assays, and neither urine of Mouse, Rat and Cat nor hair extracts of Rat and Cat produced appreciable inhibitions in Guinea pig ELISA studies. Thus, although the physicochemical characteristics of Cav p 1 are very similar to those of other rodent allergens, and partial sequence identity with Mus m 1 occurs, Cav p 1 is an immunologically independent major allergen (6).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis occur frequently following sensitisation to Guinea pig allergens (7-11).

In a study of atopic children with contact with pets, 29% were sensitised to Guinea pig and 21% showed clinical signs in the animal's presence (12).

In New Delhi, India, the role of animal dander in the aetiology of bronchial asthma was studied. Intradermal and bronchial provocation tests with Guinea pig whole pelt extracts performed on 68 asthmatics resulted in significant positive skin reactions in 1.4% of the group (13).

In 20 laboratory workers who experienced allergic symptoms after exposure to laboratory animals, 9 manifested elevated IgE antibodies to Guinea pig urine, pelt, or albumin, according to a radioallergosorbent test. Skin-specific IgE showed documented allergenic activity with all 3 Guinea pig allergens. Guinea pig urine allergen activity was detected in all indoor air filter samples by RAST inhibition. The authors conclude that urine appears to be the major source of Guinea pig allergens, and that it is present in airborne particles small enough to penetrate the lower respiratory tract when inhaled (4).

Guinea pig-allergic individuals show high serum levels of specific IgE and have demonstrated an immediate positive reaction to nasal provocation testing with urine-derived antigens (1).

Other reactions

Contact urticaria in laboratory technicians has been reported (14).

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e84 Hamster epithelium

Cricetus cricetus, Mesocricetus auratus and Phodopus sungorus

Family:	*Cricetidae*
Common names:	Hamster
Cricetus cricetus	– Common hamster
Mesocricetus auratus	– Golden hamster
Phodopus sungorus	– Siberian hamster, Dwarf hamster
Source material:	Epithelium

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house dust.

Allergen Exposure

Geographical distribution

This Old World rodent is related to voles, lemmings, and New World Mice. There are many Hamster species, classified in several genera. They are solitary, burrowing, nocturnal animals, with chunky bodies, usually short tails, soft, thick fur, and large external cheek pouches used for holding food. Hamsters feed on grain and other plant matter and are serious agricultural pests in many parts of their range. The Syrian, or Golden hamster, of Eastern Europe and Western Asia, is familiar as a laboratory animal and pet (prized for its placidity and cleanliness), but is little known in the wild state. About 15 cm long, it is light-colored, with white underparts.

Environment

See Geographical distribution.

Allergens

No allergens from this animal have yet been characterized. The allergens are probably, as with other rodents, to be found in the hair, epithelia, saliva, serum and urine.

Potential cross-reactivity

The Siberian hamster, a member of the same family as the Common and Golden hamster, is able to induce both sensitisation and disease, but importantly, there is no cross-reactivity between this Hamster and the latter 2 (1).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis occur frequently in laboratory workers dealing with Hamsters and in individuals keeping these rodents as domestic pets (1-9).

Hamster is a popular pet in Japan, and the numbers of these pets have been increasing (3-4). About 20 to 30% of asthma patients show positive skin-specific IgE responses to Hamster allergens (1-2).

Children of parents occupationally exposed to laboratory animals presented significantly more positive skin-specific IgE against allergens from the hair of laboratory animals, compared to children of nonexposed parents. These children may experience cough and rhinitis while visiting their parents' workplace (1).

Anaphylaxis following a Hamster bite has been reported (1).

Other reactions

Allergic contact dermatitis to Hamster has been described (1).

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e3 Horse dander

Equus caballus

Family: *Equidae*

Common names: Horse, Domestic horse

Source material: Dander

See also: Horse serum proteins Re205, and Horse meat Rf321

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

Except for a few feral populations, and one extremely endangered wild one (Przewalski's horse), Horses are domesticated. Long used as a means of transportation, pleasure, work, and even war, Horses have been involved in much of human history. Domestic horse breeds are numerous and highly various. Although little used for work today in developed countries, Horses are widely owned for recreational riding and show activities.

Environment

Horses are found in agricultural and recreational settings.

Unexpected exposure

Horsehair is encountered in antique furniture, and Horse meat is eaten in some countries in place of Beef. Horsehide is used in making baseballs and certain other leather goods.

Allergens

At least 16 allergens have been isolated from Horse (1-4). Several allergens have been shown to be glycoproteins, including a 27 and a 31 kDa protein (5).

A number of allergens have been characterized.

Equ c 1, Mw 25 kDa, a lipocalin (6-10).

Equ c 2, Mw 16 kDa, a lipocalin (6,8,10-12).

Equ c 3 Mw 67 kDa albumin (Ag3) (10,12).

Equ c 4, Mw 18.7 kDa (6,12).

Equ c 5, Mw 16.7 kDa (6).

Various isoforms of Equ c 1 and Equ c 2 have been identified, including Equ c 2.0101 and Equ c 2.0102 (4,11). Both allergens have been cloned from the sublingual salivary glands and have also been found to be expressed in the liver and submaxillary salivary glands (7).

The protein content of Horse dander is more than double that of Horse hair and skin scrapings, while the carbohydrate content is of the same order. The most important allergen in Horse dander appears to be a 27 kDa glycoprotein (the lipocalin Equ c 1). An important 67 kDa allergen was also isolated and was thought to probably be Horse albumin. Although common allergens appeared to be present in these extracts, unique allergens were present in all extracts (13).

e3 Horse dander

Breeders and patients with asthma have claimed that Bashkir horses are nonallergenic. A study demonstrated considerable inter-breed and within-breed variation but no breed-specific allergens. Dander from all breeds investigated contained the most important known allergens, and the allergenic content of dander from Bashkir horses was similar to that of other breeds (14).

Horse allergens can be carried on clothing and can thus be found in domestic dust samples from urban environments (15).

Potential cross-reactivity

RAST inhibition experiments have demonstrated cross-reactivity between Fallow deer and Horse allergen extracts (16).

Clinical Experience

IgE mediated reactions

Horse allergy occurs among people who regularly handle Horses, either professionally or for recreational purposes, resulting in the induction or exacerbation of asthma, allergic rhinitis, allergic conjunctivitis and occupational asthma (17-23). Horse allergy has also been reported to result in angioedema, respiratory distress, and poorly controlled asthma (15).

In a study reviewing children seen for allergy to Horses over a period of 11 years (35 boys and 21 girls, 35 of whom were under 10 years of age), the main clinical signs reported were ocular symptoms (36), asthma (30) and rhinopharyngitis (24). All the children had highly positive skin-specific IgE tests, and 62% had high specific IgE (class 3 and 4) and were polysensitised. In several children, the first symptoms occurred at the time of the first known contact with a Horse or Pony (24). Horse allergy has been reported to decrease with age (25).

A postal questionnaire sent to a random sample of 2,500 farmers throughout New Zealand reported that asthma prevalence was higher for Horse breeders/groomers (16.5%), Pig farmers (18.2%), poultry farmers (17.4%), and those working with Oats (17.4%). Hay fever was significantly higher in Deer and crop farmers, and farmers working with Horses and Goats; eczema was higher for Goat and Deer farmers (26).

The significance of Horse allergens in allergy has also been reported in Turkey (27), and in Indian subjects (28). In a Swedish study, Horse allergy was recorded in both boys and girls; it was noted that, whereas girls were more commonly horseback riders, boys were more often sensitised to Horses (29).

Skin-specific IgE responses to a variety of allergens, including Horse hair, have been reported to be higher in brittle compared to non-brittle asthma (30).

Other reactions

Contact urticaria from Horse saliva has been reported (31).

A high proportion of workers on a pure-bred Horse farm showed a positive skin response to *Saccharopolyspora rectivirgula* (51.6%), or showed the presence of precipitins to *Acinetobacter calcoaceticus* (32.3%). No significant relationship could be found between the presence of symptoms and positive allergy reactions, and the possibility of Organic Dust Toxic Syndrome occurring in a high proportion of the workers was suggested (32).

Farmer's Lung is a rural disease that can be caused by inhalation of airborne Thermophilic actinomycetes. One case report is of an 11-year-old girl briefly exposed to this mould at a riding school (33).

See also: Horse serum proteins Re205, and Horse meat Rf321.

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Equus caballus

Family: *Equidae*

Common names: Horse, Domestic horse

Source material: Serum

See also: Horse dander e3 and Horse meat Rf321

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

Except for a few feral populations, and one extremely endangered wild one (Przewalski's horse), Horses are domesticated. Long used as a means of transportation, pleasure, work, and even war, Horses have been involved in much of human history. Domestic horse breeds are numerous and highly various. Although little used for work today in developed countries, Horses are widely owned for recreational riding and show activities.

Environment

Horses are found in agricultural and recreational settings.

Unexpected exposure

Horsehair is encountered in antique furniture, and Horse meat is eaten in some countries in place of Beef. Horsehide is used in making baseballs and certain other leather goods.

Allergens

At least 16 allergens have been isolated from Horse (1-4). Several allergens have been shown to be glycoproteins, including a 27 and a 31 kDa protein (5).

A number of allergens have been characterized.

Equ c 1, Mw 25 kDa, a lipocalin (6-10).

Equ c 2, Mw 16 kDa, a lipocalin (6,8,10-12).

Equ c 3 Mw 67 kDa, albumin (Ag3) (10,12).

Equ c 4, Mw 18.7 kDa (6,12).

Equ c 5, Mw 16.7 kDa (6).

Various isoforms of Equ c 1 and Equ c 2 have been identified, including Equ c 2.0101 and Equ c 2.0102 (4,11) . Both allergens have been cloned from the sublingual salivary glands and have also been found to be expressed in the liver and submaxillary salivary glands (7).

Already in early studies an important 67 kDa allergen has been isolated that was thought to be Horse albumin (13).

Potential cross-reactivity

In a study assessing the importance of albumin as a cross-reactive allergen in patients sensitised to Cat, Dog and Horse, 117 patients sensitised to Cat were tested for IgE reactivity using skin-specific IgE and RAST assays with Cat, Dog and Horse hair/ dander extracts and their purified albumin extracts. Of these patients, 22% exhibited specific IgE to Cat albumin; 41% of patients sensitised to Cat were also sensitised to Dog and Horse. Of these patients, 21% had IgE antibodies to 3 albumins and 17% to 2. Specific IgE binding to Horse extract was inhibited in 30% of samples by its homologous albumin, and IgE binding to Cat and Dog extracts in almost 15% by their respective albumins. The study concluded that albumins from these 3 animals share some epitopes that account for the cross-reactivity observed in around 1/3 of patients sensitised to Cat, Dog and Horse. Nevertheless, more than 50% of specific IgE that cross-reacts among these 3 animals is directed to allergens other than albumin (14). Similar findings were documented in a second study (15).

Clinical Experience

IgE mediated reactions

Horse allergy occurs among people who regularly handle Horses, either professionally or for recreational purposes, resulting in the induction or exacerbation of asthma, allergic rhinitis, allergic conjunctivitis and occupational asthma (16-22). Horse allergy has also been reported to result in angioedema, respiratory distress, and poorly controlled asthma (23).

In a study reviewing children seen for allergy to Horses over a period of 11 years (35 boys and 21 girls, 35 of whom were under 10 years of age), the main clinical signs reported were ocular symptoms (36), asthma (30) and rhinopharyngitis (24). All the children had highly positive skin-specific IgE tests and 62% had specific IgE (class 3 and 4) and were polysensitized. In several children, the first symptoms occurred at the time of the first known contact with a Horse or Pony (24). Horse allergy has been reported to decrease with age (25).

Eosinophilic granuloma of the lung with sawdust and Horse protein hypersensitivity has been reported (26).

Other reactions

Contact urticaria from Horse saliva has been reported (27).

A high proportion of workers on a pure-bred Horse farm showed a positive skin response to *Saccharopolyspora rectivirgula* (51.6%), or showed the presence of precipitins to *Acinetobacter calcoaceticus* (32.3%). No significant relationship could be found between the presence of symptoms and positive allergy reactions, and the possibility of Organic Dust Toxic Syndrome occurring in a high proportion of the workers was suggested (28).

Farmer's Lung is a rural disease that can be caused by inhalation of airborne Thermophilic actinomycetes. Farmer's Lung occurred in an 11-year-old girl briefly exposed to this mould at a riding school (29).

See also: Horse epithelium/dander e3, and Horse meat Rf321.

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Re203 Mink epithelium

Mustela spp.

Family:	*Mustelidae*
Common names:	Mink, American mink, European mink
Source material:	Epithelium

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

The Mink is a small mammal of the *Mustelidae* family. This animal is a semi-aquatic carnivore related to the weasel, and characterized by a slender body and thick, soft, dark-brown, durable fur that is highly valued commercially. To supply the demands of the fur industry, Minks are raised on a large scale on fur farms.

Environment

See under Geographical distribution.

Allergens

Allergens with the same molecular weight were found in the fur and urine extracts, the most prominent allergenic bands being of 62-67 kDa, 23-25 kDa and 18-19 kDa (1).

Potential cross-reactivity

In a report on Ferret allergy, the authors note that in a Mink-allergic subject, specific IgG to Ferret interfered with the specific IgE measurement; it was hypothesised that the Mink-allergic subject's serum contained similar and competing antibodies (2). Mink is a mammal of the same family as Ferret.

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis occur commonly in fur farmers and fur garment workers (3).

