Review Article

Paederus dermatitis

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Abstract

Paederus dermatitis is an irritant dermatitis caused by pederin, a toxin produced by the rove beetle (*Paederus*). The disease occurs worldwide, but it is often not recognized as a history of contact with the insect is frequently absent. It is commonly seen in the rainy season. Crushing the insect releases pederin, resulting in the characteristic linear lesions with a burning sensation that heal with hyperpigmentation. Treatment comprises immediate washing of the area to eliminate the toxin and topical application of a topical steroid-antibiotic combination. Preventive measures may include reducing the insect population in the surroundings, avoiding contact of insects with the skin, minimizing the lesions after contact. Awareness of the etiology and clinical manifestations makes it easier to suspect this condition even in the absence of a history of exposure to the insect. We present a comprehensive review of the etiopathogenesis, pathology, clinical features, treatment and prevention of *Paederus* dermatitis and also review the biology of the insect and its behavior.

Key words: Beetles, contact dermatitis, irritant dermatitis, *Paederus* dermatitis

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Introduction

Insects represent more than half of all known living organisms in the world and have an enormous influence on human life. They may harm man by stinging, biting or transmitting diseases. Some insects, such as *Paederus*, contain toxins that directly irritate the skin. This beetle has been given various names in different countries [Table 1].[1-7]

The epidemiology, biology, pathology, clinical features, treatment and prevention of *Paederus* dermatitis are discussed in this review.

History

Paederus dermatitis was first reported in the literature in 1901 by Vorderman, who reported an outbreak of dermatitis in personnel at the Anjet-Kidoel lighthouse in Jawa caused by insects that were known locally as semoet-kalong.[8] The species described by Vorderman was *Paederus peregrinus*, believed to be a variety of *Paederus fuscipes*. A second outbreak was described by Pirajá da Silva in 1912 in Brazil, caused by *Paederus columbinus*.[8]

The toxicity of *Paederus* and the skin reaction to the beetles named "Ching Yao Chung" was known in Chinese medicine as far back as 1200 years ago and it has been suggested in Chinese literature that the toxin removes tattoos.[9] Fossil rove beetles dating back to almost 200 million years have been discovered.[10] Norton and Lyons suggest that the third and fourth plagues of the ten plagues of Egypt described in the bible could have been caused by *Paederus alfieri* which flourishes in the Nile basin under favorable conditions.[11]

Various names given for this condition include "dermatite vesiculeuse saisonnière" (1915), "dermatitis linearis" (1917), "rove beetle dermatitis" (1963), "*Staphylinidae* dermatitis" (1968), "whiplash dermatitis" (1954) and spider lick.[2,3,12] Frank recommends the use of the term dermatitis linearis as the other terms are misleading.[12]

Epidemiology

Paederus dermatitis is found in all zoogeographic regions across the world except in Antarctica but is more common in tropical and subtropical regions.[13,14] Outbreaks have been reported mainly from the southern regions of Europe and Asia, and in other continents at lower latitudes.[12] Sporadic cases are seen in any season when the insect is active, but large outbreaks occur particularly during the rainy months.[3] An increase in the population of *Paederus* insects

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has been reported due to rains occurring as a result of the El Nino phenomenon in Peru and in East Africa especially in Kenya and Northern Tanzania in 1997-1998.[5,15] A large outbreak of *Paederus* dermatitis in Australia that forced the evacuation of an entire Australian Aboriginal community in response to the outbreak was reported in 1996.[16] Banney *et al*. reported a large series of about 250 cases in a period of several weeks in Queensland.[17]

A study found that dispersal of *P. fuscipes* occurred mainly during rice harvesting, plowing and straw burning due to destruction of habitat and non-availability of food. After an initial migration to non-harvested areas *P. fuscipes* then spread to residential areas at dusk.[18]

