



Insects Under The Skin? Ziploc And Matchbox Evidence In The Expert Forensic Stain Laboratory

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Abstract

The idea of insects living inside and on the (human) body literally drives people affected by the thought crazy. We receive samples containing alleged insect stain evidence on a regular basis which on examination mostly turn out to be non-animal fragments of skin, hair, fibers et cetera. Those insects (mostly parts) found in the samples cannot survive in or on the human body and do not cause the reported health problems. We present cases from our forensic laboratory, collected over twenty years, together with information about the samples and our way to handle the clients.

Introduction

Those affected by so-called delusional parasitosis believe that their bodies are infested with insects, parasites, worms, or fungi; this delusional perception may also extend to inanimate or “unknown, as yet unexplored” objects, so-called Morgellons [1-3]. This idea has been around for quite a while and has just as many faces as it has names: delusional insect infestation, Ekbom syndrome, delusional parasite infestation, delusional parasitosis, Morgellons, delusional infestation, epizoonosis delusion, chronic tactile hallucinosis, and so on (summary found in [4]). Delusional parasitosis is a delusional syndrome [5,6]. Recent psychiatric literature makes a further distinction between primary (ICD F22) and secondary delusional parasitosis (ICD F20) [5]. The

syndrome may occur alone or in association with other conditions, such as a stroke, vitamin B12 deficiency, liver or kidney disease, hyperthyroidism, diabetes, depression, anxiety, substance abuse, Parkinson’s disease, dementia, schizophrenia, Lyme disease, and the like [6-17], or even after taking certain medications [18]. Furthermore, the category of “delusional disorder” remains distinct from, for example, schizophrenia in ICD-11 (2022) [19].

According to the literature, the condition predominantly affects single women over the age of 50 [7,11,15,17,18,20-23].

This applies to our cases as well. A core feature of the disorder includes the collecting of traces of putative insects in small baggies or matchboxes (“matchbox / ziploc symptom”) [5,7,22-28]. This, too, is reflected in our cases

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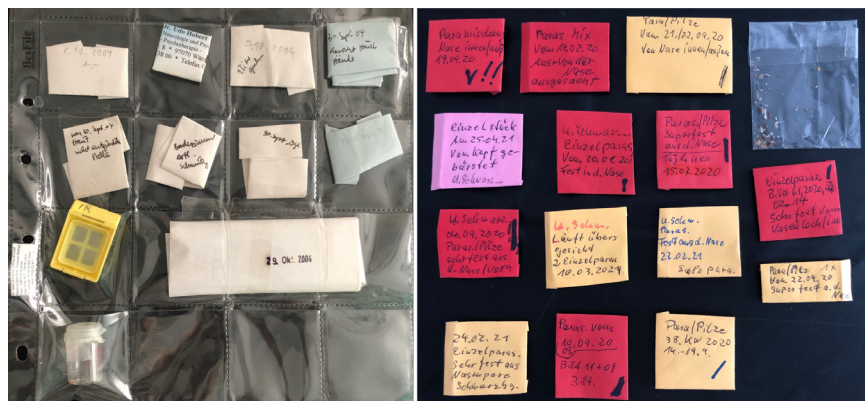


Figure 1. “Matchbox symptom” related stains: Clients with delusional parasitosis send their (numerous) samples individually packed: left: case 7; right: case 8. For further explanations, see text.

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(Figure 1). Any examination of these samples, if carried out at all, usually reveals that there is no objective evidence for an infestation by insects, other living creatures, or fibers or the like growing in the body [13,26,27]. In both our expert forensic services and numerous scientific publications, tracks perceived as those of living creatures or parasites turn out to be threads, (finger or toe) nails, pieces of skin, hair, dirt (soil), dust, and the like [21,23,24,26].

The psychodynamic nature of the syndrome is unclear. Since we are a forensic stain lab, we prefer not to give psychological or psychiatric expertise. Our extensive collection of cases here shows the diversity of stain material that is encountered, and should give an overview for all professions who might get into contact with these patients: dermatologists, psychiatrists, psychologists, medical students as well as centers for community and family medicine. Since the condition itself and even more the stains are more frequently seen by dermatologists than by psychiatrists, we also hope to encourage fruitful exchange of information between experts in the respective fields.