In 42 women occupationally exposed in the fur manufacturing industry, the highest prevalence of positive immediate skin reactions to antigens of animal hair was found for Marten (10%), followed by Fox and Lamb (7%), Mink (5%), and Chinese lamb, Domestic fox, and Chinese calf (2%). Precipitating antibodies were demonstrated for Lamb (17%), astrakhan (14%), Mink, Domestic fox and skunk (12%), Chinese lamb (10%), and Chinese calf (7%) (4).

A patient who developed occupational asthma, characterized by dry cough, dyspoea, wheezing, rhinoconjunctival itching, sneezing and rhinorrhoea as a result of exposure to Mink urine has been reported. Skin-specific IgE was positive to Mink urine and negative to Mink pelt (5).

Re203 Mink epithelium

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Mus spp.

Family: *Muridae*

Common names: Mouse, House mouse, Common house mouse

Source material: Epithelium

See also: Mouse e88, Mouse urine proteins, and Mouse serum proteins

The white Mice used in research laboratories are albinos bred from *Mus Musculus*.

Mus domesticus is the most common Mouse that is a commensal of man. But in the familes *Muridae* and *Cricetidae* are many wild species of Mouse, and rarer commensals such as the Doormouse.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and animal laboratory dust.

Allergen Exposure

Geographical distribution

Native to Asia, House mice are now ubiquitous. They exist in all climates and are routinely found both indoors and out. Their constant gnawing damages buildings, furniture and equipment. Mice carry diseases such as salmonella and leptospirosis. They are everyday pests because of their consumption of foodstuffs, and also because their continual dribble of urine and their faeces cause contamination. Mice breed more prolifically than Rats, and spread faster, being smaller (which makes concealment easier) and more migratory, but are more easily controlled by poison, traps and predators. They are generally not as troublesome as Rats. In cultivated fields they may be beneficial, eating weed seeds and insects.

Environment

Agile and having a varied diet, Mice are found in every kind of building. They are a particular problem in poultry units, Pig housing, grain stores, warehouses, shops, and hospitals. They often migrate from cultivated fields into buildings after harvest. Where conditions permit, Mice may be found in meadows, along watercourses, and in other places where vegetation is dense enough to afford concealment, but they are not nearly as common in undisturbed or natural habitats.

Especially because of the numbers of Mice used in laboratories, allergy to Mice is an important occupational health problem.

Unexpected exposure

Like Rats, Mice interact unseen with humans, through mainly nocturnal foraging, which leaves behind urine, feces, saliva and skin flakes on many surfaces, especially those used for the preparation of food.

e71 Mouse epithelium

Allergens

Mouse allergens were identified over 2 decades ago. Major allergens were found in Mouse skin, serum, and urine: a 67 kDa protein, identical to Mouse albumin, and an approximately 17 kDa protein. Some individuals were sensitised predominantly to the large allergen, some to the smaller allergen, and a not one group of patients reacted to both allergens (1).

The concentration of the major allergens from Mouse, including Mouse serum albumin (MSA) and Mouse urinary protein (MUP) complex, vary in urine, serum, and pelts of Mice (2).

To date, a number of allergens have been characterised.

Mus m 1 is a major allergen and a prealbumin. This 19 kDa protein is found in hair, dander and urine. This allergen is a lipocalin-odorant binding protein (3-4) and was formerly known as MUP (major urinary protein) and also known as MAI and Ag1 (5-11). Mus m 1 is produced in liver cells, circulates in the bloodstream, and is cleared by the kidneys. Males produce approximately 4 times more of this allergen than females. The allergen is low in serum (6,12).

Mus m 2, a 16 kDa glycoprotein, is found in hair and dander.

Hair and epithelial fragments also carry allergenic molecules, which are primarily derived from urine and saliva. Most of the allergenic components of urine and saliva have also been detected in the fur extract. Significant concentrations of airborne rodent allergens have been measured in both laboratories and apartments in inner cities (13-15).

Mouse epithelium may be present in dust, and these Mouse allergens are carried mainly on particles of 6-18 microns. Allergen levels have been shown to correlate well with the number of animals present in the room and the degree of worker activity during sampling (16). The higher the number of animals in a room, the higher the allergen concentrations, and higher concentrations were also associated with cleaning activities. The highest personal exposure levels occurred when contaminated bedding and high numbers of conscious animals were handled. The highest airborne Mouse allergen levels have been reported to occur during manual emptying of cages, during changing of cages on an unventilated table and during handling of male animals on an unventilated table (17-18). The proportion of time spent on these tasks determined the degree of allergen exposure to a large extent.

The concentration and type of Mouse allergen varies between locations and within the same location. Mouse pelt extract allergenic activity may be detected in rooms away from Mouse-care rooms, whereas Mouse urine allergenic activity may be found only in the Mouse-care room. In a study, airborne allergen content ranged from 1.8 to 825 ng/m^3 and varied according to both the number of Mice and the amount of work activity in the rooms (2).

Mouse allergens are also very prevalent in ordinary homes. Of inner-city homes in Baltimore and Cleveland, USA, 95% had detectable Mouse allergen (Mus m 1) in at least one room, with the highest levels found in kitchens (kitchen: range, 0-618 µ/g; median, 1.60 µg/g; bedroom: range, 0-294 µg/g; median, 0.52µg/g; television-living room: range, 0-203 µg/g; median, 0. 57 µg/g). By city, 100% of the kitchens in Baltimore had detectable Mouse allergen, with a lower percentage (74%) in Cleveland. Mouse allergen levels correlated according to room. Furthermore, 49% of the homes had reported problems with Mice within the previous year, and 29% of the homes had evidence of Mice in one or more rooms on home inspection; these homes had higher levels of Mouse allergen. Higher allergen levels were also associated with evidence of Cockroach infestation in any room (19).

Potential cross-reactivity

Practically all respiratory animal allergens, including Mouse, characterised at the molecular level belong to the lipocalin family of proteins. Examples are the major allergens of Horse, Cow, Dog, Mouse and Cockroach as well as beta-lactoglobulin of Cow's milk (4). A certain degree of cross-reactivity is thus possible.

Clinical Experience

IgE mediated reactions

Mouse allergens found in dust, urine, epithelium and saliva are a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis, mainly in laboratory workers but also in ordinary individuals (2,20-22).

Various studies have examined the prevalence of allergic disease in the workplace to Mouse. Initial studies reported that about 20% of the exposed workers have symptoms of allergy to Mice (23). In a study evaluating the risk of laboratory animal allergy among research staff working in laboratories separate from the animal confinement area, 20% of the subjects had serum-specific IgE >0.35 kU/l to Rat urinary allergens and/or Mouse urinary allergens, and 32% had experienced animal work-related symptoms, although 90% of aeroallergen samples from the laboratories in question were below the detection limit. More than 4 years of exposure significantly increased laboratory animal sensitisation and symptoms. Working mainly with male rodents resulted in increased risk for sensitisation and for symptoms (24).

Hollander *et al.* demonstrated that the prevalence rates of allergy symptoms caused by working with Rats and Mice were 19% and 10%, respectively (25). A large epidemiological study of 5,000 laboratory workers reported symptoms in 26% exposed to Mice, 25% to Rats, 31% to Guinea Pigs, 30% to Rabbits, 26% to Hamsters, 25% to Dogs, 30% to Cats and 24% to Monkeys (26). Allergic rhinoconjunctivitis with nasal congestion, rhinorrhoea, sneezing and itchy, watery eyes can occur in up to 80% of symptomatic workers (9).

Although Mouse allergen is known to cause occupational asthma in laboratory workers, its potential significance in home environments has been underplayed. Through skin-specific IgE tests, 89 (18%) of 499 inner-city children were shown to be sensitised to Mouse. Children whose homes had Mouse allergen levels above 1.60 µg/g in the kitchen had a significantly higher rate of Mouse sensitisation than those with levels below (23% vs 11%). Atopy was also significantly related to Mouse sensitisation, with 40% of those with more than 4 positive skin-specific IgE responses having Mouse sensitivity, compared with 4% of those with no other positive skin-specific IgE responses (27).

Two hundred and sixty-three United Arab Emirates nationals with a respiratory disease suspected of being of allergic origin were submitted to skin- and serum-specific IgE measurement. Of these individuals, 8.3% were sensitised to Cat fur, 4.9% to Goat hair, and 0.7% to Rat hair and Mouse hair (28).

Importantly, children of parents exposed to Mice, Rats and Hamsters in an occupational setting, e.g., a laboratory, were shown to be more likely to have allergic symptoms, and to have significantly more positive skin-prick tests against allergens from the hair of laboratory animals, compared to children of non-exposed parents (29).

Occupational contact urticaria due to Mouse hair has been reported (30).

Other reactions

Contact urticaria in laboratory technicians has been reported (31).

See also: Mouse e88, Mouse urine proteins e72, and Mouse serum proteins e76.

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e88 Mouse epithelium, serum proteins and urine proteins

Mus spp.

Family: *Muridae*

Common names: Mouse, House mouse, Common house mouse

Source material: Epithelium, serum and urine

See also: Mouse epithelium e71, Mouse urine proteins e72, and Mouse serum proteins e76

The white Mice used in research laboratories are albinos bred from *Mus Musculus*.

Mus domesticus is the most common Mouse that is a commensal of man. But in the familes *Muridae* and *Cricetidae* are many wild species of Mouse, and rarer commensals such as the Doormouse.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and animal laboratory dust.

Allergen Exposure

Geographical distribution

Native to Asia, House mice are now ubiquitous. They exist in all climates and are routinely found both indoors and out. Their constant gnawing damages buildings, furniture and equipment. Mice carry diseases such as salmonella and leptospirosis. They are everyday pests because of their consumption of foodstuffs, and also because their continual dribble of urine and their feces cause contamination. Mice breed more prolifically than Rats, and spread faster, being smaller (which makes concealment easier) and more migratory, but are more easily controlled by poison, traps and predators. They are generally not as troublesome as Rats. In cultivated fields they may be beneficial, eating weed seeds and insects.

Environment

Agile and having a varied diet, Mice are found in every kind of building. They are a particular problem in poultry units, Pig housing, grain stores, warehouses, shops, and hospitals. They often migrate from cultivated fields into buildings after harvest. Where conditions permit, Mice may be found in meadows, along watercourses, and in other places where vegetation is dense enough to afford concealment, but they are not nearly as common in undisturbed or natural habitats.

Especially because of the numbers of Mice used in laboratories, allergy to Mice is an important occupational health problem.

Unexpected exposure

Like Rats, Mice interact unseen with humans, through mainly nocturnal foraging, which leaves behind urine, feces, saliva and skin flakes on many surfaces, especially those used for the preparation of food.

Allergens

Mouse allergens were identified over two decades ago. Major allergens were found in Mouse skin, serum, and urine: a 67 kDa protein, identical to Mouse albumin, and an approximately 17 kDa protein. Some individuals were sensitised predominantly to the large allergen, some to the smaller allergen, and a not one group of patients reacted to both allergens (1).

The concentration of the major allergens from Mouse, including Mouse serum albumin (MSA) and Mouse urinary protein (MUP) complex, vary in urine, serum, and pelts of Mice (2). Male rodents excrete higher levels of urinary allergens than female rodents (3).

As rodents have permanent proteinuria, the allergen is constantly present in their urine. They spray urine on their surroundings, where the proteins dry up and become airborne on dust particles.

To date, a number of allergens have been characterized.

Mus m 1 is a major allergen and a prealbumin. This 19 kDa protein is found in hair, dander and urine. This allergen is a lipocalin-odorant binding protein (4-5) and was formerly known as MUP (major urinary protein) and also known as MAI and Ag1 (6-12). Mus m 1 is produced in liver cells, circulates in the bloodstream, and is cleared by the kidneys. Males produce approximately 4 times more of this allergen than females. The allergen is low in serum (7,13).

Mus m 2, a 16 kDa glycoprotein, is found in hair and dander.

Albumin, a 65-69 kDa protein, is found in serum and urine. Approximately 30% of Mouse-sensitised individuals are sensitised to this allergen (14) .

Hair and epithelial fragments also carry allergenic molecules, which are primarily derived from urine and saliva. Most of the allergenic components of urine and saliva have also been detected in the fur extract. Significant concentrations of airborne rodent allergens have been measured in both laboratories and apartments in inner cities (15-17).

Mouse allergens are carried mainly on particles of 6-18 microns. Allergen levels have been shown to correlate well with the number of animals present in the room and the degree of worker activity during sampling (18). The higher the number of animals in a room, the higher the allergen concentrations, and higher concentrations were also associated with cleaning activities. The highest personal exposure levels occurred when contaminated bedding and high numbers of conscious animals were handled. The highest airborne Mouse allergen levels have been reported to occur during manual emptying of cages, during changing of cages on an unventilated table and during handling of male animals on an unventilated table (19-20). The proportion of time spent on these tasks determined the degree of allergen exposure to a large extent.

A study reported that total Mus m 1 recovered ranged from 0.2 to 1.5 ng/m^3 in rooms without Mice and 0.5 to 15.1 ng/m^3 in rooms with Mice. Allergen recovered from the zone of worker activity ranged from 1.2 to 2.7 ng/m^3 in rooms without Mice and from 16.6 to 563.0 ng/m^3 in rooms with Mice. Direct Mouse contact was associated with the highest levels of exposure to Mus m I. Analysis revealed the bulk of allergen to be in mid-particle size range (3.3 to 10 microns) for Mouse-containing rooms and in small particle size range (0.43 to 3.3 microns) for non-Mouse-containing rooms, suggesting that small particles were carried along corridors from rooms with Mice into non-Mouse-containing rooms (21).

In disturbed air, allergen concentration has been shown to increase between 1.4-fold, for albumin allergens, and 5-fold, for crude allergens. The proportion of small particles increased from 1.4% in calm air to 4.5% in disturbed air (22).

