EXOTHERMIC FORMULATIONS FOR THE TREATMENT OF ECTOPARASITES

INTRODUCTION TO THE INVENTION

The present invention relates generally to the removal of ectoparasites from the bodies of humans and animals, and more particularly to a topical treatment to facilitate such removal.

Ectoparasite infestation of humans and animals is a serious health problem throughout the world. Of particular importance as a public health issue is pediculosis, or infestations with lice, which are pervasive among children and can quickly be spread in a school setting. A very common parasite is *Pediculus humanus* var *capitis*, the common head louse, although there are other important parasites, including *Pthirus pubis* (the pubic louse) and *Pediculus humanus* var *corporis* (the body louse). Infestations are frequently accompanied by itching and skin damage. Infections and other adverse conditions may occur when the skin is scratched in an attempt to relieve the itching. Further, lice are known to be capable of transmitting serious diseases, including trench fever, relapsing fever and typhus.

Pediculosis is most frequently treated by applying pesticidal compositions, such as lotions or shampoos, to the affected body areas, such as the hair, and then exhaustively combing with a fine-tooth comb made especially for the purpose of removing nits. Commercially available preparations may include as their active ingredients pyrethrins, piperonyl butoxide, malathion, lindane or permethrins, many of which unfortunately have neurotoxicity effects, and are readily absorbed through the skin and therefore can establish undesirable systemic concentrations. It is perceived that the effectiveness of pesticides has recently diminished, as the parasites appear to continually become more resistant to their action. The resistance may be aggravated by small amounts of residual pesticide on the treated areas, following the procedure, and by consumer misuse of the products. This resistance also contributes to an increased opportunity for toxic systemic exposure to the active ingredients, since the preparations must be applied repeatedly to obtain an eradication of the infestation. Further, the pesticides do not usually kill the parasite's eggs that may be present on a host, so the tedious mechanical removal techniques must also be

used. When dead lice remain attached to hair shafts, then mechanical means must also be used for their removal.

Successful ectoparasite infestation treatment involves not only removal of pests from the host, but also a concurrent removal of the pests from the environment. It is recommended to scrupulously clean clothing, bed linens, etc. to avoid reinfestation. Of course, if other residents of the household are hosting ectoparasites, the probability of eradicating them on an individual is quite low.

DiNapoli et al., "Eradication of Head Lice with a Single Treatment," *American Journal of Public Health*, Vol. 78, pages 978-980, 1988, reported a study in which 7 percent of patients treated with a commercial 1 percent permethrin cream rinse, and 16 percent of patients treated with a commercial product containing 0.3 percent pyrethrins, 3 percent piperonyl butoxide, 1.2 percent petroleum distillate and 2.4 percent benzyl alcohol, experienced adverse reactions including pruritis, erythema, tingling, rash and other conditions. Further, by 14 days following treatment 38 percent of the patients treated with the pyrethrin product were found to host live lice, considered to constitute a treatment failure. Permethrin is described as having residual activity on the hair for up to two weeks. Since the publication of this study, the resistance of lice to these products has increased significantly.

R. J. Roberts et al., "Comparison of Wet Combing with Malathion for Treatment of Head Lice in the UK: a Pragmatic Randomised Controlled Trial," *The Lancet*, Vol. 356, pages 540-544, 2000, report that mechanical removal of lice with a commercial comb every 3-4 days for two weeks gave a "cure" rate of only 38 percent, while two treatments with 0.5 percent malathion lotion seven days apart gave a "cure" rate of 78 percent.

Published results for the various topical pesticidal treatments were compared by. R. H. Vander Stichele et al., "Systematic Review of Clinical Efficacy of Topical Treatments for Head Lice," *British Medical Journal*, Vol. 311, pages 604-608, 1995. It was concluded that only permethrin had sufficient evidence of efficacy.

There are other approaches to treating the infestations, including the application of heavy, oily substances such as mineral oil, petrolatum, mayonnaise and the like in an attempt to suffocate the ectoparasites, but these have not been found particularly effective, esthetically pleasing or convenient. One major disadvantage of such treatments is the prolonged time (usually several hours) required to achieve suffocation, after the agent has been applied.

The suffocation technique has been refined, such as by the approach of U.S. Patent 6,139,859 to Precopio which utilizes air-impermeable water-dispersible liquid compositions containing surface active agents. Another type of treatment refinement is the technique of Pearlman et al. in PCT International Publication WO 99/18800, involving the topical application of surfactant substances as "pediculostatic agents" which immobilize the parasites to permit their removal by combing.

Various cosmetic products that generate heat in the presence of moisture have been reported. U.S. Patent 3,250,680 to Menkart et al. describes cleansing and other liquid, creamy or pasty consumer product compositions that contain the alkali metal aluminosilicate called Molecular Sieve 5A; when applied following contact with water, the compositions are said to impart a pleasing warmth to the skin. U.S. Patent 4,379,143 to Sherry et al. is directed toward analgesic balms, ointments or lotions that contain activated zeolites which hydrate exothermically using skin moisture and can thus provide heat to relieve muscle pain and the like.