Due to the contradiction between the results of the examination and what those affected have experienced, the sufferers feel misunderstood and become increasingly desperate, as they isolate themselves socially and sometimes carry self-injurious actions: Affected persons hold on to their imaginative beliefs and begin to rid their bodies and environments of suspected parasites, insects, etc. This can take on dangerous forms: furniture may be burned; knitting needles are used to “fish” for putative worms under the skin; corrosive liquids such as alkaline solutions and hydrogen peroxide, or even insect repellents, are applied externally and internally to combat suspected parasitic infestations on (as well as in) the body [5,7,24].

When any sort of healing remains absent, sufferers sometimes assume that their doctors have conspired against them; however, the lever for improvement or even healing lies with themselves. It is precisely those who are affected by such delusions who do not recognize their complaints as a psychiatric disorder (the core of delusion) and therefore reject psychological examinations and treatments [7,29].

Taking antipsychotic medicines may alleviate the delusion(s) or make them disappear completely [9,11,14,15,22,23,25,27,28,30-33].

Furthermore, there are cases of delusional parasitosis whereby skin symptoms are actually (though contrary to what sufferers believe) caused by living creatures, including scabies (scabies mites) [34,35], lice, other mites, bed bugs, fleas, or thrips [36], or by bacteria (Lyme disease) [37]. Affected persons predominantly choose dermatologists as the first point of contact for their complaints. However, they are sometimes creative in seeking out possible help by contacting others in various other professional disciplines, such as pest control, zoology, or our expert office for biological stain evidence.

In the following, we will present selected cases from our laboratory, as affected persons have been contacting us for more than twenty years concerning such matters, and we have, therefore, been confronted with this topic for a longer period of time [38]. Our main focus when processing such cases has been on biological traces and the examination of samples. However, medical advice can only be given by medical professionals, and so we also refer our clients to such professionals for further blood tests (vitamin D, vitamin B, Lyme disease, scabies, liver values, allergies, etc.).

Table 1 gives an overview over the cases and findings presented in this paper.

Table 1. Overview of the cases.

Case #	Year of first contact	Type of material found	Figure(s)
1	2022	Hair, skin tissue, plant material, insect, inorganic object	2a,2d,3a
2	2020	Textile fibres, inorganic object, insect fragments	2b,3b-d,4a
3	2022	Skin tissue	4b
4	2021	Earwax, skin tissue, textile fibres, inorganic object, nasal content, insect parts	4b,4c,4e
5	2020	<i>Willowsia nigromaculata</i> (springtail)	-
6	2015	Larva of <i>Anthrenus</i> sp. (museum beetle), adult <i>Dermestes lardarius</i> (skin beetle)	4f-h
7	2014	From the nose: skin tissue, clotted blood, mucosa, nasal content, textile fibres, inorganic object, plant material	2c,2e-h
8	2004	Insect and arthropod fragments, skin tissue	5a
9	2015	Skin tissue, textile fibres, plant material	5b-f

Materials and methods

The nine cases described below were chosen out of the many case requests we receive for microscopy and general advice. We did not select the cases presented here with reference to psychiatric or psychological criteria but only on persistence on the clients' side to deliver suitable samples. Many clients will just follow our advice to visit a medical doctor but do not send in or deliver samples. Instead, those clients send photographs of low quality and very long, handwritten letters. Therefore, we restricted our choice of cases which we present to such cases that allowed us microscopic examination of actual material.

We inspected the submitted samples using stereomicroscopes (Leica Mz 12.5, Leica S9E) and a transmitted light microscope (Leica DM LM). The samples were examined without further treatment depending on whether they were sent in loose or glued on, mostly with sticky tape. They were then photographed with a scale (scale 1 mm) and subsequently stored in an appropriate manner. The figures here are, therefore, photographs from our routine operations that were primarily intended to generally classify the objects.

The living creatures found in the samples, which were often beetles, were primarily identified in accordance with Zahradnik (1985) and Weidner (1993) insofar as sufficient morphological characteristics were preserved [39,40]. In some cases, specialized laboratories and institutions (veterinary schools, veterinary surgeons, zoological institutes, additional experts for biological stains) were called in by the clients or by us to assess or identify the samples.

As previously mentioned, the illustrations are photographs taken during our routine operations.