The concentration and type of Mouse allergen varies between locations and within the same location. Mouse pelt extract allergenic activity may be detected in rooms away from Mouse-care rooms, whereas Mouse urine allergenic activity may be found only in the Mouse-care room. In a study, airborne allergen content ranged from 1.8 to 825 ng/m^3 and varied according to both the number of Mice and the amount of work activity in the rooms (2).

Mouse allergens are also very prevalent in ordinary homes. Of inner-city homes in Baltimore and Cleveland, USA, 95% had detectable Mouse allergen (Mus m 1) in at least one room, with the highest levels found in kitchens (kitchen: range, 0-618 µg/g; median, 1.60 µg/g; bedroom: range, 0-294 µg/g; median, 0.52 µg/g; television-living room: range, 0-203 µg/g; median, 0. 57 µg/g). By city, 100% of the kitchens in Baltimore had detectable Mouse allergen, with a lower percentage (74%) in Cleveland. Mouse allergen levels correlated according to room. Furthermore, 49% of the homes had reported problems with Mice within the previous year, and 29% of the homes had evidence of Mice in one or more rooms on home inspection; these homes had higher levels of Mouse allergen. Higher allergen levels were also associated with evidence of cockroach infestation in any room (23).

Potential cross-reactivity

In IgE immunoblot inhibition studies and histamine release tests, it has been demonstrated that patients who react to Dog albumin exhibit IgE reactivity with purified albumins from Cat, Mouse, Chicken, and Rat. Significant sequence homologies have been demonstrated with albumins from different species: Human: 82.6%, Pig: 81.8%, Cattle: 77.3%, Sheep: 78.8%, Mouse: 75.8%, and Rat: 76.2% (24).

Practically all respiratory animal allergens, including Mouse, characterised at the molecular level belong to the lipocalin family of proteins. Examples are the major allergens of Horse, Cow, Dog, Mouse and Cockroach as well as beta-lactoglobulin of Cow's milk (5). A certain degree of cross-reactivity is thus possible.

Clinical Experience

IgE mediated reactions

Mouse allergens found in dust, urine, epithelium and saliva are a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis, mainly in laboratory workers but also in ordinary individuals (2,25-27).

Various studies have examined the prevalence of allergic disease in the work-place to Mouse. Initial studies reported that about 20% of the exposed workers have symptoms of allergy to Mice (28). In a study evaluating the risk of laboratory animal allergy among research staff working in laboratories separate from the animal confinement area, 20% of the subjects had serum-specific IgE >0.35 kU/l to Rat urinary allergens and/or Mouse urinary allergens, and 32% had experienced animal work-related symptoms, although 90% of aeroallergen samples from the laboratories in question were below the detection limit. More than 4 years of exposure significantly increased laboratory animal sensitisation and symptoms. Working mainly with male rodents resulted in increased risk for sensitisation and for symptoms (3).

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e76 Mouse serum proteins

Mus spp.

Family: *Muridae*

Common names: Mouse, House mouse, Common house mouse

Source material: Serum

See also: Mouse e88, Mouse epithelium e71, and Mouse urine proteins e72.

The white Mice used in research laboratories are albinos bred from *Mus Musculus*.

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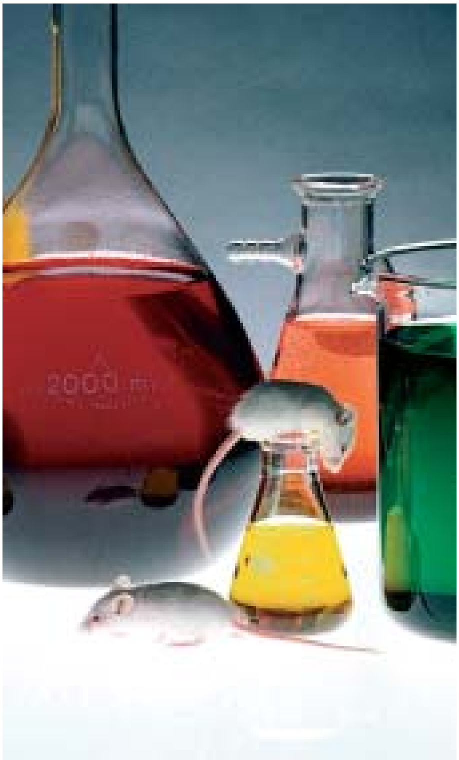

Allergen Exposure

Geographical distribution

Native to Asia, House mice are now ubiquitous. They exist in all climates and are routinely found both indoors and out. Their constant gnawing damages buildings, furniture and equipment. Mice carry diseases such as salmonella and leptospirosis. They are everyday pests because of their consumption of foodstuffs, and also because their continual dribble of urine and their feces cause contamination. Mice breed more prolifically than Rats, and spread faster, being smaller (which makes concealment easier) and more migratory, but are more easily controlled by poison, traps and predators. They are generally not as troublesome as Rats. In cultivated fields they may be beneficial, eating weed seeds and insects.

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Especially because of the numbers of Mice used in laboratories, allergy to Mice is an important occupational health problem.

Unexpected exposure

Like Rats, Mice interact unseen with humans, through mainly nocturnal foraging, which leaves behind urine, feces, saliva and skin flakes on many surfaces, especially those used for the preparation of food.

e76 Mouse serum proteins

Allergens

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Albumin, a 65-69 kDa protein, is found in serum and urine. Approximately 30% of Mouse-sensitised individuals are sensitised to this allergen (13).

Serum proteins, being present in urine, will be present in the significant concentrations of airborne rodent allergens that have been measured in both laboratories and apartments in inner cities (14-16).

Mouse allergens are carried mainly on particles of 6-18 microns. Allergen levels have been shown to correlate well with the number of animals present in the room and the degree of worker activity during sampling (17). The higher the number of animals in a room, the higher the allergen concentrations, and higher concentrations were also associated with cleaning activities. The highest personal exposure levels occurred when contaminated bedding and high numbers of conscious animals were handled. The highest airborne Mouse allergen levels have been reported to occur during manual emptying of cages, during changing of cages on an unventilated table and during handling of male animals on an unventilated table (18-19). The proportion of time spent on these tasks determined the degree of allergen exposure to a large extent.

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0. 57 µg/g). By city, 100% of the kitchens in Baltimore had detectable Mouse allergen, with a lower percentage (74%) in Cleveland. Mouse allergen levels correlated according to room. Furthermore, 49% of the homes had reported problems with Mice within the previous year, and 29% of the homes had evidence of Mice in one or more rooms on home inspection; these homes had higher levels of Mouse allergen. Higher allergen levels were also associated with evidence of cockroach infestation in any room (22).

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In IgE immunoblot inhibition studies and histamine release tests, it has been demonstrated that patients who react to Dog albumin exhibit IgE reactivity with purified albumins from Cat, Mouse, Chicken, and Rat. Significant sequence homologies have been demonstrated with albumins from different species: Human: 82.6%, Pig: 81.8%, Cattle: 77.3%, Sheep: 78.8%, Mouse: 75.8%, and Rat: 76.2% (23).

Practically all respiratory animal allergens, including Mouse, characterised at the molecular level belong to the lipocalin family of proteins. Examples are the major allergens of Horse, Cow, Dog, Mouse and Cockroach as well as beta-lactoglobulin of Cow's milk (4). A certain degree of cross-reactivity is thus possible.

Clinical Experience

IgE mediated reactions

Mouse allergens found in dust, urine, epithelium and saliva are a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis, mainly in laboratory workers but also in ordinary individuals (2,24-26).

Various studies have examined the prevalence of allergic disease in the work-place to Mouse. Initial studies reported that about 20% of the exposed workers have symptoms of allergy to Mice (27). In a study evaluating the risk of laboratory animal allergy among research staff working in laboratories separate from the animal confinement area, 20% of the subjects had serum-specific IgE >0.35 kU/l to Rat urinary allergens and/or Mouse urinary allergens, and 32% had experienced animal work-related symptoms, although 90% of aeroallergen samples from the laboratories in question were below the detection limit. More than 4 years of exposure significantly increased laboratory animal sensitisation and symptoms. Working mainly with male rodents resulted in increased risk for sensitisation and for symptoms (28).

Hollander *et al.* demonstrated that the prevalence rates of allergy symptoms caused by working with Rats and Mice were 19% and 10%, respectively (29). A large epidemiological study of 5,000 laboratory workers reported symptoms in 26% exposed to Mice, 25% to Rats, 31% to Guinea Pigs, 30% to Rabbits, 26% to Hamsters, 25% to Dogs, 30% to Cats and 24% to Monkeys (30). Allergic rhinoconjunctivitis with nasal congestion, rhinorrhoea, sneezing and itchy, watery eyes can occur in up to 80% of symptomatic workers (9).

Although Mouse allergen is known to cause occupational asthma in laboratory workers, its potential significance in home environments has been underplayed. Through skin-specific IgE tests, 89 (18%) of 499 inner-city children were shown to be sensitised to Mouse. Children whose homes had Mouse allergen levels above 1.60 µg/g in the kitchen had a significantly higher rate of Mouse sensitisation than those with levels below (23% vs 11%). Atopy was also significantly related to Mouse sensitisation, with 40% of those with more than 4 positive skin-specific IgE responses having Mouse sensitivity, compared with 4% of those with no other positive skin-specific IgE responses (31).

Two hundred and sixty-three United Arab Emirates nationals with a respiratory disease suspected of being of allergic origin were submitted to skin- and serum-specific IgE measurement. Of these individuals, 8.3% were sensitised to Cat fur, 4.9% to Goat hair, and 0.7% to Rat hair and Mouse hair (32).

Importantly, children of parents exposed to Mice, Rats and Hamsters in an occupational setting, e.g., a laboratory, were shown to be more likely to have allergic symptoms, and to have significantly more positive skin-prick tests against allergens from the hair of laboratory animals, compared to children of non-exposed parents (33).

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e72 Mouse urine proteins

Mus spp.

Family: *Muridae*

Common names: Mouse, House mouse, Common house mouse

Source material: Urine

See also: Mouse e88, Mouse epithelium e71, and Mouse serum proteins e76.

The white Mice used in research laboratories are albinos bred from *Mus Musculus*.

Mus domesticus is the most common Mouse that is a commensal of man. But in the familes *Muridae* and *Cricetidae* are many wild species of Mouse, and rarer commensals such as the Doormouse.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and animal laboratory dust.

Allergen Exposure

Geographical distribution

Native to Asia, House mice are now ubiquitous. They exist in all climates and are routinely found both indoors and out. Their constant gnawing damages buildings, furniture and equipment. Mice carry diseases such as salmonella and leptospirosis. They are everyday pests because of their consumption of foodstuffs, and also because their continual dribble of urine and their feces cause contamination. Mice breed more prolifically than Rats, and spread faster, being smaller (which makes concealment easier) and more migratory, but are more easily controlled by poison, traps and predators. They are generally not as troublesome as Rats. In cultivated fields they may be beneficial, eating weed seeds and insects.

Environment

Agile and having a varied diet, Mice are found in every kind of building. They are a particular problem in poultry units, Pig housing, grain stores, warehouses, shops, and hospitals. They often migrate from cultivated fields into buildings after harvest. Where conditions permit, Mice may be found in meadows, along watercourses, and in other places where vegetation is dense enough to afford concealment, but they are not nearly as common in undisturbed or natural habitats.

Especially because of the numbers of Mice used in laboratories, allergy to Mice is an important occupational health problem.

Unexpected exposure

Like Rats, Mice interact unseen with humans, through mainly nocturnal foraging, which leaves behind urine, feces, saliva and skin flakes on many surfaces, especially those used for the preparation of food.

Allergens

Mouse allergens were identified over two decades ago. Major allergens were found in Mouse skin, serum, and urine: a 67 kDa protein, identical to Mouse albumin, and an approximately 17 kDa protein. Some individuals were sensitised predominantly to the large allergen, some to the smaller allergen, and a not one group of patients reacted to both allergens (1).

The concentration of the major allergens from Mouse, including Mouse serum albumin (MSA) and Mouse urinary protein (MUP) complex, vary in urine, serum, and pelts of Mice (2). Male rodents excrete higher levels of urinary allergens than female rodents (3).

As rodents have permanent proteinuria, the allergen is constantly present in their urine. They spray urine on their surroundings, where the proteins dry up and become airborne on dust particles.

To date, a number of allergens have been characterized.

Mus m 1 is a major allergen and a prealbumin. This 19 kDa protein is found in hair, dander and urine. This allergen is a lipocalin-odorant binding protein (4-5) and was formerly known as MUP (major urinary protein) and also known as MAI and Ag1 (6-12). Mus m 1 is produced in liver cells, circulates in the bloodstream, and is cleared by the kidneys. Males produce approximately 4 times more of this allergen than females. The allergen is low in serum (7,13).

Mus m 2, a 16 kDa glycoprotein, is found in hair and dander.

Albumin, a 65-69 kDa protein, is found in serum and urine. Approximately 30% of Mouse-sensitised individuals are sensitised to this allergen (14).

Rat and mouse urinary allergens are mainly present as large particles (>5.8 microm). The higher the number of animals in a room, the higher the allergen concentrations (15).

Hair and epithelial fragments also carry allergenic molecules, which are primarily derived from urine and saliva. Most of the allergenic components of urine and saliva have also been detected in the fur extract. Significant concentrations of airborne rodent allergens have been measured in both laboratories and apartments in inner cities (16-18).

