American Journal of Food Science and Health
Vol. 2, No. 6, 2016, pp. 169-175
http://www.aiscience.org/journal/ajfsh
ISSN: 2381-7216 (Print); ISSN: 2381-7224 (Online)

Diseases Transmitted by Blood Sucking Mites and Integrated Mite Management for Their Prevention

Muhammad Sarwar*

Department of Entomology, Nuclear Institute for Food & Agriculture (NIFA), Tarnab, Peshawar, Pakistan

Abstract

On a worldwide basis, mites are important nuisance pests and some are capable of transmitting disease causing agents to humans. There are many different species of bloodsucking mites, some mites live in people's skin (mites that cause scabies), while other species may take blood meals on human hosts. For this reason, this article has been designed to highlight disease agents vectored by mites and evaluate various tactics for their efficacy in managing populations especially in houses. Fortunately, the majority of mites are free-living, but few of species are serious parasites of humans. Most of these are external parasites (they feed on the exterior of their hosts), but some species inhabit ear canals, lungs, intestine and bladder of vertebrate hosts. Their biting and bloodsucking behaviour causes considerable discomfort to their hosts and a few species also cause serious allergic reactions, such as asthma, in peoples. Understanding of mite's biology and symptoms associated with mite infestations can help to determine if they are the actual cause of a particular problem. Leptotrombidium species of trombiculid larval mites (chiggers) can transmit scrub typhus in endemic regions, and house-mouse mite can transmit rickettsial pox in both urban and rural dwellings. Rickettsial disease encompasses a group of diseases caused by microorganisms rickettsiae that occupy a position between bacteria and viruses, and they can only survive inside cells. These organisms cause disease by damaging blood vessels in various tissues and organs, and in severe cases multiple tissues and organs are affected. Transmissions of disease-causing organisms, primarily of encephalitis, tularemia, asthma, scrub typhus, dermatitis, filariasis and mites as intermediate hosts of tapeworms have been substantiated. Further, mites are mostly ubiquitous and bothersome species of medical importance, and of these, most are scabies mites on human hosts. All patients with scabies and their close household and institutional contacts may be informed that scabies is a highly transmissible ectoparasitic infestation and several topical treatments, and an effective oral treatment are readily available and highly effective. Scratching of bite locations of mites is discouraged as it can result in secondary bacterial infections. Physicians suggest the use of calamine lotions and other itch creams to reduce itching that at times can be intense. Significant progress can be made when a brief exposure to kill surface microbes, mites and their offending by-products to ultraviolet light into a vacuum cleaner is conducted and while removing them. Finally, Integrated Mite Management (IMM) strategy is commercially available wherein vector control is the primary means of preventing vector-borne diseases.

Keywords

Mite Vector, Allergies, Dust, Integrated Control, Allergens, Disease Prevention

Received: July 25, 2016 / Accepted: August 19, 2016 / Published online: December 27, 2016

1. Introduction

Mites belong to the Acarina group of arthropods, and unlike adult insects they have only two main sections to their body, and the adults have four pairs of legs as opposed to three pairs in insects. Mites are among the smallest arthropods with most of species barely visible without magnification. Mites are closely related to ticks, but they are tissue-juice feeders, not blood-feeders, and do not

* Corresponding author
E-mail address: drmsarwar64@yahoo.com

transmit a broad variety of infectious microbial diseases (Sarwar, 2016 a). In fact, the most crucial infectious diseases transmitted by mites are rickettsial pox and scrub typhus. The most common ectoparasitic dermatoses are caused by chiggers and scabies mites. Peoples are uniquely predisposed to contracting several mite-transmitted dermatoses and infectious diseases including, scabies mites from close personal contacts; zoonotic scabies from domestic or wild animals and pets; rickettsial pox from sleeping in or visiting mice-infested dwellings; and chiggers and scrub typhus after stumbling onto trombiculid larvae-infested mite endemic regions worldwide (Walker, 1994; James, 2010; Sarwar, 2016 b). This review will describe the epidemiology, clinical manifestations and management of the most common mite-transmitted dermatoses and infectious diseases.