Results

Case 1

A man of unknown age, according to the file “with family ties” (we did not learn any more details about what this meant), reported in July 2022 that he had been “struggling” with a “very big problem” for five years: his “body is overrun and ruled by parasites.” He had already visited “many specialists, such as dermatologists, neurologists, psychiatrists and skin clinics.” “Nobody believes me. I am alone with my problem.” He asked for our help and sent us samples containing an animal or human hair several centimeters long (Figure 2a), pieces of skin, plant material (Figure 2d), an insect (Figure 3a), and an ash-like platelet. Findings: no evidence of parasite infestation. We did not identify the insect, as it certainly could not live in the human body (under the skin) because it needed oxygen to survive.

All samples sent in neither presented any indications of disease nor qualified as macroscopic pathogens. After receiving our report, the client did not contact us again.

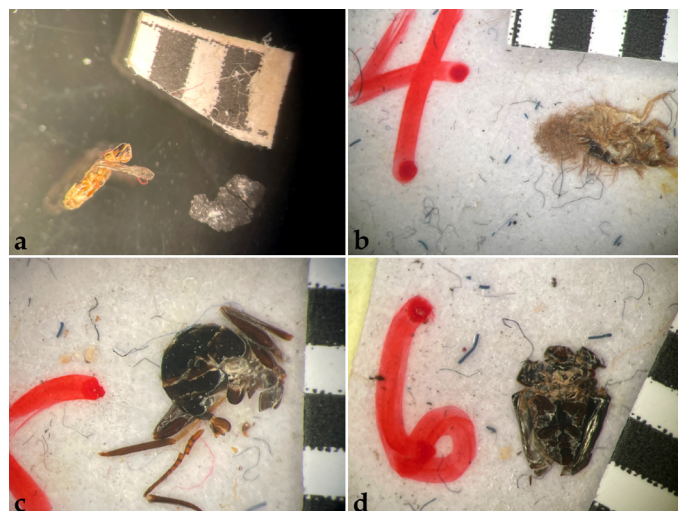


Figure 3. Unspecified insects and insect fragments from the samples of cases 1 (a) and 2 (b-d).



Figure 2. Case work samples: (a) Mammalian hair (case 1); (b) Ball of textile fibres (case 2); (c) Skin component with textile fibre (case 7); (d) Skin component and two pieces of wood (case 1); (e) Sepals of a plant (case 7); (f) Seed capsule (above), mucus and skin components (case 7); (g) Seed capsule (case 7); (h) Wooden object (case 7).

Case 2

A married woman of unknown age contacted us in 2020. She had been perceiving bites on her body for a long time and described this condition as “hell”. Her complaints began after attending an open-air festival in 2019. In this case, Ms. S. was sitting under a tree with possible bird nests and visitors, “the ‘hygiene principles’ of whom were gravely different from mine, which was already clearly recognizable by just looking,” “wandered” past her. In the days that followed, she avoided “all places where there could have been gnats or other flying and stinging insects.” It must be noted here that Ms. S. lives in Baden-Württemberg and, therefore, the description “gnats” may in local accent refer to mosquitoes (Culicidae). Ms. S. was continuously being “bitten”. During this period, she remembered “a ‘stressful event’ that occurred years earlier whereby bird fleas were in the school that I was in charge of” after being “introduced into the school building via a bird’s nest brought in by a student.” The problem inside the school could be solved by a pest control company. Ms. S. turned to the junior manager of this same company in 2019 to solve the same problem at home as well. This was not successful.

Subsequently, Ms. S. did a lot to keep the alleged bugs away: She taped baseboards, seat cushions and parts of furniture with (also double-sided) tape, used lint rollers in affected rooms daily (also at night), changed and washed clothes sometimes several times a day. Ms. S. sent us forty (!) different samples using glue. They consisted mainly of everyday textile fibers twisted together into small lumps (Figure 2b). Assuming that the textiles / fabrics were not washed with an allergenic laundry detergent, no connection with the described complaints could be identified here. In one of the samples was a solid crumb that resembled chipped paint (Figure 4a).