Mouse allergens are carried mainly on particles of 6-18 microns. Allergen levels have been shown to correlate well with the number of animals present in the room and the degree of worker activity during sampling (19). The higher the number of animals in a room, the higher the allergen concentrations, and higher concentrations were also associated with cleaning activities. The highest personal exposure levels occurred when contaminated bedding and high numbers of conscious animals were handled. The highest airborne Mouse allergen levels have been reported to occur during manual emptying of cages, during changing of cages on an unventilated table and during handling of male animals on an unventilated table (20-21). The proportion of time spent on these tasks determined the degree of allergen exposure to a large extent.

A study reported that total Mus m 1 recovered ranged from 0.2 to 1.5 ng/m^3 in rooms without Mice and 0.5 to 15.1 ng/m^3 in rooms with Mice. Allergen recovered from the zone of worker activity ranged from 1.2 to 2.7 ng/m^3 in rooms without Mice and from 16.6 to 563.0 ng/m^3 in rooms with Mice. Direct Mouse contact was associated with the highest levels of exposure to Mus m I. Analysis revealed the bulk of allergen to be in mid-particle size range (3.3 to 10 microns) for Mouse-containing rooms and in small particle size range (0.43 to 3.3 microns) for non-Mouse-containing rooms, suggesting that small particles were carried along corridors from rooms with Mice into non-Mouse-containing rooms (22).

In disturbed air, allergen concentration has been shown to increase between 1.4-fold, for albumin allergens, and 5-fold, for crude allergens. The proportion of small particles increased from 1.4% in calm air to 4.5% in disturbed air (23).

Measurements of Mouse urine proteins showed that people with direct contact with Mice (animal technicians) have the highest exposure, followed in decreasing order by those working with anaesthetised animals, post-mortem workers, and those with indirect contact with Mice (e.g., supervisors, office workers, and slide production workers) (24).

The concentration and type of Mouse allergen varies between locations and within the same location. Mouse pelt extract allergenic activity may be detected in rooms away from Mouse-care rooms, whereas Mouse urine allergenic activity may be found only in the Mouse-care room. In a study, airborne allergen content ranged from 1.8 to 825 ng/m^3 and varied according to both the number of Mice and the amount of work activity in the rooms (2).

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Other reactions

See under Geographical distribution.

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Ara spp.

Family: *Psittacidae*

Common names: Parrot, Macaws; also se below

Source material: Feathers

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

The Parrot is one of the most common domestic birds, together with Budgerigars and Canaries. In 1994, Parrots were estimated at 25 million in US households, and more than 8 millions in German ones (1).

Parrot is the common name for members of the order *Psittaciformes*, comprising 315 species of colorful birds, pantropical in distribution, including such divergent types as the small Parakeet and the large, crested Cockatoo. Parrots have large heads and short necks, strong feet with two toes in front and two in back (facilitating climbing and grasping), and strong, thick bills, with the larger hooked upper mandible hinged to the bones of the head. They are prized worldwide as pets and zoo animals for their beautiful, bright plumage, their sociability, and their ability as mimics.

Environment

See above.

Unexpected exposure

Cockatoos have a down powder beneath their feathers, which provides insulation to keep them warm. The down also sheds a thick powder, which the birds use to waterproof and clean their outer feathers.

Allergens

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1). The allergens have not been fully characterized yet.

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components which cross-react with serum allergens/ antigens of the same as well as of other bird species (1).

Cross-reactivity between Parrot and other phylogenetically related bird species may be expected, and in Parrot-allergic patients, significant IgE antibody titers to Canary, Budgerigar, Chicken, Pigeon, Goose and Duck have been reported (2-3), even in patients without known exposure (1). Moreover, cross-reactivity to Hen's egg, Bird-Egg Syndrome, should be considered. Here the livetins present in egg yolk have been suggested as the major cross-reacting allergen (4-5).

e213 Parrot feathers

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may result following exposure to Canary feathers, epithelial cells or droppings (6,7). The allergic manifestations may present as Bird Fancier´s Asthma and as the so-called Bird-Egg Syndrome, with symptoms such as rhinitis, urticaria and angioedema (2), and also as gastro-intestinal problems (3).

Specific IgE has been found in patients exposed to Parrots (1-3). In 2 case reports (2,5), adult patients, both having developed allergy after acquiring a Parrot, experienced urticaria, angioedema and asthma after eating egg. Previously, they had never had allergy to egg. They had specific IgE to egg, but in these cases it seems that the egg yolk was the trigger, not the egg white, which is the common causative allergen in childhood egg allergy.

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

The disease occurs after exposure to organic dust, especially after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, Doves or Finches. Exposure results in the development of immunoglobulin antibodies including IgE (1), IgM (8), IgA and various IgG subclasses (9-11). The antibodies may be found in the sera and saliva of patients (12) as well as in the sera of asymptomatic but exposed subjects (13).

The allergenic proteins may be found in bird serum, droppings, skin scales, feathers and, in the case of Pigeons, Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). Contact may result from handling birds, cleaning their lofts, or exposure to the organic dust drifting down from a ceiling or roof where birds nest.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (14).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of extrinsic allergic alveolitis (15).

Hypersensitivity pneumonitis has also been reported following contact with a wild Moluccan cockatoo (16).

Other reactions

Bird Breeder´s Lung has also been described as caused by Parrot droppings (17).

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Columba livia

Family: *Columbidae*

Common names: Pigeon, Feral pigeon, Town pigeon, City pigeon

Source material: Droppings

See also: Pigeon feathers e215

Direct or indirect contact with Pigeon allergens frequently causes sensitisation. Pigeon allergens may be major components in house dust.

Allergen Exposure

Geographical distribution

The number of domestic birds is currently estimated at 25 million in the USA and more than 8 million in German households. In Germany, an additional 11 million Pigeons are kept by more than 140,000 registered breeders of fancy Pigeons. (The Homing/racing pigeon is a specifically bred variety of Pigeon. These Pigeons are capable of returning home within the day after being released several hundred miles from their loft.) This number does not include the breeding of fattened Pigeons for the table.

There are over 300 species of Pigeons and Doves around the world. Feral, Town or City pigeons are believed to have descended from domesticated strains of the Rock dove. In the wild they then interbred (and continue to interbreed) with Racing pigeons and Pigeons from bird fanciers' lofts. The Feral pigeon is found worldwide. It is closely associated with humans and is a common sight in urban environments.

Feral pigeons are seen as a pest, due to the noise they create from cooing and scratching; damage to cars, domestic premises, monuments and commercial properties due to droppings; the resultant smell, and of course the potential slip hazard. (Gutters and drainpipes may become blocked, leading to flooding and associated problems.) Extensive damage to air conditioning units and other rooftop machinery is commonplace.

Environment

Feral pigeons build their nests in or on buildings and other structures, where they are usually found on ledges or in hollows - often under eaves or on girders. They may, however, be found in more rural situations, e.g., farmland, parks, golf courses, moorland and woodland.

Allergens

Pigeon droppings contain excreted serum protein antigens which may have been degraded, making identification difficult. But it is clear that IgA and intestinal mucin are major antigen components. Droppings may also include bacterial endotoxin and other non-specific biological substances.

In a study of patients with Pigeon Breeder's Lung, a 21-kDa protein was shown, by immunoblotting tests, to be the only protein that identified individuals exposed to Pigeons (1). Antigens identified by indirect immunofluorescence staining, and specific for sera from patients with Pigeon Breeders' Lung or healthy Pigeon breeders, have been isolated from Pigeon intestinal mucus. Two antigenic peaks, one being Pigeon intestinal mucin and the other IgA, were isolated. These studies demonstrate that antibodies to 2 quite different antigens are associated specifically with sera from Pigeon breeders (2). Pigeon intestinal mucin is a complex high-molecular-weight glycoprotein shown to be a key antigen in the development of Pigeon Breeder's Lung. Different IgG subclasses appear to recognise different epitopes on mucin (3).

Potential cross-reactivity

Positive IgE antibody reactions to sera and feathers from 5 bird species (Pigeon, Budgerigar, Parrot, Canary and Hen), and to Pigeon droppings, have been found in subjects with Bird Fancier's Asthma (4). Since antibodies of each of the patients also recognised antigens of birds with which they were not in contact, immunological cross-reactivity between different avian species was suggested. Pigeon allergens also appear to cross-react with Dove droppings (5).

Clinical Experience

IgE mediated reactions

Diseases associated with exposure to Pigeon include Extrinsic Allergic Alveolitis/ hypersensitivity pneumonitis, asthma, allergic rhinitis, ornithosis (microbial infections transmitted to man) and lung inflammation caused by irritant dusts (6).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result. The disease is also known as Pigeon Breeder's Disease, a type of hypersensitivity lung disease due to the inhalation of Pigeon-derived antigens, such as antigens from dried Pigeon droppings (6-8). In Mexico, the most frequent form is due to the inhalation of avian antigens, mainly Pigeon proteins (9). A nasal form of Pigeon Breeder's Disease also exists (10).

It occurs after exposure to organic dust and may occur after close contact with Pigeons or other birds such as Budgerigars, Parrots, Canaries, Parakeets, Cockatiels, and Doves. Exposure results in the development of various immunoglobulins including IgE (4), IgM (11), IgA and various IgG subclasses (12-14). The antibodies may be found in the sera and saliva of patients (15) as well as in the sera of asymptomatic but exposed subjects (16).

The allergenic proteins are found in bird serum, droppings, skin scales, feathers and Pigeon bloom (a waxy fine dust which coats the feathers of Pigeons). “Fancy” birds produce copious bloom; poultry (Duck, Chicken, Turkey) produces very little bloom. Contact may result from handling birds, cleaning the loft, or from exposure to the organic dust drifting down from a ceiling where birds nest.

Diagnosis is based on a characteristic clinical picture and a typical x-ray pattern, accompanied by the presence of specific IgG antibodies (17).

The measurement of specific IgG using IgG tracer technology has been shown to be a sensitive and specific assay for the routine diagnostic testing of Extrinsic Allergic Alveolitis caused by bird antigens (18).

Extrinsic Allergic Alveolitis may also occur in families, as reported in a study where the cause was wild city Pigeons (19).

Extrinsic Allergic Alveolitis is not common in childhood (20-22). A study from Malta reports on 5 cases in the pediatric population. All were males, and were initially diagnosed as having other respiratory illnesses or mental disturbances. A final correct diagnosis was made based on a history of exposure to birds, clinical findings, positive avian precipitins, a restrictive defect shown on pulmonary function tests, and a suggestive chest X-ray appearance (23).

A typical clinical presentation would be a male Pigeon breeder who develops a sudden fever, cough and dyspnoea, with diffuse nodular shadows on the chest X-ray film (24). In a study conducted in the Canary Islands, of 343 Pigeon breeders, 29 (8%) fulfilled the classic Pigeon Breeder's Disease criteria. One hundred and six (31%) had rhinitis, 62 (19%) had immediate bronchial symptoms, and 51 (15%) suffered from chronic bronchitis. A significant level of specific IgG was detected in 139 (40%) cases. A statistical relationship between the intensity of exposure and specific IgG response was also found (17).

The presence of IgG, IgA, IgM and IgE antibodies against Pigeon serum and Pigeon droppings has been demonstrated in serum from symptomatic breeders (6,25-27). Positive IgE antibody reactions to sera and feathers from 5 bird species (Pigeon, Budgerigar, Parrot, Canary and Hen), and to Pigeon droppings, have been found in subjects with Bird Fancier's Asthma (4). Pigeon Breeder's Disease has been found in 6-21% of breeders (6), with the figure differing from country to country. Rhinitis in bird fanciers can be associated with an IgE-mediated allergy to bird antigens.

A 61-year-old woman was diagnosed with chronic hypersensitivity pneumonitis due to Wild Pigeons. The patient was not a Pigeon breeder, but she could have been exposed to Pigeons at her workplace. She had specific antibodies against Pigeon serum and droppings, and her peripheral lymphocytes showed proliferation in response to Pigeon serum. A positive provocation test involving inhalation of Pigeon serum confirmed that she had chronic hypersensitivity pneumonitis caused by allergy to Pigeons. This is a rare case of chronic hypersensitivity pneumonitis, associated with Wild Pigeons, that progressed to pulmonary fibrosis (28).

Other reactions

Acute urticaria may be caused by Pigeon ticks, which, according to a report, had dropped from wooden ceiling beams. The patient was living in the centre of Milan in a very old house, where numerous Pigeons had built their nests under the rooftop (29).

The House Dust mite *Dermatophagoides farinae* has been found in samples from a Pigeon loft. Besides Mites of the family *Pyroglyphida*e, Mites of the *Tyroglyphidae* family and/or mucedine were found. House dust mites should be considered in patients with apparent allergic disease to Pigeon (30).

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e215 Pigeon feathers

Columba livia

Family: *Columbidae*

Common names: Pigeon, Feral pigeon, Town pigeon, City pigeon

Source material: Feathers

See also: Pigeon droppings e7

Direct or indirect contact with bird allergens may cause sensitisation. Bird allergens may be major components of house dust.

Allergen Exposure

Geographical distribution

The number of domestic birds is currently estimated at 25 million in the USA and more than 8 million in German households. In Germany, an additional 11 million Pigeons are kept by more than 140,000 registered breeders of fancy Pigeons. (The Homing/ racing pigeon is a specifically bred variety of Pigeon. These Pigeons are capable of returning home within the day after being released several hundred miles from their loft.) This number does not include the breeding of fattened Pigeons for the table.

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Feral pigeons are seen as a pest, due to the noise they create from cooing and scratching; damage to cars, domestic premises, monuments and commercial properties due to droppings, the resultant smell, and of course the potential slip hazard.

Environment

Feral pigeons build their nests in or on buildings and other structures, where they are usually found on ledges or in hollows - often under eaves or on girders. They may, however, be found in more rural situations, e.g., farmland, parks, golf courses, moorland and woodland.