2. Mites Transmitted Infectious Diseases

Mites are important to man because they are associated with scabies or mange-like conditions, produced primarily by mange or itch mites in the families Sarcoptidae, Psoroptidae and Demodicidae. Transmission of disease-causing organisms, primarily of four groups; viral diseases such as encephalitis by certain bird mites; rickettsial diseases such as scrub typhus by chiggers, rickettsial pox by the house mouse mite and possibly murine typhus by the tropical rat mite; bacterial diseases such as tularemia by the tropical rat mite in the laboratory or epidemic hemorrhagic septicemia by the snake mite; and filarial disease of the cotton rat by the tropical rat mite have been proved. Tapeworm infestations of domestic animals have been found as some beetle mites serve as intermediate hosts for certain tapeworms. Dermatitis is caused primarily by direct attack of chiggers in the family Trombiculidae, bird and rat mites in the family Dermanyssidae, straw itch mites in the family Pyemotidae, and by contact with cheese mites in the families Acaridae and Glycyphagidae. Annoyance and invasion of buildings, without causing dermatitis or transmitting of any disease-causing agent, is common by the clover mite. Infestations of the lungs, intestine, or urinary passages occur by the lung mites or certain cheese mites (Alexander, 1984; Andrews et al., 2009).

2.1. Scabies Diseases

Scabies, which is also known as mange, itch, Norwegian itch and crawcraw, occurs throughout the world. Scabies is one of the most important disease conditions caused by mites, and infestation occurs when female mites burrow under the skin and lay small numbers of eggs each day for several weeks. Sometimes the mites cause only mild infection, but often scabies causes serious skin irritations with secondary infections leading to impetigo-like conditions, or severe allergic reactions that prevent peoples from sleeping at night. It is therefore often thought as a family disease such as it could be contracted by children sharing the same bed. Scabies is spread by prolonged direct contact with skin or through shared bedding, towels and clothing of an infected person. The mites burrow under the skin leaving open sores as sources for secondary infections. The first symptom of scabies is itching, especially at night and frequently found over much of body. Other symptoms include a rash and intense itching that are especially severe at night. The itching and rash are believed to be allergic reactions to the mites and may occur away from the burrows themselves. The most common sites for the rash are the folds of skin between fingers, around wrists and elbows, and armpits. Other areas may include knees, waistline, thighs, male genitals, lower portion of buttocks, abdomen, and nipples on women. In infants and young children, the palms, soles, head, neck and face may also be affected. Victims of attacks may become pale and haggard from loss of sleep. Apparently the tissues in these peoples become sensitized to certain proteins liberated by the scabies mites of the initial infestation. When a later infestation occurs, an allergic reaction develops with intense itching, redness or rash, over much of the body, even though the actual number of mites may be only a dozen or two in small areas between the fingers. Itch mites on domestic animals are almost indistinguishable from human Sarcopte mite. The itch and mange mites which burrow in the skin belong to the genera Sarcoptes and Notoedres, but, *Notoedres cati* causes a severe, sometimes fatal, infection in cats. Demodex, the hair follicle or face mite (family Demodicidae), is a cigar-shaped mite living in the hair follicles beneath the surface of the skin. Although this species is usually harmless to man, but in dogs and other domestic animals demodectic mange may be very severe and can even cause death. Another mite *Dermatophagoides scheremeteuiskyi* (family Epidermoptidae), causes mange-like symptoms, and it differs from Sarcoptes in burrowing under skin on the head as well as other parts of the body. Most of the other genera of itch mites in the family Psoroptidae may be lumped together as ‘scab mites’. These do not burrow into the skin, but remain on the surface, often causing such irritation that a many-layered scab is produced, with tremendous numbers of the mites living between the scab and the tissue (Blankenship, 1990; Koehler and Chaskopoulou, 2013; Menzano et al., 2004; Kemal et al., 2005; Rather and Hassan, 2014).

A physician should be seen when scabies infestation is suspected and if there is a question of scabies, skin scrapings

may be done before medication is prescribed. Several prescription medications might be available from physician to effectively control the mites. Most are applied thinly, but thoroughly to the entire body from the neck to down ward. Pay particular attention to hands and feet areas between fingers and toes, and under fingernails. In infants and small children, apply medication to face and scalp, but avoid the area close to the eyes (Sule and Thacher, 2007).