The samples also contained three severely desiccated insect fragments (Figures 3b-d). We were unable to identify the exact species of insect. In one sample, it could have been a skin beetle (dermestid beetle); however, these beetles do not live on humans (rather on dry corpses, in stuffed animals, on carpets, etc.). Another insect could have come from outdoors (garden?) and also does not live on humans. The third insect could have also been a beetle that does not live on the human body. Based



Figure 4. Case work samples: (a) Inorganic object (case 2); (b) Ditto (case 4); (c) Piece of skin from the ear (case 4); (d) Sample glued to a roll of lint, partially containing blood input (case 3); (e) Unspecified insect (case 4); (f) Larva from the common carpet beetle *Anthrenus* sp. (case 6); (g,h) Well preserved larder beetle *Dermestes lardarius* (case 6).

on these results, we suggested that the client hire a cleaning company to carry out a thorough cleaning of the premises as well as have tests done for both Lyme disease, which often causes itching, and allergies.

After sending our report, Ms. S. wrote back: “The results of your examination are certainly technically perfect. However, I probably didn’t send you the actual “bug” that is constantly tormenting me for examination.” She continues to have possible bites or stings on her body. Further, she asked for contact information for a pest control company. We have not heard from her since.

Case 3

In 2022, a 57-year-old woman reported to us that she was scratching her skin a lot. She was of the opinion “that there is something under her skin.” Medical examinations of her skin were inconclusive, and she has lived a very secluded life ever since. She had stuck the samples that she sent to us on the adhesive pages of lint rollers. In all the samples that we examined, we found no parts of any living creatures. The samples consisted mainly of skin tissue, some of which had trace amounts of reddish stains that appeared like dried blood (Figure 4d).

After she received our report in April 2022, Ms. G. contacted us again in July 2022 and sent in additional samples as her condition continued. She did not address our previous examination findings and insisted on her own perception of the problem.

Case 4

In November 2021, we were contacted by Ms. S. with a request to find “evidence of a parasite that has not previously been known to be a human parasite.” She had “after about 10 years the feeling for the first time that something under her skin was moving and that she thought, also for the first time, that it might be a parasite. Several times in the sink, there was small red fuzz, which I then put under a microscope, and you could then see that it was alive.” Ms. S. had sent these samples to the University of Veterinary Medicine Hanover and, according to her, received verbal feedback that it was a rare species of skin beetle that lived in old buildings or on old fir trees. In a report from the university, which was made available to us, the test result showed “larva from *Dermestidae* (skin beetle)”.

When her problems began, Ms. S. had already been living in an old building for about one and a half years that was surrounded by old fir trees. She described her condition as follows: “It feels like there is a layer of air or liquid under the skin, and it causes severe pain in those places where I lie down. When I lie on my side, my face and scalp area make a crackling sound.” She took her samples from her ear, face, back of the hand, and nose. They included earwax, pieces of skin (Figure 4c), textile fibers of various colors, a drop-shaped dark object, skin flakes, an angular object (Figure 4b), and nasal contents. However, from her forehead, she collected obvious insect parts (Figure 4e). These fragments certainly did not come from insects that had been or were living in or on her body. Rather, we suspected that they might have gotten on the skin while she was outdoors.

Ms. S. did not consider or respond to our findings and continued to insist that we please take a more detailed look at everything again. Ms. S. has not yet complied with our renewed request to have certain blood values (vitamin D, vitamin B, liver values, etc.) examined by her general practitioner, as itching can be caused by certain illnesses (allergies, scabies, Lyme disease, liver disease) or (vitamin) deficiencies. We have not heard from her since.

Case 5

In September 2020, a man contacted us whose partner had been experiencing “open, stinging, painful areas of skin all over her body” for five years. A medical diagnostic laboratory detected springtails in a sample containing “skin secretions”. This report was made available to us; however, mites and mite eggs were not mentioned there. According to the laboratory, the springtail (*Willowsia nigromaculata*) that was detected and identified by the laboratory was “not an ectoparasite and thus cannot be the cause for a scabies-like symptomatology.”

The couple felt as though they were not being taken seriously. We provided information stating that springtails are also found in the garden, and some species are also found in more suitable and humid environments and thus can also come in contact with human skin; however, the couple never responded to this.

Case 6

Ms. H. contacted us in March 2015. She was single and severely disabled and spoke of her move in 2012 to an apartment where someone had previously died. The neglected apartment had to be cleaned by pest controllers before she could move in.

Ms. H. paid great attention to hygiene and cleanliness. In her apartment, she found skin beetles and their larvae. She indicated that the laminate in the apartment could be a possible source of larval development. "They were everywhere in the apartment", and "even her cat had larva on its chin." These findings were confirmed by a veterinarian and a zoological institute. The records sent to us included a report detailing that the "mandible of a skin beetle larva" had been removed from the cat's chin. An entomological expert could not detect any skin beetles or any other insects in the apartment. Ms. H. described the expert as clueless: "He doesn't know these living creatures that well... The expert submitted a report that is not truthful."