The application of very hot water can kill head lice on articles such as combs and brushes. It has also been proposed in U.S. Patent 5,261,427 to Delov to use electric hair dryer-type devices for killing lice in the hair, but lice are well-known to have a high mobility that would enable them to rapidly move from the necessarily limited area of heating. Moreover, the temperatures and times required for efficacy of a treatment involving only heating would not be tolerable on the skin of a person or animal, and may even cause injury to the skin.

It remains desirable to have a treatment for ectoparasitic infestations which is efficacious, acts rapidly and does not generate great discomfort or require any exposure of the host to toxic agents.

SUMMARY OF THE INVENTION

The present invention is a treatment for ectoparasitic infestations, particularly those involving fleas, ticks, mites or lice, comprising establishing temperature conditions above or below the normal range of skin temperatures in the infested area, for a time sufficient to immobilize or kill the ectoparasites, then removing the pests and their eggs by mechanical means such as combing.

In one embodiment, the invention involves fluid compositions which generate elevated temperatures when contacted with water, such as is present in moistened hair or skin. The elevated temperatures are maintained for a time sufficient to cause immobilization and/or mortality of the parasites, facilitating their mechanical removal by combing, rinsing with water and other techniques.

Treatment can be conducted using a composition which generates heat, when contacted with water, the composition comprising a fluid containing substantially no aqueous matter, or in some instances only a small amount of water, and which contains a particulate inorganic substance that can react exothermally with water. Examples of suitable substances are aluminosilicates and alkaline earth metal oxides. The exothermic reaction is not necessarily one which results in formation of any new chemical compound, but can be an absorption-type reaction.

In another embodiment, the temperature is reduced below the usual range of skin temperatures for the infested area.

DETAILED DESCRIPTION OF THE INVENTION

The invention will be described primarily as it relates to the reduction of human head lice infestations, although those skilled in the art will recognize its applicability to other ectoparasites and non-human animal subjects, and the inventors intend that their invention will have such other applicability.

In the following description and the claims, it is intended that a reference to a percentage means percent by weight, unless the context clearly indicates otherwise. Since the chemical names for certain composition ingredients are quite cumbersome, some ingredients are identified herein by their adopted names as given in standard reference works, including J. A. Wenninger et al, Eds., *International Cosmetic Ingredient Dictionary and Handbook, 8th Ed.*, The Cosmetic, Toiletry and Fragrance Association, Washington, D.C., 1999.

The present invention extends the observed phenomenon of head lice mobility impairment when their environmental temperature deviates significantly from about 32°C. Nearly complete mortality occurs from exposure to temperatures of about 46°C for several minutes, and a decrease in mobility is seen when the environmental temperature is reduced below about 30°C. Since such elevated or lowered skin temperatures are easily tolerated

by humans and most animals, the inventors determined that treated ectoparasites can be readily removed from the body by simple mechanical means, such as combing with a fine-tooth comb or rinsing with water, while the parasites are immobilized or after their death. It is generally preferred that the elevated or reduced temperatures be maintained during at least a part of a combing process, to prevent individual parasites from simply evading the comb if they should regain their mobility. The duration of combing will vary, depending upon a subject's hair density, texture and length, and sometimes amounts to several hours.

Lice egg cases ("nits") are thought to be attached to hair by means of mucopolysaccharide adhesive substances. Removal of the nits therefore requires a very thorough combing operation, and is not appreciably facilitated by many of the usual pesticide treatments. However, one embodiment of the present invention provides both moisture and heat which tend to degrade the adhesive and facilitate nit removal by combing, as well as probably providing the effects of desiccation and an increased pH in the microenvironment of the nit, both of which are thought to alter the physical and chemical nature of the egg casing itself. Certain compositions of the invention can also cause swelling of the nits, rendering the combing more effective. Including lubricious agents in a composition also can facilitate lice and nit removal by combing.

The presence of a desiccating microenvironment about the live lice can cause rapid mortality, as evidenced by physiologic changes in the organisms under microscopic observation. These changes include collapsing of the abdomen. Another property of the self-heating compositions of the present invention which is postulated to affect lice mobility and mortality is an elevation of the microenvironmental pH. The active ingredients for heat generation should create high pH regions on their surfaces, during the hydration reaction; it is likely that ectoparasites do not readily tolerate such conditions and are adversely impacted by the high pH. Of course, it is not possible to measure the actual pH conditions at the particle surface, but this surface pH value is likely to be quite different from the bulk pH of the composition.

Lice tenaciously attach to hair shafts and are adept at grasping hair to facilitate their movement to different areas of the host. The present invention can cause rapid physical and chemical changes, including changes in temperature, desiccation and microenvironmental pH, and lice are typically caused to detach from hair shafts promptly upon exposure to the treatment. Since the pests are no longer attached, removal is greatly simplified.