2.2. Dermatitis

Skin irritations or dermatitis, are caused by a number of types of mites, primarily chiggers, rodent and bird mites, straw itch mites, and grain or cheese mites. The chiggers attach themselves especially in areas where the clothing fits tightly, such as the tops of the stockings, the waist area where belts or underwear are fastened or the armpit area. Chiggers do not feed on blood, although their red colour when these are engorged gives that impression, hence the common name 'redbug' is given to this vector. Chiggers inject saliva into the host's tissue, forming a stylostome, or feeding tube, due to the reaction of the saliva and the insoluble flesh. This feeding tube is filled with semi digested tissue debris from which the mite sucks up as food. Severe chigger attacks can itch and be as serious as acute cases of poison ivy or sumac. The tropical rat mite (*Ornithonyssus bacoti*) may likewise bite to humans and become a pest. Typically, though, peoples are not always bitten when the normal host, the rat is not available to the mites. Frequently, such attacks are associated with death of the rat as a result of trapping, poisoning, or disease; the destruction of rat harbourage; or building rats out of premises by rat stoppage. The straw itch mite, *Pyemotes ventricosus* (formerly Pediculoides), is normally a parasite of the larvae of a number of borers, such as the Angumois grain moth and the wheat jointworm. Their outbreaks are usually associated with infested straw. The grain and cheese mites are frequently found in tremendous numbers in flour, grain, dried fruits, and cheese, particularly when humidity and temperature are high. Some of them are comparatively unimportant to except that they are liable to cause dermatitis to peoples handling the infested foods. These skin irritations have been given specific names in particular industries, for instance, 'Vanillism' among vanilla workers who come in contact with heavy infestations of mites (*Acarus siro*) on vanilla pods and beans; 'copra itch' among workers in copra mills due to attacks of *Tyrophagus castellani*; and 'Grocers itch' due to bites of *Glycyphagus domesticus* which is very common on dried fruits (Bellido-Blasco et al., 2000; Ansart et al., 2007).

Tropical rat mite *Ornithonyssus bacoti* is associated with rats throughout the world. Infestation of human follows by rat control or when the rodent is not available. Its bite is painful, causing intense itching and a skin irritation known as rat-mite dermatitis having cutaneous sign in neck, shoulders, face and upper trunk. The attacked patient can be treated with topical corticosteroids and antihistamines. Transmission of some pathogen agents such as *Rickettsia* and bacterial by *O. bacoti* is important. It is suggested that in rat control program, insecticide should also be applied to control mites that escape of their host (Baumstark et al., 2007; Rahdar and Vazirianzadeh, 2009).

Frequent changing of bedding and use of nonfibrous bedding can reduce mite populations. Frequent vacuum cleaning and correction of excess humidity problems can also aid in mite control. Use of vacuums equipped with air cleaners and air filters for air and heating units can help to reduce allergen effects. Remove carpeting where possible and if carpeting cannot be removed, use an appropriate acaricide application, by following the label instructions (Sabol-Jones et al., 2005).

2.3. Mite Infestations of Internal Organs

A number of mites are obligate parasites which live in the respiratory tract of common laboratory animals such as dogs, monkeys and birds. Mite *Pneumonyssoides caninum* has been found in the sinuses and nasal passages of dogs, and *Pneumonyssus simicola*, in the lungs of a high percentage of rhesus monkeys used in laboratory research. The canary mite *Stemostoma tracheacolum* has been found in the trachea and air sacs of canaries. Other species of nasal mites in the family Rhinosyssidae are found in the sinuses of many species of wild and domestic birds. Related species of these mites have been found in the lungs of snakes and seals. There are a number of reports in the literature of mite infestations of the alimentary canal and urinary passages. Laboratory workers at the Communicable Disease Centres have examined faecal and urine samples in which mites have been found. Most of the mites in the faecal samples examined have been common grain and cheese mites in the families Acaridae, Glycyphagidae and Tarsonemidae, which also infest vegetable products and could have been ingested with food. In some of the faecal samples, and in most of the urine samples examined, it seems likely that the mites observed are really contaminants from packing in the containers after they are unpacked. The presence of acaroid mites in cheese and ingestion of this cheese with its thousands of mites and their excretions may cause gastrointestinal disturbances when it is eaten for the first time. Under most of conditions there is no good evidence that ordinary contamination of human food with mites leads to gastrointestinal disturbances, and there is little reason to believe that mites ever become established in the alimentary canal (Goddard, 1993; Diaz, 2010).