Our examination revealed that the samples did, in fact, contain the larva of a museum beetle (*Anthrenus* sp.) (Figure 4f) and well-preserved skin beetles (*Dermestes lardarius*) (Figures 4g,h). In another container holding a sample, there were brittle remains about 1 mm in length. Ms. H. assumed this was excrement: It "always trickles down" everywhere. Although dermestid feces look filamentous, it could not be ruled out that they could be organic remains, including those of beetles. Another sample contained the larvae of a springtail (*Collembola*). Springtails are rarely found inside houses, but they can nonetheless be found in places where organic, decomposing material is present, e.g. soil and foliage that is kept moist in a terrarium or that has accumulated in damp nooks and crannies of the house. They can also be introduced into the household through shoe soles (rubber boot soles, etc.) after, for example, a walk in the woods. If springtails are found consistently inside a house, this indicates that the house is generally not in a proper living condition.

Here, this could point to the presence of moist, organic material (decomposing foliage, old, damp woody debris, or the like). Ms. H. never contacted us again after receiving our report.

This case provides a perfect example of a situation in which the client's observations are correct, but are incorrectly evaluated.

Case 7

Since June 2014, Mr. S. has been suffering from the idea that his entire body, in particular his head, is infested with insects and parasites. He sent us numerous packages wrapped in paper that contained samples in December 2021. These samples consisted of numerous small pieces (Figure 1). We examined the samples collected from different locations on the body, but concentrated on samples from the nose.

These samples from the nose contained skin tissue (rolled or folded together, scaly), clotted blood, (nasal) mucosa, nasal contents, textile fibers (Figure 2c), a dark object that could not be identified, and plant material (Figures 2e-h). The latter could have entered the nose while Mr. S. was in the garden or simply outdoors. The samples that, according to the client, were "brushed off from the head" contained what appeared to be a woody object, such as one might find in a garden or a park. A piece of wood was also found in another sample. The samples contained no evidence of an infestation by parasites, fungi, or insects, as well as no pieces or parts of insects. It was clear from Mr. S.'s descriptions that he had already tried many of his own made-up treatments, some of which were dangerous: He made himself a sack for his entire body, which he put over himself in order to get rid of the parasites underneath by means of a sulfur burn (!); he also washed his head with pure alcohol as well as diesel; and he sprayed his head with hair spray "until everything stuck together." He was diagnosed with delusional parasitosis by a doctor, which he contends is incorrect. His records show that he had taken an antipsychotic drug under psychiatric

supervision and had subsequently behaved "inconspicuously". We are currently still in regular contact with him. He feels that he is being taken seriously by us due to our willingness to continue to engage with him and his complaints, as well as due to our factual-style communications.

Case 8

Ms. B. first contacted us in 2004 and reported that her body had been infested with insects for many years. After five years of searching for help, she had found a dermatologist who performed numerous skin biopsies on her. Ms. B. also sent these to a university clinic, among others. She was then informed that the samples contained dust, dirt, etc. and could not have come from her skin. We were able to disprove this statement after performing our first examination using a light microscopic in 2004. In addition to parts of insects and fragments of arthropods, pieces of skin were also included. Ms. B. also sent us insects that she had collected and photographed on herself, then glued (Figure 5a).