Allergens

"Pigeon bloom" consists of keratin particles. These are produced copiously from feathers and transport serum proteins to peripheral airways and may act as a local irritant or adjuvant.

Well-defined major allergenic bands with molecular mass of 20-30 kDa and 67 kDa have been detected and identified in IgE immunoblots with feather extracts as well as with serum proteins of Budgerigar, Parrot, Pigeon, Canary, and Hen. Inhalable feather dust was shown to contain several allergenic components which cross-react with serum allergens/antigens of the same as well as of other bird species (1). These allergens have not yet been fully characterized.

The allergens detected to date include numerous proteins in Pigeon serum (2-3). Pigeon intestinal mucin, an allergen found in Pigeon droppings, may also be found in Pigeon sera and feathers (4).

e215 Pigeon feathers

Potential cross-reactivity

As noted above, inhalable feather dust contains several allergenic components which cross-react with serum allergens/ antigens of the same as well as of other bird species (1).

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis may occur after exposure to Pigeons (5-7). Other diseases associated with exposure to Pigeon include extrinsic allergic alveolitis/hypersensitivity pneumonitis, asthma, allergic rhinitis, ornithosis (microbial infections transmitted to man) and lung inflammation caused by irritant dusts (8).

Extrinsic allergic alveolitis, also known as hypersensitivity pneumonitis, Bird Fancier's Lung and Farmer's Lung, is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result. The disease is also known as Pigeon Breeder's Disease, an example of hypersensitivity lung disease due to the inhalation of Pigeon-derived antigens.

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Other reactions

The House dust mite *Dermatophagoides farinae* was found in 5 samples derived from conventional Hen housing with fowls and Pigeons and from a test animal hutch with Rats, Mice and Rabbits. Besides Mites of the family *Pyroglyphidae*, Mites of the *Tyroglyphidae* family and/or mucedine were found, which affects the development of Mite populations. House dust mites should be considered in the aetiology of allergic diseases from Dog, Cat and livestock (18).

Feather mites are a major source of soluble proteins derived from feathers, accounting for up to 10% of the total weight of the feather. RAST inhibition indicated feather Mites had species-specific epitopes as well as ones that cross-reacted with *Dermatophagoides pteronyssinus* (19-20).

A case has been reported where acute urticaria was caused by Pigeon ticks, which had dropped from wooden ceiling beams. The patient was living in the center of Milan in a very old house, where numerous Pigeons had built their nests under the rooftop (21).

Cryptococcus neoformans is a Yeast with a large polysaccharide capsule that may be found in Pigeon droppings and result in opportunistic infections in man, but not in Pigeons. Inhalation of spores can cause pulmonary infection, although this is usually mild and sometimes even asymptomatic (22).

See also: Pigeon droppings e7.

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e82 Rabbit epithelium

Oryctolagus cuniculus

Family: *Leporidae*

Common names: Rabbit, Common European rabbit, Domestic rabbit

The New World genus *Sylvilagus* includes the many species of Cottontail rabbit, which resemble the European rabbit in appearance. The North American species called Jackrabbit are actually Hares (having longer ears and legs, and giving birth to already furred and open-eyed young), as is the Snowshoe rabbit. The domesticated so-called Belgian hare, on the other hand, is a Rabbit.

Source material: Epithelium

See also: Rabbit urine proteins Re211 and Rabbit serum proteins Re206

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens may be major components of house dust or laboratory dust.

Allergen Exposure

Geographical distribution

The Common European rabbit is native to Southern Europe and Africa, but is now found, in its domestic varieties, throughout the world; wild varieties have also been introduced in some places, such as England. All Domestic rabbits belong to this species. They may be various colours but are commonly white, and are bred for food and for their fur, which is often used in making fur trim and felt. They are also frequently used as laboratory animals and are kept as pets. Wild rabbits feed on a wide variety of vegetation and are responsible in many areas for the stunted nature of the ground cover.

Environment

See under Geographical distribution.

Allergens

Several allergens have been identified in Rabbit saliva, fur, urine, dander and dust. Allergenic proteins of 18-38 kDa have been detected (1). To date, 2 have been characterized:

Ory c 1, a 18 kDa protein, found in hair, dander and saliva (2-3).

Ory c 2, found in hair, dander and urine (2-3).

Serum albumin may be of minor allergenic importance (4-6).

Serum-specific IgE suggests that epithelium has different allergens from those in saliva, urine and fur. Saliva is the most potent extract. Overall, 26 protein bands are recognised as allergens. Saliva has 12, urine 7 and fur 7. Molecular weights varied from 8 kDa in saliva to 80 kDa in urine. An 18 kDa and 21 kDa protein were shown to belong to the lipocalin family. Saliva appears to contain the most potent allergen, which probably has a high homology with a 21 kDa lipocalin-odorant binding protein from Rabbit nasal mucosa (2-3,7).

e82 Rabbit epithelium

Potential cross-reactivity

A 15 kDa allergen separated from a mixed Rabbit fur and dander extract was shown to cross-react with IgE antibodies in Deer-allergic individuals (7). (This is possibly not a dominant cross-reactivity. – Editor)

Clinical Experience

IgE mediated reactions

Of the 90,000 laboratory animal workers in the United States, between 21% and 46% develop allergy to laboratory animals. Of those who develop symptoms, more than 10% eventually develop occupation-related asthma with symptoms that persist even after exposure ceases (3,8-9). These individuals are susceptible to life-threatening (but rare) anaphylactic reactions following animal bites and scratches and pricking with needles contaminated with the animal proteins (8). Many animals associated with laboratories may actually be adopted as pets, resulting in allergies in their owners and owners' family members.

Allergy to animals may range from allergic rhinitis to allergic conjunctivitis to dermatitis to severe asthma. These may result from inhalation of or contact with the animal's dander, epithelium cells, urine, saliva, serum or hair. Most animals shed allergens through these substances, but not all species or strains do so equally. Different routes of exposure, e.g., respiratory, oral, mucosal and transdermal, elicit different symptoms.

A large study of laboratory animal workers in Japan recorded that symptoms were reported in 26% of workers exposed to Mice, 25% for Rats, 31% for Guinea pigs, 30% for Rabbits, 26% for Hamsters, 30% for Cats, 25% for Dogs and 24% for Monkeys. About 70% of laboratory animal allergy (LAA) subjects developed symptoms during their first 3 years of exposure. A close relation between nasal symptoms and exposure to Rabbits and between skin symptoms and exposure to Rats was found. LAA subjects developed symptoms most quickly to Rabbits (10). The commonest symptom is allergic rhinoconjunctivitis with nasal congestion, rhinorrhoea, sneezing and itchy, watery eyes, which can occur in up to 80% of symptomatic workers (2).

While Rabbits are common as pets, severe allergic reactions to Domestic Rabbits in homes are unusual. Typically, allergic manifestations are mild to moderate allergic rhinitis, conjunctivitis, pruritus and/or asthma, contact urticaria and contact dermatitis in laboratory animal caretakers with frequent exposure (1,11-12). In a study of atopic children with contact with pets, 18% were sensitised to Rabbit and 12.3% showed clinical signs in the animal's presence (13). Cumulative duration of exposure to domestic animals is a significant determinant for immediate sensitisation to animal-derived antigens in subjects with asthma (12).

An atopic child developed anaphylaxis following inhalant exposure to a Rabbit. The patient had elevated serum-specific IgE to Rabbit epithelium and fur but not to Rabbit serum (14).

A 32-year-old male research physician accidentally received a minor wound from a needle which had been previously used on Rabbit tissue. Within 15 minutes serious anaphylactic reactions started and he was taken to hospital, where his condition stabilised within 5 hours. Serum immunoglobulin E antibodies to Rabbit epithelium were high (16.2 U/ml) (15).

Other reactions

Papular urticaria may result from contact with the Rabbit fur mite or Cat flea that may be found on Rabbits (16).

Wild Rabbits are frequently infected with tularemia, which may be transmitted to humans.

See also: Rabbit urine proteins Re211 and Rabbit serum proteins Re206.

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Oryctolagus cuniculus

Family: *Leporidae*

Common names: Rabbit, Common European rabbit, Domestic rabbit

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Source material: Serum

See also: Rabbit epithelium e82 and Rabbit urine proteins Re211

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

The Common European rabbit is native to Southern Europe and Africa, but is now found, in its domestic varieties, throughout the world; wild varieties have also been introduced in some places, such as England. All Domestic rabbits belong to this species. They may be various colours but are commonly white, and are bred for food and for their fur, which is often used in making fur trim and felt. They are also frequently used as laboratory animals and are kept as pets. Wild rabbits feed on a wide variety of vegetation and are responsible in many areas for the stunted nature of the ground cover.

Environment

See under Geographical distribution.

Allergens

Several allergens have been identified in Rabbit saliva, fur, urine, dander and dust, but most have not been fully characterised yet. Serum albumin may be of minor allergenic importance (1-4).

Serum-specific IgE results suggest that saliva is the most potent extract. Overall, 26 protein bands are recognised as allergens. Saliva has 12, urine 7 and fur 7. Molecular weights varied from 8 kDa in saliva to 80 kDa in urine. An 18 kDa and 21 kDa protein were recognised as lipocalins. Saliva appears to contain the most potent allergen, which probably has a high homology with a 21 kDa lipocalin-odorant binding protein from Rabbit nasal mucosa (5,6-7).

Clinical Experience

IgE mediated reactions

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10% eventually develop occupation-related asthma, with symptoms that persist even after exposure ceases (6,8-9). These individuals are susceptible to life-threatening (but rare) anaphylactic reactions following animal bites and scratches and pricking with needles contaminated with the animal proteins (8). Many animals associated with laboratories may actually be adopted as pets, resulting in allergies in their owners and owners' family members.

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Other reactions

See also: Rabbit epithelium e82 and Rabbit urine proteins Re211.

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Re211 Rabbit, urine proteins

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Source material: Urine

See also: Rabbit epithelium e82 and Rabbit serum proteins Re206

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens may be major components in house dust or laboratory dust.

Allergen Exposure

Geographical distribution

The Common European rabbit is native to Southern Europe and Africa, but is now found, in its domestic varieties, throughout the world; wild varieties have also been introduced in some places, such as England. All Domestic rabbits, belong to this species. They may be various colours but are commonly white, and are bred for food and for their fur, which is often used in making fur trim and felt. They are also frequently used as laboratory animals and are kept as pets. Wild rabbits feed on a wide variety of vegetation and are responsible in many areas for the stunted nature of the ground cover.

Environment

See under Geographical distribution.

Allergens

Several allergens have been identified in Rabbit saliva, fur, urine, dander and dust, but most have not been fully characterized yet (1-4).

Ory c 2, found in hair, dander and urine (5-6).

Serum-specific IgE results suggest that epithelium has different allergens from those in saliva, urine and fur. Saliva is the most potent extract. Overall, 26 protein bands are recognised as allergens. Saliva has 12, urine 7 and fur 7. Molecular weights varied from 8 kDa in saliva to 80 kDa in urine. An 18 kDa and 21 kDa protein were shown to belong to the lipocalin family. Saliva appears to contain the most potent allergen, which probably has a high homology with a 21 kDa lipocalin-odorant binding protein from Rabbit nasal mucosa (5-7).

Re211 Rabbit, urine proteins

Clinical Experience

IgE mediated reactions

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In a cross-sectional survey carried out on 138 workers exposed to laboratory animals, 60 (44%) had symptoms, as shown in a self-completed questionnaire, that were consistent with laboratory animal allergy (LAA); of these individuals, 15 (11%) had chest symptoms. There was a positive skin-prick test to one or more animal urine extracts (Rat, Mouse, Guinea pig, Rabbit) in 13%, and 38% had a positive specific IgE test to urine extract (14).

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Rattus norvegicus

Family: *Muridae*

Common names: Rat, Brown rat, House rat, Norway rat

Source material: Epithelium

See also: Rat e87, Rat urine proteins e74, and Rat serum proteins e75

Selective breeding in this species has produced the albino Laboratory rat, widely used for medical and other research purposes.

House rats comprise two species, *Rattus norvegicus*, the Brown or Norway rat, and *Rattus Rattus*, the Black or Alexandrine rat, which also originated in Asia, spread worldwide by ships, and is a well-known disease carrier, but has been largely displaced in cooler regions by the Brown rat. They are roughly similar in appearance and habits. (The Brown rat is larger, but with a shorter tail and smaller ears, while the dark-grey Black rat is a better climber.)

Besides the House rats, the genus *Rattus* contains several hundred wild-living species. In addition, many other members of the order Rodentia are called Rats: e.g., the Bandicoot rat, the Wood or Pack rat, the Rice rat, the Muskrat, and the Kangaroo rat.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and laboratory dust.

Allergen Exposure

Geographical distribution

This species of Rat is not a native of Norway, as its name suggests. The species originated in Asia, reached Europe early in the eighteenth century and arrived in North America about 1775 on ships from England. Its distribution is now worldwide.

Many consider this Rat to be the greatest mammal pest of all time. It has caused more deaths than all the wars in history. It harbours lice and fleas and has been the source of bubonic plague, typhus, trichina, tularemia, infectious jaundice and other serious diseases. These Rats are usually a contributing factor of first importance in the spread of pandemics during war. They also cause considerable depletion and pollution of human food stores, and damage to buildings and their contents from destructive chewing of wiring, pipes, and walls. But despite human efforts to exterminate Rats, the House rat population is probably equal to the human population.