2.4. Mites as Intermediate Hosts of Tapeworms

Some more than forty species of beetle mites in the grouping Oribatei and *Glycyphagus domesticus* serve as intermediate hosts of at least thirteen species of tapeworms. One of these mites, *Bertiella studeri*, has been reported only eleven or twelve times from man. A well-known tapeworm of sheep, goats and cattle, *Moniezia expansa*, has oribatid mites as an intermediate host. The eggs of the tapeworms are ingested by the mites in whom the parasites develop to the infective cysticeroid stage in several months. Herbivorous animals feeding on vegetation on which infested mites are crawling easily can acquire the infestation, and the tapeworms develop to the adult stage in a period of several weeks. Six species of adult oribatid mites (*Galumna racilis, Kilimabates pilosus, Kilimabates* sp., *Scheloribates fusifer, Muliercula ngoyensis* and *Zygoribatula undulata*) and two immature stages belonging to the super families Galumnoidea and Ceratozetoidea have been isolated from a lawn (mixed Pennisetum and Cynodon spp.). The mites have been subsequently used in an infection trial using *Moniezia expansa* eggs. Tapeworm cysticercoids have been recovered in *G. racilis, K. pilosus, Kilimabates* sp., *S. fusifer, M. ngoyensis* and *Z. undulata,* as well as in immatures of Ceratozetoidea (Denegri, 1993; Demetri et al., 1998; Schuster et al., 2000).

2.5. Mites Asthma

Many of us take breathing for granted and asthma is coughing and difficulty in breathing. But, if anyone has got asthma, coughing, wheezing, a tight chest and shortness of breath are common struggles that may have an irritating cough. Although, it is difficult to say for sure what causes asthma, researchers think that both genes and the environment could be responsible for it. It may have an inherited risk of developing allergies (atopy) or might have respiratory infections as a child. When a person comes into contact with something that is allergic (airborne allergens), this can irritate his airways. As a result, airways get tighten and narrow, making it difficult to breathe. Cigarette smoke, perfume, cleaning products, exercise and even stress can trigger symptoms of asthma. Even though there is not a cure for asthma, most peoples can manage their symptoms with an inhaler. This helps to relax the muscles in airways and control the swelling and inflammation caused by a trigger (Chosidow, 2006).

Too small to be seen with the naked eye, a dust mite measures only about one-quarter to one-third of a millimetre. An average adult human sheds two pounds of dead skin per year and much of it occurs while sleeping. Dust mites live in bedding and mattresses and eat these flakes of skin, and they prefer warm, humid environments. The dust in home contains droppings from dust mites, and dust mites are too small to be visible to the human eye and they thrive in humid climates. This is why they love the damp and warm conditions that are created in bedding where dust mites live off the dead skin cells that all humans shed. Two dust mites species, *Dermatophagoides pteronyssinus* and *D. farinae* are also found in carpets, soft furnishings and clothing, and often cause allergies because humans react to various proteins (allergens) contained in their droppings. It is these droppings, rather than the dust mites itself, to which many peoples are allergic. The best way to control asthma is to take any medicines that are prescribed correctly by physician and avoiding anything that can trigger symptoms. If anyone smokes, it is important to stop it, also, if a child has asthma, it is important for both to give up smoke well away from them. But, if anyone thinks that house dust mites are a trigger to bring on asthma symptoms, then washing of bedding on a high temperature is imperative (Beatty and Marquardt, 1996).

House dust mite allergy is very common and is associated with asthma, eczema and hay fever. Hay fever, otherwise known as seasonal allergic rhinitis, is an allergic reaction to airborne substances that get into the upper respiratory passages, the nose, sinus, throat and also the eyes. Hay fever, is accompanied by runny nose, itching, sneezing, itchy and watery eyes, frequent sneezing, a bunged up, itching on the roof of the mouth, coughing, and wheezing or a burning sensation in the throat. Symptoms usually appear in childhood first and then are lessen by the age of 30 or 40. Hay fever is the most common of all the allergic diseases and about 15 per cent of the population in industrialized countries suffers from this condition. Perennial allergic rhinitis is a similar allergy that occurs all year round and is caused by things such as house dust mites and pets, however the predominant allergen changes from time to time (Kettle, 1997).