Etiological Agent

The *Paederus* group of insects belong to the rove beetle family which is the second largest family of beetles (*Staphylinidae*, *Coleoptera*).[10] The term *Coleoptera* was given by Aristotle to insects with wing cases, referring to the koleon (sheath) and pteron (wing). Staphylinid beetles are referred to as rove beetles because of the tendency to wander.[2] The phylogeny of *Paederus* is given in Table 2. Identification of species is not possible from the phenotype alone and requires dissection of genitalia.[3] [Figure 1]. The insects are usually around 7–13 mm long and are often mistaken for ants.[3] They are brightly colored with metallic blue- or green-colored elytra, and many with bright orange or red on the pronotum and the basal segments of the abdomen. These bright colors may be an example of aposematism, that is, a warning signal to potential predators.[9]

Table 1: Nomenclature of *Paederus* in different countries

West Africa	Nairobi Fly
Malaysia	Semut Semai or Semut Kayap
Iran	Balaloos, Onion Fly and Dracula
Venezuela	Puri-puri or tar-tari
Egypt	El-Rawagha or the escaper
Brazil	Poto
Iraq	Phosphorus insect

Table 2: Phylogeny of *Paederus*

Category	Name
Phylum	*Arthropoda*
Class	*Insecta*
Order	*Coleoptera*
Suborder	*Polyphaga*
Superfamily	*Staphylinoidea*
Family	*Staphylinidae*
Genus	*Paederus*

Figure 1: *Paederus* insect (©entomart)

Paederus is an important predator found associated with many crop pests throughout the world and may help in their biological control. Adults are polyphagous and exhibit necrophagy and cannibalism.[19] They feed mainly on other insects, moths, live tadpoles and soil nematodes, decaying organic matter, but not on the living tissues of plants.[10,13] They are also commonly found under stones and on the banks of ponds, streams, rivers and marshes.[13] In Malaysia, rice fields are a major habitat.[20,21] In Venezuela, farmers collecting oranges and lemons are commonly exposed.[3]

Phototaxis

Paederus beetles exhibit positive phototaxis while flying and running[23] and are preferentially attracted to long wave ultraviolet and white light compared to orange and yellow light to which they are relatively insensitive.[24,25] In Tanzania, the replacement of ultraviolet light emitting mercury lights with yellow light emitting incandescent bulbs terminated an outbreak of *Paederus* dermatitis.[3] Vasudevan and Joshi studied 154 cases of *Paederus* dermatitis in the United Nations Mission area in the Congo and found that insects were attracted to orange-colored flowers in a nearby garden.[22] Bright lights can attract insects in the dark over a distance of many miles.[25] *P. fuscipes* has been collected on a ship 97 km from the land.[13]

Pederin

Pavan and Bo coined the term pederin for the principal toxin produced by *Paederus*. Two other toxins, pseudopederin and pederone pederin ($C_{25}H_{45}O_9N$) are also known to be produced by the insect. Pederin is an amide with two tetrahydropyran rings.[12,26] It is weakly acidic and has been demonstrated in all developmental stages of *P. fuscipes* and in all parts of the adult insect except the wings.[13] Pederin is the most complex non-proteinaceous insect secretion known and is produced only in female insects.[27] It has weak antibacterial activity but it is a very potent toxin for eukaryotic cells and is more potent than *Latrodectus* (black widow spider) venom which is 15 times more potent than that of cobra venom.[12,26] It produces severe internal damage if ingested and is lethal if injected into the bloodstream.[28] The topical toxicity of pederin is greater than that of the potent organophosphorus insecticide, parathion. The toxicity is maintained even after 10 months and dried *P. fuscipes* has shown to retain toxicity up to 8 years. Boiling in water does not destroy the toxin.[13]

Pederin is believed to have anti-tumor and antiviral properties. It is extremely toxic and at levels as low as 1 ng/ml can inhibit deoxyribonucleic acid and protein synthesis.[3,13,29] It is 1000–10,000 times as potent as some commonly used antimetabolites.[30]

Pederin may constitute up to 1/40 of an insect's weight.[31] However, there is wide variation in the pederin content of various insects. Only females possessing endosymbiotic bacteria can manufacture pederin and may contain up to 20 μg of pederin; however males and females without endosymbiotic bacteria (aposymbiotic females) may possess a very small quantity of the toxin (0.1–1.5 μg) but are not capable of biosynthesizing it.[32] It has been shown that pederin is produced by endosymbiotic *Pseudomonas* species.[33]