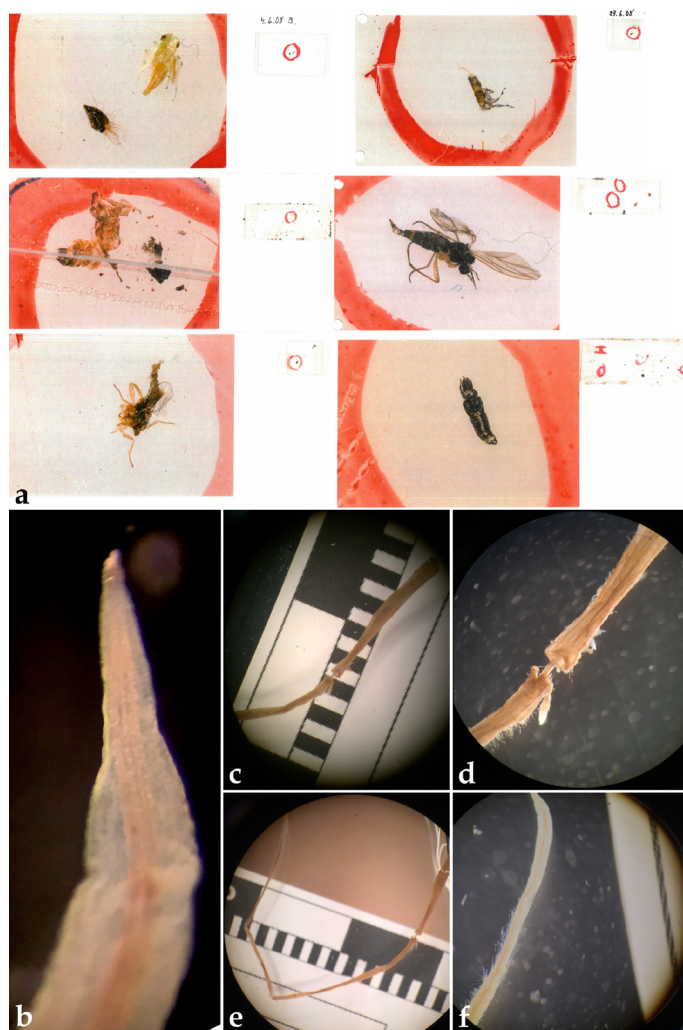


Figure 5. Case work samples: (a) Various objects (mainly insects) collected, glued on and photographed by a client in 2008 (case 8); (b-f) Various parts of plants that can easily be confused by laymen with the front end of nematodes (b) or insect legs (c-f) (case 9).

The free-living insects found certainly did not come from the client's body, but had gotten onto her skin from Ms. B's surrounding environment.

As we also suspected that there were springtails present in the samples, we sent two samples to Belgian specialist Frans Janssens (University of Antwerp), who then informed us that one of the samples contained mostly plant material: a bolus-shaped sample had many fibers (from textiles?) adhering to the outside. The colleague did not rule out the possibility that it could be vomit from a cat. He also found in this sample the larva of a thrips (Thysanoptera), of which no parasitic forms are known. A second sample contained a 3 mm springtail of the species *Seira domestica*. The colleague stated that *S. domestica* was commonly found indoors and was not a parasite of humans or their skin. These insects are heavily scaled; however, the scales spread very easily through the air — similar to fungal spores — and as soon as a *Seira* colony is present in a household, the air is "contaminated" with its scales. Those living in the house could develop allergic reactions as a result. In order to find out whether Ms. B. was allergic to *S. domestica*, the expert advised spreading a fresh specimen on her arm; however, this was not carried out by her.

Up until 2011, we had heard nothing more from Ms. B. However, she contacted us in order to report that "after many years a blood analysis proved that there indeed was a concrete transfer [sic!] by insects. Two orthodox medical practitioners are also not considering whether or not it is Morgellon's disease. At this stage, the foreign bodies found in the skin samples could easily be removed." We replied to her that we no longer handle her case.

Ten years later (!), Ms. B., in referring to our previous rejection in a new letter, asked once again whether or not we would be willing to take up her case, which had now continued on for almost two decades.

She again sent pictures of specimens and recognizable insects and spoke of "threads and spots (almost like dust and dirt)" as well as of her husband's death from "this hospital germ" — here "la Maffia [sic!] clearly comes to mind."

We again informed Ms. B. that the fragments found in her samples could never have come from insects that lived in humans because those insects required oxygen to survive and could not possibly breathe there. It could have been the case that the insects were only able to be removed from the client one piece at a time. However, the client was not under the assumption that only parts of the insects were actually living inside her.

Ms. B. did not want to provide us with her new "evidence". She reported to us an examination that took place in a "Borreliose Center" whereby "Lyme disease and Morgellons" were the diagnoses: "In vain, they fought against the assumption of chemtrails, as they assume transmission by insects."

In 2022, we offered Ms. B. the opportunity, once again, to examine her samples with her using microscopes, exactly as we had done two decades ago. It has not yet come to a meeting and the joint examination because refuses to comply with "certain health precautions" that she believes must be taken before any meeting, and therefore nothing has come of this case as of yet.