Dry, red, itchy, sore or broken skin are just some signs of skin that may have eczema, which is an inflammatory skin disease (also known as atopic dermatitis). Although it is not exactly clear what causes eczema, yet, it may tends to run in families as a part of genetic make-up. However, there are many things that can cause it to flare up, from cold weather to perfume, changes in temperature, and feeling unwell and stress can also make worse. Tips to manage eczema are try not to scratch as scratching can really damage the skin, and sometimes even causing it to bleed and become infected. Although a long hot bath may be appealing, it can dry out skin and make eczema worse. Keep skin moist and regularly apply a body oil or moisturizer to keep it hydrated (Savilahti et al., 1993; David, 1998). Some of the methods commonly promoted for control of this vector are:-

i. Mattress, pillow and dust mite covers

These may reduce allergen exposure in bed, and is generally suggested that covers should completely encase the bedding, and must be removable and machine washable.

ii. Washing of bedding, soft toys and soft furnishings

Washing in warm water with commercial detergent about every 8 weeks can remove most of the allergens, but does not kill dust mites. When it is possible to wash a toy, freeze it overnight in a plastic bag to kill the mites, but this does not remove the allergen.

iii. Regular vacuuming

This may help to reduce mite allergens in carpet and rugs, but vacuuming alone cannot reduce the dust mite level significantly. Removal of carpets in favour of hard floors is sometimes recommended, but this has not been shown to reduce asthma symptoms (Svennberg and Wadso, 2005).

2.6. Scrub Typhus

The most common endemic rickettsioses include scrub typhus, murine typhus and Q fever, which may be difficult to differentiate clinically and also serologically due to cross-reacting antigens. Among the scrub typhus-carrying Leptotrombidium larval chigger mites, Leptotrombidium clinical manifestations include bite-eschar, lymphadenopathy, conjunctival injection, hearing loss and centrifugal rash. Scrub typhus may present with a non-specific influenza like prodrome of fever, chills, diaphoresis, headache (in approximately 60%), malaise, and weakness. In classical cases, this prodrome may be followed by skin rash, bite-eschars, regional lymphadenopathy, conjunctival injection, icteric sclera, jaundice and bradycardia. Later, patients may develop potentially fatal complications including adult respiratory distress syndrome, especially in older patients, hypotensive shock, acute renal failure, encephalomyelitis, and disseminated intravascular coagulation. The presentations for scrub typhus are, chest findings cough, tachypnea, dyspnea and bibasilar rales; chest X-ray findings infiltrates common; potential complications adult respiratory distress syndrome, acute renal failure, disseminated intravascular coagulation and encephalomyelitis; and differential diagnoses infectious mononucleosis, leptospirosis, tularemia, anthrax, spotted fever group rickettsioses, murine typhus and Q fever. Diagnostic methods for screening of rapid dipstick are recombinant 56-kd protein antigen test, serodiagnostic indirect immunofluorescent antibody tests and immunoperoxidase assays; confirmatory microscopic isolation of causative agent from blood or tissues, and polymerase chain reaction for causative agent DNA or RNA. Frequently, patients presenting with similar constellations of constitutional symptoms and few pathognomonic signs (eschar, rash and hearing loss) in rural scrub typhus-hyperendemic areas are often treated pre-emptively and empirically with oral doxycycline. Rural regions may have limited access to specific serological tests (immunofluorescent antibody assays and paired sera comparisons for rising specific antibody titers) required to differentiate scrub typhus from other endemic rickettsial diseases. Weekly doses of 200 mg of doxycycline can prevent *O. tsutsugamushi* infections (Service, 1996; Watt and Walker, 2006; Lai et al., 2008).