Pathogenesis and Pathology

The hemolymph of the *Paederus* beetle contains pederin which is released on crushing of the insect onto the skin due to the reflex of

brushing away the insect.[13] However, there have been reports that the insect can occasionally sting and that the toxin may be released while the insect is moving.[34]

Pederin causes contraction, pyknosis and disorientation of the chromosomes, karyorrhexis, karyopyknosis and vacuolization leading to cutaneous necrosis. Early lesions demonstrate neutrophilic spongiosis, exocytosis and epidermal reticular degeneration. More advanced lesions show intraepidermal vesiculation and confluent epidermal necrosis; however, the suprabasal cells are usually spared. Scattered acantholytic cells may be seen. These features of acute toxic injury to skin are characteristic of Paederus dermatitis. A predominantly perivascular dermal edema and a mixed interstitial infiltrate may also be seen in advanced lesions.[31,35]

Older lesions may show irregular acanthosis and parakeratosis, and the basal and suprabasal cells may demonstrate mitotic figures; scattered cells in these areas may show evidence of DNA fragmentation.[35] Ultrastructural findings on electron microscopy support light microscopic findings of toxic damage to the upper epidermis and evidence of apoptosis in the lower epidermis.[35]

During healing, a picture similar to that of the spongiform pustule of Kogoj seen in pustular psoriasis may be seen.[31]

Clinical Features

Paederus dermatitis is a self-healing condition affecting individuals of both sexes and all ages.[2,23] Patients are often unaware of contact with the insect as it usually occurs at night during sleep when the insects are crushed reflexly. Lesions are commonly noticed on awakening in the morning and hence it is known as "wake and see" disease[36] in Nigeria and as "night burn" in Turkey.[38] The time delay between the first contact of skin with the toxin and the earliest erythematous lesion is known as the latent period.[2,37] Pederin may be transferred by sheets or clothing and affect remote areas of the body.[39] Exposed areas of the body such as the face [Figure 2], neck and arms are most affected, the palms and soles being spared.[13,31] The toxin also usually spares the mucosa of the mouth.[37] The incidence of cases increases in the period immediately following the rainy season. It has been suggested that penetration of pederin might be facilitated by wet and sticky skin in areas of high humidity.[40]

Symptoms typically begin between 24 and 48 h after contact with the insect with the most common being itching and burning or smarting sensation.[41] The characteristic linear appearance [Figures 3-5] of the lesions results from crushing of the insect and subsequent smearing of the toxin on the skin. However, there are reports of the insect stinging and releasing toxin during simple movement; occasionally, the linear appearance may suggest a "railroad pattern".[7,34] Lesions evolve through an initial erythematous phase followed by vesiculation and subsequent crusting [Figures 6 and 7] and desquamation. Mild cases with only erythema may resolve within 2 days. Moderately severe cases with significant vesiculation may dry out and exfoliate (squamous phase) in about 7–8 days. Sequelae include hyperpigmentation that may last up to a month. Cutaneous necrosis may occur occasionally.[20] Severe cases are characterized by a more extensive skin involvement and systemic features such as fever, arthralgia, neuralgia, rhinitis and tympanitis. Erythema may persist for many months.[13] Skin lesions are not restricted by dermatomal borders.[42]

Figure 2: Multiple linear erythematous lesions on the face

The clinical presentation is determined by:

1. The species of *Paederus*
2. Recurrent contact during a short period of time
3. The existence of underlying disorders such as atopic dermatitis
4. An immunologic phenomenon resulting in an eczematous reaction pattern.

The various morphological patterns encountered include:

1. Dermatitis linearis: It is the most common pattern. The lesions can occur at any site but more often occurs on exposed areas. They present as erythematous or linear streaky lesions
2. Localized pustular dermatitis: It resembles an irritant contact dermatitis and presents as grouped pustules in the area of contact
3. Kissing lesions [Figure 8]: These occur due to contact of adjacent areas of the skin, often in the flexures such as the cubital fossa or axilla
4. Extensive skin involvement: This is sometimes associated with systemic symptoms such as fever, neuralgia, arthralgia and vomiting[13]
5. Genital lesions: They occur due to passive transfer of toxin to the genitalia. Balanitis is an uncommon manifestation[43]
6. Erythematous patches with pustules and erosions [Figure 9]