Case 9

A young man contacted us in 2015 with the suspicion that worms were pushing out of his body, especially from the anal

area. Since threadworms (roundworms of the genus *Ascaris*) — also in the anal region — were quite common in Germany until the Second World War, we examined the material sent in. There were pieces of skin that were worm-shaped and rolled together along with textile fibers, as well as small parts of plants that could be mistaken for threadworms by laypersons (Figures 5b-f).

It is understandable that the client was disappointed after hearing once again that there was "nothing" on or in his body and that he therefore doubted the diagnosis. Although what was found was neither parasitic nor of animal origin, the delusional belief that was present — and this applies to all those affected — could, in many cases, be alleviated a little by carrying out examinations of the samples, and this without personal, psychologizing evaluations of the actual findings and laboratory results.

The 'fact checking' of stains can however not substitute clinical treatment, especially since a longer duration of untreated psychosis leads to a worse prognosis of mitigation or healing of the symptoms [41].

Discussion

The numerous lint, hair and dirt particles frequently contained in the samples, or even stuck on with adhesive tape, initially suggested inadequate hygienic conditions in the clients' homes. However, this contradicts the findings of Musalek, who observed that bodily and environmental hygiene was very important to those affected [4]. The author suggests that the obsessive cleanliness observed later was actually present before the onset of delusional parasitosis. Such cleanliness does not always arise from the delusion, but is, in many ways, a pre-existing personality trait of those who later suffer from delusional parasitosis. He describes the insect problem as a "close issue" for people with "pronounced dirt-avoidance behavior" [4] (p. 110). Noticeably thickened pieces of tissue that appear blister-like (Figure 4c) are often found in the samples and could indicate another skin condition that may have influenced or caused the symptoms. This must be examined and clarified by a doctor. Goddard examined the occurrence of delusional parasitosis in 2003 vis-a-vis the time of year [42]. Cases became more frequent in the late summer and fall. This could be attributed to the lower humidity at that time of year, the preference of those affected to stay indoors, or a combination of both. A connection between itching and dry skin cannot be ruled out, as healthy people are also aware of this ("heated air"); however, they can usually put such situations in the right context.

If insects were found, it was not because insects lived in or on the bodies of the clients. These insects would not be able to find suitable food or living conditions on the human body, as the body is not an appropriate environment for such insects, and so they cannot survive there. Unlike scabies mites, which can survive under human skin by taking up oxygen via diffusion through the surface of the skin [43], the insects identified in the samples could not have possibly survived under the skin. However, these insects provide us with a glimpse into the clients' living conditions, and in order to improve their respective situations, changes should be made, especially for those with allergies, such as replacing furniture or even moving to other regions.

Skin beetles tend to feed on dry organic material and are found in households (storage areas / cellars / pantries), animal nests, museums, and the forest. Furthermore, the larvae of *Dermestes lardarius* hide in harder materials (wood cracks,

carpet strips, etc.) [44]; although larvae prefer softer wood, they can nonetheless also live and grow in harder species of wood. If skin beetles are found, organically contaminated areas that could be problematic (pantries, unsanitary living conditions, animal gatherings) should first be ruled out as the cause of the infestation.

Moreover, very dry and deteriorating areas of the house should be inspected, as well as the areas under carpet strips and old floor coverings (carpets, floorboards). Experts can offer assistance here. However, there is always the possibility that the fine hairs of the larvae of the skin beetle may cause allergies and therefore trigger or reinforce symptoms. Whether or not this is actually the case must be clarified by the clients individually. The identified larvae of the museum beetle can also feed on (human or animal) hair and are therefore also found in (old) furs, wool and clusters of animal and human hair. Museum beetles, in our experience, are easily controlled through normal hygienic measures in homes (which is more difficult in some museums). Springtails are often found in the literature concerning delusional parasitosis because they frequently appear in corresponding cases. Some articles advocated an association between springtails in skin samples and the complaints of affected individuals [45]. However, one of these articles has come under heavy criticism because the digital images of freshly taken skin samples appear to have been altered [46,47,48]. According to Janssens & Christiansen, there is very little evidence that people are allergic to springtails [49]; however, such an allergy is not impossible. Skin inflammation sometimes happens due to allergic reactions [50-53].