The Brown rat grows up to 25 cm long, excluding the naked, scaly tail, and sometimes weighs more than half a kilogram. It is commonly brown with whitish underparts and pink ears, feet, and tail. It breeds, and therefore aggressively forages, all year round.

e73 Rat epithelium

Environment

As small, intelligent, bold, prolifically breeding omnivores, nesting in practically any sort of disused cavity or burrowing in the ground, and adept at swimming, jumping and climbing, Brown rats are highly adaptable and live in a great variety of environments. They may hide in huge numbers in and around human dwellings, especially in cities, towns and their surroundings, There, they live principally in basements, on the ground floor, in subways, and in burrows under sidewalks or outbuildings. They are also frequently found in cultivated fields, grain storage facilities, livestock housing and garbage dumps. Basically, they are at home wherever there is a food source and sufficient cover from predators, and this includes some unexpected places like the salt marshes of the US Atlantic coast, where edible flotsam is washed up on the beaches.

Especially because of the numbers of Rats used in laboratories, allergy to Rats is an important occupational health problem.

Unexpected exposure

Most exposure to Brown rats is unexpected. These secretive, mainly nocturnal animals pass unseen in more or less regular scavenging journeys over a variety of surfaces with which humans have daily contact. Their skin flakes, urine, feces, and saliva are left behind. They have also been known to bite sleepers.

Allergens

Hair and epithelial fragments carry allergenic molecules, which are primarily derived from urine and saliva. Most of the allergenic components of urine and saliva have also been detected in the fur extract. Some of the minor allergens are those antigens which appear to be unique to urine, saliva or the skin, suggesting that sensitisation to Rats can result from exposure to allergenic material from any of these 3 sources. Significant concentrations of airborne rodent allergens have been measured in both laboratories and apartments in inner cities (1-5).

Through the study of Rat-allergic patients, at least 23 allergens have been identified in Rat fur. Allergens of molecular weights of 55, 51, 19, and 17 kDa were isolated and determined to be “major” allergens. Other allergens of 74, 67 (probably albumin) and 21.5 (diffuse) kDa molecular weights were also isolated. Fur is the most probable source of the high-molecular-weight allergens found in Rat room dust. There was considerable variation among the Rat-allergic individuals in the binding of IgE to the separated fur and saliva allergens (6).

The number of Rats, Rats' bedding, cage design, and stock density influence the level of aeroallergen concentration and exposure (7). Rat allergen can also be carried on clothes or by wind to distant sites, with traces of Rat urinary aeroallergens measured in tea rooms inside and near offices outside the animal housing (8-9).

The highest airborne Mouse allergen levels have been measured during manual emptying of cages, during changing of cages on an unventilated table, and during handling of male animals on an unventilated table. Using ventilated cage-changing wagons has been shown to reduce the allergen exposure level from 77 to 17 ng/m^3 (10). Similar results can be expected with Rats. Airborne Rat allergens are particles ranging from 1 to 20 micrometres in size, and can remain airborne for 60 minutes or more after disturbance. Rat allergen exposure levels less than 0.7 µg/m^3 appear not to be associated with an increased risk of occupational asthma (11).

Rat dust is a complex allergenic source and contains allergens from Rats' urine, epithelium and saliva (12).

Potential cross-reactivity

Practically all respiratory animal allergens, including Rat, characterised at the molecular level belong to the lipocalin family of proteins. Examples are the major allergens of Horse, Cow, Dog, Mouse and Cockroach as well as beta-lactoglobulin of Cow's milk (13). A certain degree of cross-reactivity is thus possible.

Clinical Experience

IgE mediated reactions

Rat allergens found in dust, urine, epithelium and saliva are a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis, mainly in laboratory workers but also in ordinary individuals (14-16).

There is a strong association between work-related symptoms and specific sensitisation (17). Workers exposed to laboratory animals are at risk of developing asthma, rhinitis, angioedema, conjunctivitis, and urticaria. Between 10% and 33% of scientists and technicians handling small animals will develop laboratory animal allergy symptoms within 3 years of employment. Many of them will have severe symptoms requiring a change of occupation (18-21).

In workers exposed to Rats, Rat urinary allergen sensitisation risk increased with increasing exposure intensity. Workers who were atopic had a clearly elevated sensitisation risk at low allergen exposure levels (22). In a cross-sectional study performed on 540 workers at 8 facilities to quantify the exposure-response relationship for allergy to Rats, no clear exposure-response relationship was observed. However, in the group of workers with less than 4 years of working experience with laboratory animals, the prevalence rate of sensitisation to Rat allergens was clearly associated with exposure levels. The exposure-response relationship was steepest for workers with atopy-associated risk factors, i.e., self-reported allergy or sensitisation to Cats or Dogs, or elevated total serum IgE. The prevalence rates of sensitisation to Rat allergens for these workers were about 15, 9.5, and 7.3 times higher in the high-, medium-, and low-exposure group, respectively, compared with the internal reference group (23).

A large epidemiological study of 5,000 laboratory workers reported symptoms in 26% exposed to Mice, 25% to Rats, 31% to Guinea pigs, 30% to Rabbits, 26% to Hamsters, 25% to Dogs, 30% to Cats and 24% to monkeys (24).

Two hundred and sixty-three United Arab Emirates nationals with a respiratory disease suspected of being of allergic origin were submitted to skin- and serum-specific IgE measurement. Of these individuals, 8.3% were sensitised to Cat fur, 4.9% to Goat hair, and 0.7% to Rat hair and Mouse hair (25).

Importantly, children of parents exposed to Mice, Rats and Hamsters in an occupational setting, e.g., a laboratory, were shown to be more likely to have allergic symptoms, and to have significantly more positive skin-specific IgE tests against allergens from the hair of laboratory animals, compared to children of non-exposed parents (26).

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e87 Rat epithelium, serum proteins and urine proteins

Rattus norvegicus

Family: *Muridae*

Common names: Rat, Brown rat, House rat, Norway rat

Source material: Epithelium, serum and urine

See also: Rat epithelium e73, Rat urine proteins e74, and Rat serum proteins e75

Selective breeding in this species has produced the albino Laboratory rat, widely used for medical and other research purposes.

House rats comprise two species, *Rattus norvegicus*, the Brown or Norway rat, and *Rattus Rattus*, the Black or Alexandrine rat, which also originated in Asia, spread worldwide by ships, and is a well-known disease carrier, but has been largely displaced in cooler regions by the Brown rat. They are roughly similar in appearance and habits. (The Brown rat is larger, but with a shorter tail and smaller ears, while the dark-grey Black rat is a better climber.)

Besides the House rats, the genus *Rattus* contains several hundred wild-living species. In addition, many other members of the order Rodentia are called Rats: e.g., the Bandicoot rat, the Wood or Pack rat, the Rice rat, the Muskrat, and the Kangaroo rat.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and laboratory dust.

Allergen Exposure

Geographical distribution

This species of Rat is not a native of Norway, as its name suggests. The species originated in Asia, reached Europe early in the eighteenth century and arrived in North America about 1775 on ships from England. Its distribution is now worldwide.

Many consider this Rat to be the greatest mammal pest of all time. It has caused more deaths than all the wars in history. It harbours lice and fleas and has been the source of bubonic plague, typhus, trichina, tularemia, infectious jaundice and other serious diseases. These Rats are usually a contributing factor of first importance in the spread of pandemics during war. They also cause considerable depletion and pollution of human food stores, and damage to buildings and their contents from destructive chewing of wiring, pipes, and walls. But despite human efforts to exterminate Rats, the House rat population is probably equal to the human population.

The Brown rat grows up to 25 cm long excluding the naked, scaly tail, and sometimes weighs more than half a kilogram. It is commonly brown with whitish underparts and pink ears, feet, and tail. It breeds, and therefore aggressively forages, all year round.

e87 Rat epithelium, serum proteins and urine proteins

Environment

As small, intelligent, bold, prolifically breeding omnivores, nesting in practically any sort of disused cavity or burrowing in the ground, and adept at swimming, jumping and climbing, Brown rats are highly adaptable and live in a great variety of environments. They may hide in huge numbers in and around human dwellings, especially in cities, towns and their surroundings, There, they live principally in basements, on the ground floor, in subways, and in burrows under sidewalks or outbuildings. They are also frequently found in cultivated fields, grain storage facilities, livestock housing and garbage dumps. Basically, they are at home wherever there is a food source and sufficient cover from predators, and this includes some unexpected places like the salt marshes of the US Atlantic coast, where edible flotsam is washed up on the beaches.

Especially because of the numbers of Rats used in laboratories, allergy to Rats is an important occupational health problem.

Unexpected exposure

Most exposure to Brown rats is unexpected. These secretive, mainly nocturnal animals pass unseen in more or less regular scavenging journeys over a variety of surfaces with which humans have daily contact. Their skin flakes, urine, feces, and saliva are left behind. They have also been known to bite sleepers.

Allergens

Rat dust is a complex allergenic source and contains allergens from Rats' urine, epithelium and saliva (1).

Allergens characterized to date include:

Rat n 1, a 17 kDa protein (1-4).

Rat n 1.01.

Rat n 1.02, a major allergen, a 17 kDa protein (also called alpha 2u-globulin).

Rat n 1A (previously known as Ag4), a 20-21 kDa protein, and Rat n 1B (previously known as Ag13), a 16-17 kDa sized protein, are both variants of the same protein. These allergens are found in hair, dander, urine and saliva (4-6).

Rat n 1A is a prealbumin. Rat n 1B is an alpha-2-eu-globulin and primarily a male Rat allergen (6).

Rat n 1.01 and Rat n 1.02 are lipocalins (lipocalin-pheromone binding proteins) (7).

Rat urine has been identified as a major source of the allergens in laboratory animal allergy. The age and sex of the Rat can influence the allergenic composition of the urine (1,8). Male rodents excrete higher levels of urinary allergens than female rodents (9).

Rodents have permanent proteinuria, and thus the allergen is constantly present in their urine. They spray urine on their surroundings, where the proteins dry up and become airborne on dust particles.

Hair and epithelial fragments also carry allergenic molecules, which are primarily derived from urine and saliva. Most of the allergenic components of urine and saliva have also been detected in the fur extract. Some of the minor allergens are those antigens which appear to be unique to urine, saliva or the skin, suggesting that sensitisation to Rats can result from exposure to allergenic material from all 3 of these sources. Significant concentrations of airborne rodent allergens have been measured in both laboratories and apartments in inner cities (10-14).

Through the study of Rat-allergic patients, at least 23 allergens have been identified in Rat fur. Allergens of molecular weights of 55, 51, 19, and 17 kDa were isolated and determined to be “major” allergens. Other allergens of 74, 67 (probably albumin) and 21.5 (diffuse) kDa molecular weights were also isolated. Salivary allergens were 17 in number, with “major” allergens of the sizes 21.5, 19.5, 19, 18, and 17.5 kDa. Many Rat-allergic subjects had serum-specific IgE to the 67 kDa (56%) and 43 kDa (64%) allergens. The most important salivary allergens have molecular weights of less than 22 kDa. Fur is the most probable source of the high-molecular-weight allergens found in Rat room dust. There was considerable variation among the Rat-allergic individuals in the binding of IgE to the separated fur and saliva allergens (8).

In serum, 75 kDa and 68 kDa serum protein allergens have been isolated, the former probably serum albumin and the latter probably transferrin. These proteins are also present in Rat urine (15). The prevalence of specific IgE in Rat-allergic patients to the 68 kDa (albumin) allergen is between 24% and 28.9% (16-18).

Prealbumin and alpha(2)-euglobulin (as these were previously termed), detected in Rat urine, are highly homologous and have now been identified as alpha(2)-globulin species. The “prealbumin” fraction corresponds to alpha(2u)-globulin originating from the salivary gland, and the “alpha(2)-euglobulin” fraction has been shown to be identical to the major urinary protein (MUP) or alpha(2u)-globulin. The two major protein fractions of Rat urine thus appear to constitute different forms of the same parent protein, alpha(2u)-globulin. These allergens are found mainly in adult male Rats. Rat n 1B is produced in the liver, where it is androgen-dependant, and in the salivary, mammary and other exocrine glands, where its production is not androgen dependant (7).

The number of Rats, Rats' bedding, cage design, and stock density influence the level of aeroallergen concentration and exposure (19). Rat allergen can also be carried on clothes or by wind to distant sites, with traces of Rat urinary aeroallergens measured in tea rooms inside and near offices outside the animal housing (20-21).

The highest airborne Mouse allergen levels have been measured during manual emptying of cages, during changing of cages on an unventilated table, and during handling of male animals on an unventilated table. Using ventilated cage-changing wagons has been shown to reduce the allergen exposure level from 77 to 17 ng/m^3 (22). Similar results can be expected with Rats. Airborne Rat allergens are particles ranging from 1 to 20 micrometres in size, and can remain airborne for 60 minutes or more after disturbance. Rat allergen exposure levels less than 0.7 µg/m^3 appear not to be associated with an increased risk of occupational asthma (23). More intense exposure to airborne Rat n 1 and endotoxin occurs not only during cleaning, but also during feeding tasks, probably because the allergens become airborne during the disturbance (24).

The 17 kDa dust allergen has immunological identity with Rat n 1 and is a suitable marker protein for the quantification of airborne Rat allergen (1).

Potential cross-reactivity

In IgE immunoblot inhibition studies and histamine release tests, it has been demonstrated that patients who react to Dog albumin exhibit IgE reactivity with purified albumins from Cat, Mouse, Chicken, and Rat. Significant sequence homologies have been demonstrated with albumins from different species: Human: 82.6%, Pig: 81.8%, Cattle: 77.3%, Sheep: 78.8%, Mouse: 75.8%, and Rat: 76.2% (25).