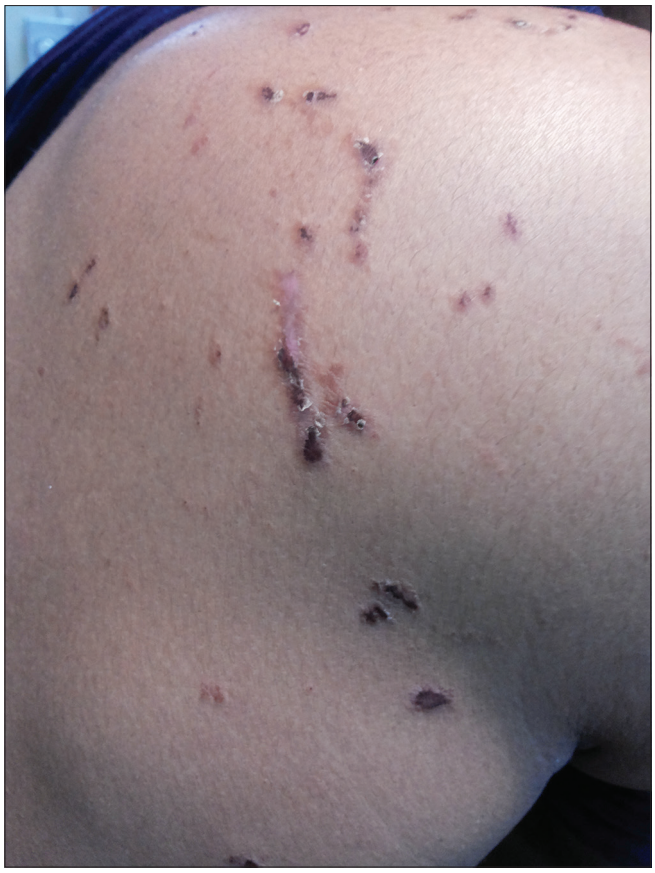

Figure 3: Multiple linear crusted lesions on the back

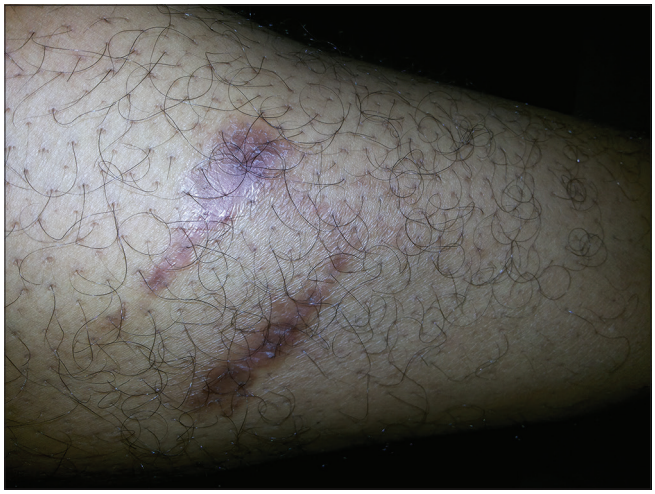

Figure 5: Linear lesions on the leg

7. Atypical variant of *Paederus* dermatitis characterized by diffuse erythematous and desquamative lesions predominantly occurring in the upper body.[16,44]

Nairobi Eye

Ocular involvement due to pederin was first reported in Zaire in 1915.[13] It presents as a keratoconjunctivitis or periorbital dermatitis and is popularly known as the "Nairobi Eye".[38] Most cases have been described in the Congo and East Africa.

Figure 4: Linear streaky lesions on the leg

Figure 6: Crusted plaque in the axilla

Periocular lesions frequently occur secondary to transfer of pederin by the fingers from elsewhere on the skin,[3,25] but sometimes due to direct contact with periorbital skin. Corneal involvement has been reported due to insects falling into the eye while driving a motorcycle.[45] Eye involvement may also occur when the insect crawls into the eye during sleep, triggering the blink reflex.[13]

The clinical presentation is that of a unilateral periorbital dermatitis with or without keratoconjunctivitis. Intense conjunctivitis and keratitis can produce temporary blindness. Kissing lesions of the eyelid are not uncommon. However, in a series of 146 cases of periorbital dermatitis described by Hashish, posterior segment complications were absent and no patient developed permanent visual disability.[4]

The toxic effects are usually limited to the conjunctiva and cornea as pederin does not penetrate the cornea.[42] Iritis has been reported to be caused by *P. columbinus* in Venezuela.[13] It is possible that keratitis and iritis may be caused by mechanical trauma when an insect hits the eye with force.