According to Pescott, injuries to human skin by springtails are not possible because of their weak mandibles [50]. Springtails in samples do provide some evidence that there are higher levels of moisture present; according to Christiansen & Bernard, they preferentially live in damp indoor areas (bathrooms, basements) [47]. Desoubeaux et al. caution against attributing existing problematic skin conditions solely to the presence of springtails [54]. These authors consider the occurrence of complaints concerning skin disorders and the coinciding presence of springtails to be coincidental and support this with examples.

Mertens reports of a woman who developed an allergy from the seat cushion of her rattan chair [52]: The springtail species *Seira domestica* had infested the entire rattan material, and the cushion contained a large number of the springtail scales and was therefore allergenic. Since the chair was on a warm and humid veranda, which can promote the growth of mold and the congregation of other microorganisms, the possibility of other or different triggers of the complaints should also be taken into consideration. Lim et al. also refer to the algae, fungi, bacteria, protozoa, mites, and other arthropods that can be found in moist and humid environments [48]. Bryk reported about a woman from Sweden who suffered from a neurological disease and whose genital area was also infested by numerous springtails [55]. The author assumes that the original source of the infestation was due to insufficient cleaning and a lack of general hygiene measures in the household: The bathroom floor was always damp, and the toilet brush “was covered with [what were then called, M.B.] parasites.” Lim et al. also consider inflammation of the skin caused by springtails to be unlikely [48]: They reported about two women in whom springtails were found but no C-protein antibodies were detected. Springtails could therefore be excluded as the causative agent of any allergic reaction for the two women.

Laboratory tests must be performed in order to rule out an actual parasitic infestation. This is especially true for patients who live in rural areas [23]. For instance, Guarneri et al. reported about a wife of a farmer who complained of very severe and prolonged itching on her head and of the movement of insects there [56]. The cause of her troubling condition was declared to be the fringe fly *Limothrips cerealium*, which were present in a nearby wheat field and granary. The woman’s symptoms disappeared when, for six months, she lived with her daughter in an urban environment.

The samples from our cases have mainly contained dirt and skin particles, fibers and hairs, as well as inorganic objects. Only occasionally are insects and / or parts thereof successfully found and identified. If the samples actually did contain insects or insect parts, they were not the type of living creature that lives on or in humans; rather, they originated from the living environment / conditions of the affected person (garden, damp environment, apartment, etc.) and are not related to the problems complained of by those affected [21,38,57]. Most are everyday objects that concentrate and build up behind furniture, under carpets, in poorly cleaned apartments, on doormats, balconies and patios, in cracks and crevices, on the street, behind flower boxes, in gutters and curbsides.

Irrespective of the results of the examination, the delusion currently affecting a person sometimes persists over a very long stretch of time (see case 9). So-called ‘Liaison Consultations’ in collaboration with psychiatrists and dermatologists can offer help [7,58-60]. Such special(ized) facilities are currently (as of 2023) not offered anymore in Germany, probably due to the strict belief of the persons affected that it cannot be of psychotic nature.

Those affected here do feel as if they are being sent off “to the insane asylum” due to the involvement of a dermatology clinic. There is sometimes a fine line between expert descriptions of the samples and “enabling” of the delusion [61]. As in our forensic stain cases, we always treat all clients equally and consider it wholly appropriate to at least examine the samples under a light microscope in order to be able to give a factual and professionally correct evaluation of the findings.

Conclusion

Our case reports from the forensic biological stain laboratory show that clients with delusional parasitosis sometimes detect actual insect parts and particles that are not related to their perceived illness. It is worth checking their observations and samples because they are often incorrectly understood by themselves as well as by their medical doctors. ‘Liaison consultation services’ – teams of a dermatologist and a psychiatrist – are useful for the affected but also for their friends and family to help differentiate between dermatological and delusional issues.

In all cases, we tried to establish a trustful fact-based relationship with the clients and always refer them to specialized medical services. Most clients strictly refuse to follow our advices. Since joint service hospitals could not be located by us – at least currently not in Germany - we tried to find out who their trusted medical specialist is and encouraged them to show our written laboratory results to this person who then tries to further persuade the patient to enter specialized medical therapy.

Clinical trial register

We checked the stains for clients who approached us in our forensic biology laboratory. There was no relation to hospital or

clinical environments, therefore no trial registration was needed or requested. This work was done on behalf of the clients.

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Author contributions

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The authors declare no conflict of interest.

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