Practically all respiratory animal allergens, including Rat, characterised at the molecular level belong to the lipocalin family of proteins. Examples are the major allergens of Horse, Cow, Dog, Mouse and Cockroach as well as beta-lactoglobulin of Cow's milk (26). A certain degree of cross-reactivity is thus possible.

Clinical Experience

IgE mediated reactions

Rat allergens found in dust, urine, epithelium and saliva are a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis, mainly in laboratory workers but also in ordinary individuals (27-29).

There is a strong association between work-related symptoms and specific sensitisation (30). Workers exposed to laboratory animals are at risk of developing asthma, rhinitis, angioedema, conjunctivitis, and urticaria. Between 10% and 33% of scientists and technicians handling small animals will develop laboratory animal allergy symptoms within 3 years of employment. Many of them will have severe symptoms requiring a change of occupation (1,31-33).

In workers exposed to Rats, Rat urinary allergen sensitisation risk increased with increasing exposure intensity. Workers who were atopic had a clearly elevated sensitisation risk at low allergen exposure levels (34). In a cross-sectional study performed on 540 workers at 8 facilities to quantify the exposure-response relationship for allergy to Rats, no clear exposure-response relationship was observed. However, in the group of workers with less than 4 years of working experience with laboratory animals, the prevalence rate of sensitisation to Rat allergens was clearly associated with exposure levels. The exposure-response relationship was steepest for workers with atopy-associated risk factors, i.e., self-reported allergy or sensitisation to Cats or Dogs, or elevated total serum IgE. The prevalence rates of sensitisation to Rat allergens for these workers were about 15, 9.5, and 7.3 times higher in the high-, medium-, and low-exposure group, respectively, compared with the internal reference group (35).

A large epidemiological study of 5,000 laboratory workers reported symptoms in 26% exposed to Mice, 25% to Rats, 31% to Guinea Pigs, 30% to Rabbits, 26% to Hamsters, 25% to Dogs, 30% to Cats and 24% to monkeys (36).

Two hundred and sixty-three United Arab Emirates nationals with a respiratory disease suspected of being of allergic origin were submitted to skin- and serum-specific IgE measurement. Of these individuals, 8.3% were sensitized to Cat fur, 4.9% to Goat hair, and 0.7% to Rat hair and Mouse hair (37).

Importantly, children of parents exposed to Mice, Rats and Hamsters in an occupational setting, e.g., a laboratory, were shown to be more likely to have allergic symptoms, and to have significantly more positive skin-prick tests against allergens from the hair of laboratory animals, compared to children of non-exposed parents (38).

In a study evaluating the risk of laboratory animal allergy among research staff working in laboratories separate from the animal confinement area, 20% of the subjects had serum-specific IgE >0.35 kU/l to Rat urinary allergens and/or Mouse urinary allergens, and 32% had experienced animal work-related symptoms, although 90% of aeroallergen samples from the laboratories in question were below the detection limit. More than 4 years of exposure significantly increased laboratory animal sensitisation and symptoms. Working mainly with male rodents resulted in increased risk for sensitisation and for symptoms (9).

The suitability of radioallergosorbent test (RAST) inhibition to quantify occupational exposure to Rat urinary aeroallergen (RUA) has been assessed. The authors conclude that, in view of the complexity of Rat allergens, RAST inhibition is an appropriate method for the quantification of occupational exposure to Rats (39).

Anaphylaxis following a Rat bite in a laboratory setting has been described and is clearly an occupational hazard (33).

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e75 Rat serum proteins

Rattus norvegicus

Family: *Muridae*

Common names: Rat, Brown rat, House rat, Norway rat

Source material: Serum

See also: Rat e87, Rat epithelium e73, and Rat urine proteins e74

Selective breeding in this species has produced the albino Laboratory rat, widely used for medical and other research purposes.

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Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and laboratory dust.

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Allergen Exposure

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Environment

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Especially because of the numbers of Rats used in laboratories, allergy to Rats is an important occupational health problem.

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Allergens

In serum, 75 kDa and 68 kDa serum protein allergens have been isolated, the former probably serum albumin and the latter probably transferrin. These proteins are also present in Rat urine (1). The prevalence of specific IgE in Rat-allergic patients to the 68 kDa (albumin) allergen is between 24% and 28.9% (2-4).

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Clinical Experience

IgE mediated reactions

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e74 Rat urine proteins

Rattus norvegicus

Family: *Muridae*

Common names: Rat, Brown rat, House rat, Norway rat

Source material: Urine

See also: Rat e87, Rat epithelium e73, and Rat serum proteins e75

Selective breeding in this species has produced the albino Laboratory rat, widely used for medical and other research purposes.

House Rats comprise two species, *Rattus norvegicus*, the Brown or Norway rat, and *Rattus Rattus*, the Black or Alexandrine rat, which also originated in Asia, spread worldwide by ships, and is a well-known disease carrier, but has been largely displaced in cooler regions by the Brown rat. They are roughly similar in appearance and habits. (The Brown rat is larger, but with a shorter tail and smaller ears, while the dark-grey Black rat is a better climber.)

Besides the House Rats, the genus *Rattus* contains several hundred wild-living species. In addition, many other members of the order Rodentia are called Rats: e.g., the Bandicoot rat, the Wood or Pack rat, the Rice rat, the Muskrat, and the Kangaroo rat.

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of house and laboratory dust.

Allergen Exposure

Geographical distribution

This species of Rat is not a native of Norway, as its name suggests. The species originated in Asia, reached Europe early in the eighteenth century and arrived in North America about 1775 on ships from England. Its distribution is now worldwide.

Many consider this Rat to be the greatest mammal pest of all time. It has caused more deaths than all the wars in history. It harbours lice and fleas and has been the source of bubonic plague, typhus, trichina, tularemia, infectious jaundice and other serious diseases. These Rats are usually a contributing factor of first importance in the spread of pandemics during war. They also cause considerable depletion and pollution of human food stores, and damage to buildings and their contents from destructive chewing of wiring, pipes, and walls. But despite human efforts to exterminate Rats, the House rat population is probably equal to the human population.

The Brown rat grows up to 25 cm long excluding the naked, scaly tail, and sometimes weighs more than half a kilogram. It is commonly brown with whitish underparts and pink ears, feet, and tail. It breeds, and therefore aggressively forages, all year round.

e74 Rat urine proteins

Environment

As small, intelligent, bold, prolifically breeding omnivores, nesting in practically any sort of disused cavity or burrowing in the ground, and adept at swimming, jumping and climbing, Brown rats are highly adaptable and live in a great variety of environments. They may hide in huge numbers in and around human dwellings, especially in cities, towns and their surroundings, There, they live principally in basements, on the ground floor, in subways, and in burrows under sidewalks or outbuildings. They are also frequently found in cultivated fields, grain storage facilities, livestock housing and garbage dumps. Basically, they are at home wherever there is a food source and sufficient cover from predators, and this includes some unexpected places like the salt marshes of the US Atlantic coast, where edible flotsam is washed up on the beaches.

Especially because of the numbers of Rats used in laboratories, allergy to Rats is an important occupational health problem.

Unexpected exposure

Most exposure to Brown rats is unexpected. These secretive, mainly nocturnal animals pass unseen in more or less regular scavenging journeys over a variety of surfaces with which humans have daily contact. Their skin flakes, urine, feces, and saliva are left behind. They have also been known to bite sleepers.

Allergens

Allergens characterized to date include:

Rat n 1, a 17 kDa protein (1-3,25).

Rat n 1.01.

Rat n 1.02, a major allergen, a 17 kDa protein (also called alpha 2u-globulin).

Rat n 1A (previously known as Ag4), a 20-21 kDa protein, and Rat n 1B (previously known as Ag13), a 16-17 kDa sized protein, are both variants of the same protein. These allergens are found in hair, dander, urine and saliva (3-5). Rat n 1A is a prealbumin. Rat n 1B is an alpha-2-eu-globulin and primarily a male Rat allergen (5).

Rat n 1.01 and Rat n 1.02 are lipocalins (lipocalin-pheromone binding proteins) (6).

Rat urine has been identified as a major source of the allergens in laboratory animal allergy. The age and sex of the Rat can influence the allergenic composition of the urine (7,25). Male rodents excrete higher levels of urinary allergens than female rodents (8). Rat and mouse urinary allergens are mainly present as large particles (>5.8 microm) (9).

Rodents have permanent proteinuria, and thus the allergen is constantly present in their urine. They spray urine on their surroundings, where the proteins dry up and become airborne on dust particles.

Some of the minor allergens are those antigens which appear to be unique to urine, saliva or the skin, suggesting that sensitisation to Rats can result from exposure to allergenic material from any of these 3 sources. Significant concentrations of airborne rodent allergens have been measured in both laboratories and apartments in inner cities (10-14).

Also isolated from Rat urine are 75 kDa and 68 kDa serum protein allergens, the former probably serum albumin and the latter probably transferrin (15). The prevalence of specific IgE in Rat-allergic patients to the 68 kDa (albumin) allergen is between 24% and 28.9% (16-18).

Prealbumin and alpha(2)-euglobulin (as these were previously termed), detected in Rat urine, are highly homologous and have now been identified as alpha(2)-globulin species. The “prealbumin” fraction corresponds to alpha(2u)-globulin originating from the salivary gland, and the “alpha(2)-euglobulin” fraction has been shown to be identical to the major urinary protein (MUP) or alpha(2u)-globulin. The two major protein fractions of Rat urine thus appear to constitute different forms of the same parent protein, alpha(2u)-globulin. These allergens are found mainly in adult male Rats. Rat n 1B is produced in the liver, where it is androgen-dependant, and in the salivary, mammary and other exocrine glands, where its production is not androgen dependant (6).

The number of Rats, Rats' bedding, cage design, and stock density influence the level of aeroallergen concentration and exposure (19). Rat allergen can also be carried on clothes or by wind to distant sites, with traces of Rat urinary aeroallergens measured in tea rooms inside and near offices outside the animal housing (20-21).

The highest airborne Mouse allergen levels have been measured during manual emptying of cages, during changing of cages on an unventilated table, and during handling of male animals on an unventilated table. Using ventilated cage-changing wagons has been shown to reduce the allergen exposure level from 77 to 17 ng/m^3 (22). Similar results can be expected with Rats. Airborne Rat allergens are particles ranging from 1 to 20 micrometres in size, and can remain airborne for 60 minutes or more after disturbance. Rat allergen exposure levels less than 0.7 µg/m^3 appear not to be associated with an increased risk of occupational asthma (23). More intense exposure to airborne Rat n 1 and endotoxin occurs not only during cleaning, but also during feeding tasks, probably because the allergens become airborne during the disturbance (24).

Rat dust is a complex allergenic source and contains allergens from Rats' urine, epithelium and saliva. Fur is the most probable source of the high-molecular-weight allergens found in Rat room dust (7,25).

The 17 kDa dust allergen has immunological identity with Rat n 1 and is a suitable marker protein for the quantification of airborne Rat allergen (25).

Potential cross-reactivity

In IgE immunoblot inhibition studies and histamine release tests, it has been demonstrated that patients who react to Dog albumin exhibit IgE reactivity with purified albumins from Cat, Mouse, Chicken, and Rat. Significant sequence homologies have been demonstrated with albumins from different species: Human: 82.6%, Pig: 81.8%, Cattle: 77.3%, Sheep: 78.8%, Mouse: 75.8%, and Rat: 76.2% (26).

Practically all respiratory animal allergens, including Rat, characterised at the molecular level belong to the lipocalin family of proteins. Examples are the major allergens of Horse, Cow, Dog, Mouse and Cockroach as well as beta-lactoglobulin of Cow's milk (27). A certain degree of cross-reactivity is thus possible.

Clinical Experience

IgE mediated reactions

Rat allergens found in dust, urine, epithelium and saliva are a frequent cause of asthma, allergic rhinitis and allergic conjunctivitis, mainly in laboratory workers but also in ordinary individuals (28-30).

There is a strong association between work-related symptoms and specific sensitisation (31). Workers exposed to laboratory animals are at risk of developing asthma, rhinitis, angioedema, conjunctivitis, and urticaria. Between 10% and 33% of scientists and technicians handling small animals will develop laboratory animal allergy symptoms within 3 years of employment. Many of them will have severe symptoms requiring a change of occupation (9,25,32-33).

In workers exposed to Rats, Rat urinary allergen sensitisation risk increased with increasing exposure intensity. Workers who were atopic had a clearly elevated sensitisation risk at low allergen exposure levels (34). In a cross-sectional study performed on 540 workers at 8 facilities to quantify the exposure-response relationship for allergy to Rats, no clear exposure-response relationship was observed. However, in the group of workers with less than 4 years of working experience with laboratory animals, the prevalence rate of sensitisation to Rat allergens was clearly associated with exposure levels. The exposure-response relationship was steepest for workers with atopy-associated risk factors, i.e., self-reported allergy or sensitisation to Cats or Dogs, or elevated total serum IgE. The prevalence rates of sensitisation to Rat allergens for these workers were about 15, 9.5, and 7.3 times higher in the high-, medium-, and low-exposure group, respectively, compared with the internal reference group (35).

In a case-referent analysis of a cohort of 342 newly employed laboratory animal workers, examining the relationship between exposure to Rat urinary allergens, atopic status, smoking and the development of allergic symptoms and specific sensitisation, of those who developed illness, 80% reported that their symptoms started within 2 years of employment. The odds ratio for development of each symptom type (respiratory, eye or nose, and skin) and of an immediate skin-specific IgE positivity was increased in those with direct contact with Rats (36).