In Kenya, *Paederus eximius* was associated with a particularly severe conjunctivitis. The toxin from this species was found to cause severe local pain and inflammation.[46] Conjunctival and lid lesions heal in about 10 days to 2 weeks but corneal lesions can take up to 50 days to heal.[13,42]

Criteria for Diagnosis of *Paederus* Dermatitis

We propose the following criteria for the diagnosis of *Paederus* dermatitis based on the history and clinical features. Histopathology is not diagnostic and was not included in the criteria.

1. Acute onset eruption with burning or itching sensation
2. Linear or streaky pattern of dermatitis with or without kissing lesions
3. History of contact with *Paederus* beetle or patient from an endemic region.

Differential Diagnosis

This includes dermatitis of varied etiology.[3] All dermatosis with localized vesicle formation can be considered in the differential diagnosis [Table 3].[47-50]

Table 3: Differential diagnosis of *Paederus* dermatitis

Acute allergic contact dermatitis
Irritant contact dermatitis
Thermal burns
Chemical burns
Herpes zoster
Herpes simplex[47]
Bullous impetigo
Phytophotodermatitis
Cutaneous larva migrans
Dermatitis herpetiformis
Pemphigus foliaceus
Caterpillar dermatitis
Millipede dermatitis[48]
Moth-related urticaria[3]
Meloid beetle toxin induced vesicular dermatitis[13]
Dermatitis artifacta[49]
Trichinosis[50]

The two most important conditions in the differential diagnosis are phytophotodermatitis and blister beetle dermatitis.[51] The difference between these three types of dermatitis is given in Table 4.[40,52]

Complications

Complications are due to the direct effect of the toxin and secondary infection.

Post-inflammatory hyperpigmentation and scarring can occur. More serious complications such as extensive exfoliating and ulcerating dermatitis may require hospitalization.[3,13,53]

Treatment

Management is similar to that of an acute irritant dermatitis. Immediate removal of the toxin may be possible if the patient presents soon after contact with the insect. However, most of the patients reach the hospital after the lesion has occurred. Magnesium sulfate compresses were advocated by Robert and Tonking for quick relief.[46] In patients presenting immediately after contact

1. The area should be washed with soap and water
2. Tincture iodine topically neutralizes pederin[13]
3. Oral antihistamines may be given.

All medical and paramedical staff in endemic areas should be made aware of this initial management in order to ameliorate the severity of the dermatitis, thereby preventing complications.

Soothing agents such as calamine, camphor and topical anesthetics (lidocaine, benzocaine) have been used for temporary relief of itching and burning sensations. Silver sulfadiazine has antibacterial activity and has been recommended to ameliorate symptoms.[54]

After the appearance of the lesions, topical steroids with or without an antibiotic are effective. Qadir *et al*. recommended a regimen consisting of oral antihistamines, topical steroids and oral ciprofloxacin.[38] The study showed early healing and a lower rate of complications. Topical steroids are given till the skin lesions crust or show signs of healing; this usually takes 7–10 days. Systemic steroid therapy is reserved for rare severe cases. Antihistamines are useful for relieving pruritus. Gabapentin or pregabalin gives complete relief in chronic dysesthesias.[3]