2.7. Rickettsial Pox

The causative agent (*Rickettsia akari*) is transmitted to man by the house mouse mite (*Dermanyssus sanguineus*) from house mouse which acts as the reservoir of the disease. Basically, the rickettsial diseases vary considerably in severity from self-limiting mild illnesses to severe life-threatening infections, particularly if complications arise. The tropical rat mite (*Omithonyssus bacoti*), which is far more abundant than the house mouse mite has been shown capable of transmitting rickettsial pox. The house-mouse mite *L sanguineus*, maintains a rickettsial zoonosis in its preferred house-mouse (*Mus musculus*) reservoir, and can transmit rickettsial pox caused by *R. akari* through bites. Its signs and symptoms differ slightly depending on the type of rickettsial disease. However, like other viral or bacterial exanthems, most patients present with fever, headache and malaise (feeling generally unwell), and a widespread rash of some description. Many experts now feel that rickettsial pox is under reported and distributed in silent sylvan cycles worldwide. The incubation period and initial clinical manifestations of rickettsial pox mirror those of scrub typhus with bite-eschar formation within 10 to 12 days, followed by fever, chills, severe headache, conjunctival injection, truncal maculopapular, vesicular and rash. Unlike scrub typhus, complications are rare, but may include thrombocytopenia and interstitial pneumonia. Hearing loss does not occur, and regional lymphadenopathy is uncommon in rickettsial pox. The clinical manifestations and diagnosis of rickettsial pox are, chest findings asymptomatic bibasilar rales; chest x-ray findings usually normal; potential complications thrombocytopenia; differential diagnoses chickenpox, tularemia, anthrax, and Q fever; diagnostic methods serodiagnostic immunofluorescent antibody assay for IgG to both *R. akari* and *R. rickettsia* with follow-up cross adsorption testing for predominant antibodies; and confirmatory isolation from skin biopsy. Serology is the mainstay to confirm diagnosis of rickettsial diseases and this is a blood test that detects the presence of antibodies to rickettsial antigens (Ozturk et al., 2003).

All rickettsial diseases should be treated with antibiotic

therapy. They should be started early in the first week of illness to be most effective and to produce a good outcome. Doxycycline is the drug of choice and its derivatives are lymecycline and minocycline (Tetracyclines are oral antibiotics often used to treat skin diseases), and chloramphenicol may be used as an alternative. Supportive therapy with electrolyte and fluid maintenance are also essential to the management of patients with rickettsial diseases, particularly if there are signs of low blood pressure, electrolyte disturbances, and blood coagulation (clotting) problems. Because these diseases are potentially serious, patient must seek urgent medical attention if there is any suspicion that may have one of these infections (Krusell et al., 2002).

3. Integrated Mite Management (IMM)

This Integrated Mite Management (IMM) section provides techniques and procedures that are commercially available wherein vector control is the primary means of preventing vector-borne disease. Much of the specialized knowledge required for an effective structural IMM program can be more accurately described as applied facilities engineering and management rather than applied biology. However, the background of most entomologists and other biologists generally tends to be strongest in pest biology and pesticide technology. Good mite management combines regular monitoring to detect pest occurrence and timely implementation of the most appropriate management tactics. Monitoring is an essential part of a mite integrated pest management program because injury cannot be seen until after feeding takes place. It is difficult to outline a monitoring program for these mites because their life cycles vary so much depending on the species. In general, monitors should be aware of the types of injury caused by parasitic mites, and that the mites are difficult to observe. Although basic concepts of cleaning, sealing, and pest-proof storage of food and garbage are often discussed in pest control training, they are rarely presented in sufficient detail to allow a pest management professional to evaluate specific options. Spray the nesting materials and dead animals with using of gloves, place dead animals and nesting materials into a plastic bag and seal the bag tightly to bury, and spray again to disinfect the entire area. Significant progress can be made when a brief exposure of surface microbes and mites to ultraviolet light is conducted to kill these organisms. When this UV-light source is incorporated into a vacuum cleaner, then it is anticipated that exposure risk to some pathogens and allergens can be reduced by killing the organisms, and removing them and their offending by-products. This is a positive step to forward especially for sensitized and immuno-compromised individuals (Lutz et al., 2010; McClure et al., 2010; Sarwar, 2015).

4. Conclusions

In summary, most mites are small, have mouth parts capable of puncturing and feeding on tissue fluids, have a high reproductive rate, and are found in all habitats, including human skin. Although mites belong to the class Arachnida, and are not true insects, they are important vectors of some of the most significant arthropod-borne diseases and have been studied intensively by entomologists and public health workers. Mites are important causes of cutaneous diseases and comprise vectors of important infectious diseases. Mite bites should be considered whenever any unexplained cutaneous eruption is presented to the dermatologist. A knowledge of the biology of the mites that can attack humans is important when taking a history and for identifying the etiology. Treatment of the dermatitis is symptomatic, with a cure depending on the identification and eradication of the causative mite.

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