In a study evaluating the risk of laboratory animal allergy among research staff working in laboratories separate from the animal confinement area, 20% of the subjects had serum-specific IgE >0.35 kU/l to Rat urinary allergens and/or Mouse urinary allergens, and 32% had experienced animal work-related symptoms, although 90% of aeroallergen samples from the laboratories in question were below the detection limit. More than 4 years of exposure significantly increased laboratory animal sensitisation and symptoms. Working mainly with male rodents resulted in increased risk for sensitisation and for symptoms (8).

The suitability of radioallergosorbent test (RAST) inhibition to quantify occupational exposure to Rat urinary aeroallergen (RUA) has been assessed. The authors conclude that, in view of the complexity of Rat allergens, RAST inhibition is an appropriate method for the quantification of occupational exposure to Rats (37).

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Re202 Reindeer epithelium

Rangifer tarandus

Family: *Cervidae*

Common names: Reindeer, Eurasian reindeer, Caribou

Source material: Epithelium

Direct or indirect contact with animal allergens frequently causes sensitisation. Animal allergens are major components of the dust of Reindeer leather workshops.

Allergen Exposure

Geographical distribution

Historically, Reindeer were found in all northern latitudes, but due to extensive hunting by humans are now extinct in many parts of their former range. The largest herds now occur in Alaska, Canada, Scandinavia and Russia. This is the only Deer in which both sexes have antlers. Reindeer have long fur, light brown in summer and whitish in winter, with dense woolly undercoats. Reindeer are gregarious and migratory; they travel up to 1,000 km between their summer and winter grounds in herds of up to 200,000 animals. They are small but extremely strong and have great powers of endurance. A Reindeer can travel 64 km a day, pulling twice its own weight on a sled. They have been domesticated for many centuries in Lapland and Siberia, where they provide meat, milk, clothing, and transportation. The Laplanders until recently were completely dependent upon the Reindeer for their livelihood and followed the herds on their annual migrations. The wild Reindeer of North America, called Caribou, are larger than but otherwise quite similar to the Eurasian type. They have never been domesticated. Domesticated reindeer were introduced into Alaska from Siberia in the 1890s and became essential to the economy of the Alaskan Eskimo. Herds were established in Canada in the 1930s.

Environment

Reindeer inhabit tundra, taiga, and temperate forests, although they are now rare in temperate climates.

Allergens

No allergens from this animal have yet been characterized.

Potential cross-reactivity

Reindeer and Deer are members of the same family. Deer dander allergens have been shown to be cross-reactive with the corresponding Cow allergens (1). RAST inhibition studies have also demonstrated antigenic cross-reactivity among Deer, Elk, Cat, Cattle and Horse (2). A certain degree of cross-reactivity may be expected for reindeer as well.

Re202 Reindeer epithelium

Clinical Experience

IgE mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis following exposure to Reindeer epithelial allergens may occur among Reindeer herders and in workshops where Reindeer leather is processed (3-4).

Reindeer herding is a major source of livelihood for more than 4,200 inhabitants of northern Finland. The prevalence of allergic symptoms among Reindeer herders was investigated. Specific IgE antibodies to Reindeer epithelium and total serum IgE were evaluated in 99 herders, 5 persons who handled Reindeer leather indoors, 21 atopic patients with Cow allergy and another 20 subjects with specific IgE to other inhalant allergens. Positive SPT to Reindeer epithelium was detected in 1, and specific IgE (by using enzyme allergosorbent test (EAST); a positive result being greater than or equal to 0.8 PRU/ml) in 7 herders (4). In a second report, these authors claim that positive skin-specific IgE to common allergens in Reindeer herders was to some extent lower than expected and that only 1 of 211 subjects had positive SPT to Reindeer epithelium (5).

Workers exposed by inhalation to dry epithelial Reindeer dust during their working shifts were examined for serum-specific IgE to Reindeer epithelial allergen. One of 5 workers was positive. Reindeer epithelial antigen concentrations varied from 0.01 µg to 3.9 $\mu g/m^3$ in the air of the workshop. With the exception of 1 worker, all claimed work-associated respiratory symptoms (3).

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e81 Sheep epithelium

Ovis aries

Family: *Bovidae*

Common names: Sheep, Domestic sheep, Ewe

Source material: Epithelium

See also: Sheep's whey Rf326 and Sheep's milk Rf325

Direct or indirect contact with animal allergens frequently causes sensitisation.

Allergen Exposure

Geographical distribution

Sheep were first domesticated c. 7,000 years ago, and the first use of their fleeces for wool is dated c. 4000 BC. (Wild Sheep, found in mountainous parts of Asia, North America, and the Mediterranean region, are agile rock climbers with large, spiraling horns. They do not bear wool.) The present-day breeds of domesticated Sheep vary greatly because they were developed for different purposes and environments. Sheep are bred for their wool, meat (mutton or lamb, according to age), skins, and, in certain parts of Europe and the Middle East, their milk, from which cheese is made. Among the important breeds are the Columbia, Cotswold, Dorset, Hampshire, Karakul, Leicester, Lincoln, Merino, Oxford, Rambouillet, Shropshire, Southdown, and Suffolk Sheep.

Environment

Sheep are found mostly in temperate climates and thrive on roughage. They tend to be kept in herds. Their wool is one of the most common sources of textiles in human culture.

Allergens

No allergens from this animal have yet been characterized.

Clinical Experience

IgE mediated reactions

Exposure to epidermal allergens may result in asthma, allergic rhinitis and allergic conjunctivitis (1).

In a Spanish questionnaire-based study of 1,164 farmers, with 808 subjects included after non-exposed workers were excluded, Sheep workers reported the highest prevalence of chronic phlegm (38.5%), work-related symptoms (53.9%) and symptoms of organic dust toxic syndrome (35.9%) (2).

Other reactions

Allergy reactions to Sheep wool have been described, but conflicting results are apparent.

A study reported that in early stages of wool processing the overall frequency of respiratory work-related symptoms was low and that the symptoms were mainly nasal and/or ocular. The symptoms were not related to the stage of processing. Serum-specific IgE against wool extracts was not detectable (3).

In 64 wool textile workers, skin testing was performed with different wool allergens (domestic and Australian). The prevalence of positive skin-specific IgE to all allergens was higher in wool than in control workers, although the difference was statistically significant only for washed domestic wool (wool workers: 42.2%; control workers: 19.6%). Increased serum IgE levels were more frequent in wool (26.6%) than in control workers (3.1%). In wool textile workers there was a high prevalence of acute and chronic respiratory symptoms. Many of the wool workers had an PEF_{25} lower than 70% of that predicted. The authors report that, in general, the prevalence of symptoms and the lung function abnormalities did not correlate with the results of specific (wool) skin tests, but that their data suggested that exposure to wool dust in some workers may be associated with the development of acute and chronic respiratory symptoms and impairment of lung function, and that immunological abnormalities, although frequent in this group, did not appear to be associated with the severity of these changes (4).

Occupational dermatitis in Ewe milkers has been reported. This may be as a result of contact with milk rather than Sheep epithelium (5-6). IgE-mediated hypersensitivity resulting in respiratory crisis in a young man every time he milked his Sheep has been reported (7).

Sheepskins may be a source of House Dust mite and Cat allergens, as they rapidly accumulate allergens from the domestic environment. Sheepskins as infant bedding should be discouraged for infants at risk of sensitisation to House Dust mites and Cats (8-9).

See also Sheep's whey Rf326 and Sheep's milk Rf325.

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e83 Swine epithelium

Sus scrofa

Family: *Suidae*

Common names: Swine, Pig, Hog, Boar

Source material: Epithelium

See also: Swine urine proteins Re212, Swine serum albumin Re222, and Pork meat f26

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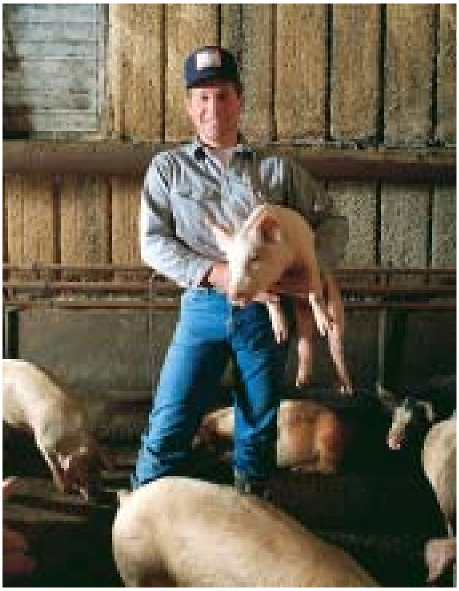

Allergen Exposure

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Allergens

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Potential cross-reactivity

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Clinical Experience

IgE mediated reactions

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Other reactions

Major constituents of Swine confinement dust include not only Mites and animal dander, but bacteria, endotoxin, and fungal spores. Gaseous pollutants include ammonia, methane, and hydrogen sulfide. These contribute to chronic inflammation of the airways and a high prevalence of respiratory symptoms. Non-obstructive (and obstructive) bronchitis and Organic Dust Toxic Syndrome have been reported in Pig farmers (19-21).

Reactive Airways Dysfunction Syndrome (RADS) was reported in a 58-year-old male, following exposure to a high level of toxic gases in a Swine confinement building. This previously healthy, nonatopic man developed moderate, partially reversible airway obstruction and increased responsiveness within a month after the toxic exposure (22).

Allergic and photoallergic contact dermatitis to Olaquindox, a growth promotor added to animal feed, has been reported in Pig breeders (23-25). Photoallergenic dermatitis to airborne Olaquindox dust has also been documented in a group of 15 Pig breeders (26).

Compared to that of a control group, a significantly higher prevalence of positive skin reaction to *Dermatophagoides pteronyssinus* was reported among meat processing workers (41 vs. 13%), animal food workers (30 vs. 13%), Swine farmers (34 vs. 13%) and wool-textile workers (32% vs. 13%) (27). Exposure to domestic Mite allergens should be taken into account when assessing occupational exposure to allergens and the respiratory health of farmers (28).

Some Swine diseases are transmissible to humans. Among them are brucellosis, trichinosis, and cysticercosis.

See also Swine urine proteins Re212, Swine serum albumin Re222, and Pork meat f26

References

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Re222 Swine serum albumin

Sus scrofa

Family:	*Suidae*
Common names:	Swine, Pig, Hog, Boar
Source material:	Serum
See also:	Swine epithelium e83, Swine urine proteins Re212, and Pork meat f26

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Re212 Swine, urine proteins

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e89 Turkey feathers

Meleagris gallopavo

Family: *Phasianidae*

Common names: Turkey

Source material: Feathers

See also: Turkey f284 for allergy to Turkey meat

Direct or indirect contact with bird allergens frequently causes sensitisation. Bird allergens are major components of house dust.

Allergen Exposure

Geographical distribution

The Turkey is a New World variety of the pheasant. The domesticated variety is bred mainly for its meat, a traditional holiday dish in the United States. Turkeys are conspicuous for their tail plumage, sometimes carried in a fan-like display like that of peacocks, but in more muted colours. It is estimated that Turkeys have approximately 3,500 feathers at maturity.

Environment

Wild turkeys are still abundant in parts of North America, and are hunted for sport. Domesticated turkeys, though sometimes kept as pets or ornamental animals, are usually raised in large commercial settings. Breeders as well as workers in the Turkey food processing industry are examples of groups with high risk of exposure. Other examples of exposure areas are pillows made with Turkey down, arts and crafts that include Turkey feathers, and wing feathers used in fletching arrows.

Allergens

No allergens have yet been characterized.

Potential cross-reactivity

IgE-mediated reactions

In general, feathers have been reported to cause allergic asthma and rhinitis and possibly also atopic dermatitis. In a study reporting sensitivity to feathers, bird serum, excrement, egg yolk, Hen´s egg-white and Chicken meat, it was found that sensitisation was acquired through the inhalation of bird components (1). Laboratory tests found specific IgE to feathers, livetin, Hen´s egg-white and yolk in these patients.

Results from Kilpiö *et al.* suggest that true feather allergy is rare and that some of the positive reactions in skin-prick tests to feather extracts are probably caused by Mite allergens present in feathers (2).

e89 Turkey feathers

Hypersensitivity lung disease has been reported in the Turkey raising industry (3). This disease is also known as extrinsic allergic alveolitis, Bird Fancier's Lung and Farmer's Lung and is a disease of inflammation of the lung parenchyma in the terminal bronchioles and alveoli. Symptoms may start soon after exposure to bird allergens or after many years, and may include breathlessness, cough, occasional chills, and fever. Death may also result.

Clinical allergy to commercial feather products is less common than usually thought, as a result of the removal of dust, washing, and drying at 125 °C. The allergens derived from unrefined feathers include bird serum proteins, bird droppings, and feather Mites (2).

Other reactions

See also Turkey f284 for allergy to Turkey meat.

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Mixes

These tests consist of a mixture of different allergens, related or unrelated. For specific information about the included allergens consult the separate descriptions.

ex1

Cat epithelium and dander (e1)	page 29
Horse dander (e3)	page 93
Cow dander (e4)	page 57
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ex2

Cat epithelium and dander (e1)	page 29
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ex70

Guinea pig epithelium (e6)	page 87
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Hamster epithelium (e84)	page 91
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Mouse epithelium, serum proteins and urine proteins (e88)	page 107

ex71

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Budgerigar feathers (e78)	page 17
Canary bird feathers (e201)	page 25
Parakeet feathers (Parakeet)	Not as single allergen
Parrot feathers (e213)	page 125
Finch feathers (Re214)	page 77

ex73

Goose feathers (e70)	page 85
Chicken feathers (e85)	page 47
Duck feathers (e86)	page 73
Parrot feathers (e213)	page 125

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