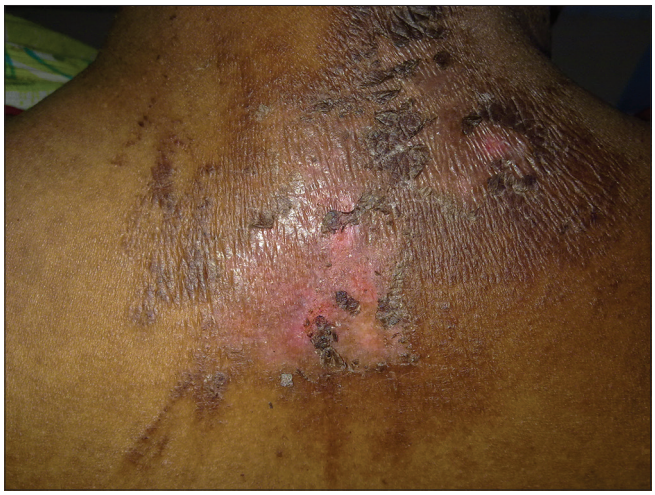

Figure 7: Crusted plaque with healing erosion

Figure 8: Kissing lesions on the arm

Table 4: Differences between *Paederus* dermatitis, blister beetle dermatitis and phytophotodermatitis

Feature	*Paederus* dermatitis	Blister beetle dermatitis	Phytophotodermatitis
Cause	Pederin from rove beetles	Cantharidin from true and false blister beetles	Furocoumarins from plants of families *Umbelliferae*, *Rutaceae* and *Moraceae*
Release of toxin	Usually when crushed	Can occur by irritation of insect by clothes,[52] or when the insect is disturbed	Contact with plants and UV exposure
Onset of lesions	Skin signs develop 24-72 h after contact with the toxin	Skin signs develop within 18-24 h of contact with the toxin	Skin lesions develop 12-36 h after contact and exposure to UV light
Inflammation	Intense	Absent	Intense
Symptoms	Usually severe, burning sensation	Mild	Severe, burning sensation
Awareness of cause	Usually absent	Often present as the insect is large	Only on detailed questioning
Population outbreaks	Common	Rare[40]	Sporadic

UV: Ultraviolet

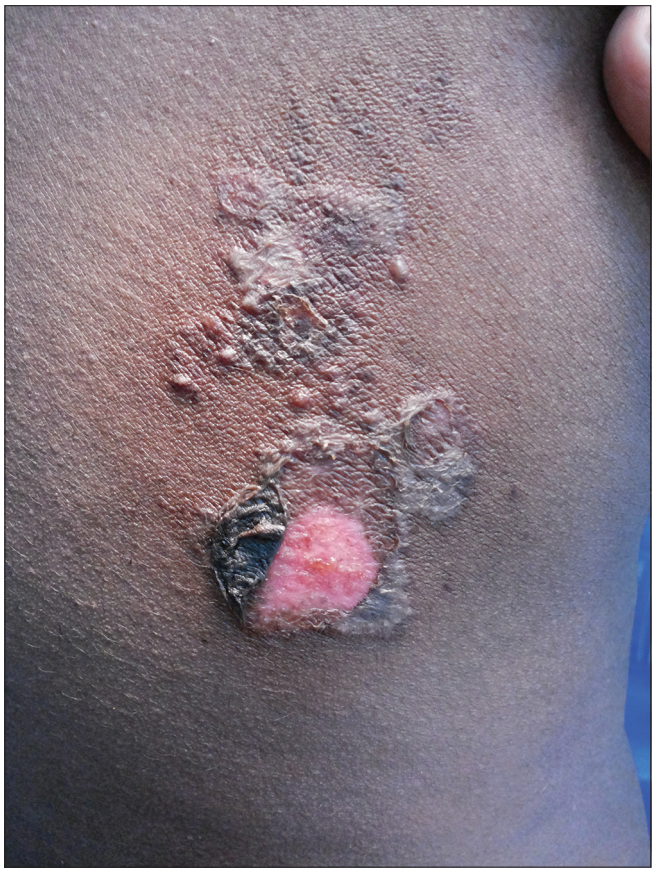

Figure 9: Erythematous patch with pustules and erosion

Ebrahimzadeh *et al*. studied the effect of a topical application of an extract of *Sambucus ebulus* (a plant commonly referred to as danewort) and found a significantly quicker healing time with the maximum effect being due to its anti-inflammatory action. The authors attribute this effect to phenols and flavonoids in the plant extract.[53] Nikookar *et al*. found oral atorvastatin to be as effective as topical triamcinolone in the treatment of *Paederus* dermatitis.[55]

Huang *et al*. found that his patients with keratitis needed topical treatment with autologous serum to hasten corneal reepithelialization.[45]

Prevention

Prevention[31,56] includes:

a. Reducing the insect population in the surroundings
b. Avoidance of contact of insects with human skin
c. Minimizing release of toxin from the insect after it alights on the skin
d. Prevention or reduction of lesions after contact.

Reduction of Insects in the Surroundings

Primary prevention[3,14,25,31] is by increasing public awareness of the habitat of the insects, their attraction to artificial lights and the manner of exposure to the toxin and prophylactic measures postexposure. This is especially important during periods of known outbreaks such as the monsoon season.

Any surrounding vegetation, preferably up to 50 m that may provide a haven for these beetles, must be cleared.[13,20] In small areas of vegetation, deltamethrin dust may help reduce the beetle load. Verma and Agarwal recommend regular preventive sprays of pyrethroids and 50% malathion in infested areas.[57]

Minimizing Contact of Insects with Human Skin

In endemic areas, especially in and around the monsoon season, the risk of exposure to the insects is still there even if the above measures are taken. In such instances, it would be prudent to put into place measures to minimize contact with skin.[3,25,31,34] Windows should be closed before putting on artificial lights in the evenings; this can prevent insects from entering the building, as it has been seen that these insects are most active from 1 h after sunset till midnight.[25] Netted screens may be placed on doors and windows to allow ventilation while keeping out insects. However, care should be exercised in selecting the appropriate size meshwork, as the insects because of their small girth, can pass through the standard mesh openings of 1.5 mm^2 as they measure only 1 mm × 0.5 mm in cross-section.[13] People in susceptible areas should avoid standing directly under fluorescent lights, especially during the monsoon season. In fact, sleeping near fluorescent lights even after they are switched off should also be avoided because that is the time when most of the contacts occur. Since this may not always be possible, nets may be placed under lights to prevent dropping of beetles onto people. Rooms can be sprayed with insecticide which can also be used to spray the insects when seen; however, care must be taken not to crush the dead beetle which can also release toxin when crushed. Use of mosquito nets which may or may not be

treated with permethrin is useful to prevent fall of insects while sleeping.[58]

Insect electrocution devices that use ultraviolet light to attract the insects may be used. However, people should avoid staying close to these contraptions to avoid contact with the beetles. Insect trapping devices such as sticky traps and glue boards may also be used. Pheromone-based baits may be used for monitoring.[48]

Insect repellent creams may be used on a short-term basis when working in areas with a heavy load. If one needs to work in an area with a high prevalence of beetles, long sleeved shirts and hats would go a long way in preventing contact of the skin with the beetles. If feasible, gloves provide additional protection. Eyeglasses can help prevent eye contact when traveling in open roofed vehicles.

People should be especially cautious when they see an insect with a red or orange belly and take care to avoid crushing such an insect.

If a *Paederus* beetle has been collected and stored in alcohol, care should be taken to avoid skin contact as pederin is soluble in alcohol.

Minimizing Release of Toxin from the Insect after it Alights on the Skin

If a beetle is seen on the skin, it should either be blown or flicked off, or removed gently with a paper or some other object taking care not to crush it.

Minimizing Lesions Once Exposure to the Toxin has Occurred

Primary lesions should not be scratched.[34] If the beetle has already been crushed, the skin must be immediately washed with soap and water to remove as much of the toxin as possible because the toxin takes some time to penetrate the skin.[25] This can be followed by cold compresses and calamine lotion. Tincture of iodine has a theoretical use as it has been shown to destroy pederin. Thorough washing the eyes with water can minimize ocular reactions.[13]

Conclusion

Paederus dermatitis caused by a casual contact with an insect is irritant dermatitis with unique clinical features. It has increased in recent years due to an increased use of fluorescent lamps and factors such as the El Nino effect, and global warming. Deforestation has led to an increased contact of human beings with this otherwise innocuous insect. This encounter may result in varied presentations ranging from mild irritant dermatitis to severe scarring. Lack of awareness of this condition both among the patients and practitioners is a major hurdle in curbing this menace. Proper education of the general population and increasing awareness can go a long way in curbing this disease which can sometimes cause significant morbidity.

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Conflicts of interest

There are no conflicts of interest.

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