The inventors presently prefer to generate elevated temperatures on hair-covered body surfaces, using compositions that contain substances undergoing hydration reactions in an exothermic manner. Such compositions have an advantage, in that they can be formulated to generate heat, then remain in place while the mechanical removal of immobilized and killed parasites, and their eggs, is effected. Another important advantage of the invention is an ability to rapidly establish adverse conditions for ectoparasite viability over substantially an entire infested area, so that pests cannot simply migrate to an untreated area and thereby avoid the effects of treatment.

Suitable self-heating compositions for use in the invention generally are non-aqueous in nature, or have only a very small water content, and contain as their active ingredient a substantially anhydrous inorganic component such as a silica, an aluminosilicate, an alkaline earth metal oxide or a combination of such components, which exhibits an exothermic reaction upon contact with water. To maximize heat evolution when the active ingredient contacts water, and to facilitate combing of hair with the composition in place, it is preferred to use particles of the active ingredients having average sizes in the range of about 3 μm to about 6 μm. However, particles having larger or smaller sizes will function adequately in the invention.

Particulate inorganic substances which are useful in the compositions of the invention include materials such as fumed silica, aluminosilicates, aluminum oxide, magnesium oxide and calcium oxide. Typically, the inorganic particulate will be present in a composition in amounts about 1 percent to about 65 percent. The use of aluminosilicates in amounts about 30 percent to about 60 percent is presently preferred, including materials commonly known as "zeolites."

Zeolites suitable for use in the invention include both the naturally occurring materials and the synthetically produced materials. Zeolites have typically been used as ion-exchange agents, adsorbents for gaseous and liquid chemical substances and as supports for catalysts, such as the catalysts used in petroleum refining. For use in the present invention, the zeolites are "activated" by removal of their crystalline water content; this is accomplished by heating to relatively high temperatures until the desired water content is obtained, the temperature and duration of heating necessarily being individually determined for each type of zeolite. Presently commercially available activated zeolites that are useful in the invention include, without limitation: MOLSIV™ products sold by UOP LLC of Des Plaines, Illinois USA and identified as Type 3A

(sodium-potassium aluminosilicate), Type 4A (sodium aluminosilicate) and Type 5A (calcium aluminosilicate). Products being sold by W. R. Grace & Co. of Columbia, Maryland U.S.A. under the trademark SYLOSIV are other examples of useful zeolites. Some of the zeolites are aluminosilicates of mixed alkali metals and/or alkaline earth metals, and these are well-suited for use in the present invention.

Suitable compositions can be in the forms of a lotion, cream or fluid pressurized aerosol. The only essential component is the particulate active ingredient, but other components, such as surfactants and lubricious agents, may desirably be added to facilitate combing such as when the composition is applied to moistened hair and to impart desirable properties to the composition.

To prepare a preferred fluid form of a self-heating ectoparasite removal composition, including a lotion, cream or aerosol form, the heat-generating inorganic particulate may be suspended in a substantially anhydrous vehicle, such as: a light or heavy mineral oil; a glycol such as polyethylene glycol, propylene glycol or triethylene glycol; glycerol; and the like. Typical concentrations of the vehicle range from about 1 percent to about 60 percent. Selection of the vehicle can affect the heat generation reaction, since, for example, a more water-impervious substance such as mineral oil can impede access of water to the particulate solid and thereby slow the rate of temperature increase and/or the maximum temperature obtained.

It is generally desired for the composition to heat to temperatures above about 37°C to maximize efficacy, but to limit the maximum temperature attained by the formulation to no more than about 55°C to avoid discomfort when applied to the body.

Optionally, a suspending agent may be present in the self-heating composition to maintain a more stable dispersion. Useful agents include, without limitation, fumed silica and polyvinylpyrrolidone having molecular weights from about 25,000 to about 100,000, in amounts about 0.1 to about 2 percent.

The compositions may further include other components, such as surfactants, lubricants, texture modifiers, acidifiers, preservatives, fragrances and other cosmetic-type ingredients used to create desired physical properties.

Useful optional surfactants include, without limitation, sodium lauryl sulfate, sorbitan laurate, mixtures of glyceryl stearate and PEG-100 stearate, methyl gluceth-10, methyl gluceth-40, sorbitan palmitate, polysorbate 20, polysorbate 80, steareth-2 and many others. The surfactants will be present in amounts about 0.1 to about 16 percent,

and can create shampoo-type products which are easily removed after the ectoparasite treatment is completed.

The lubricants that can be incorporated are represented by dimethicone, simethicone and other silicone-type materials, and act to lubricate and condition the hair, as well as facilitate passage of a comb through the hair. Useful concentrations, when this component is present, are typically about 0.1 to about 2 percent.

Optional texture modifiers that may be included are exemplified by stearic acid, cetyl alcohol, PEG-180, polyethylene glycol 1450 and polyethylene glycol 3350, in amounts usually about 0.1 percent to about 5 percent.

It may be desired to incorporate an acidic ingredient in the composition, since the heat-generating active ingredients tend to produce alkaline suspensions in water. Optional acidifiers that may be used include, without limitation, benzoic acid, citric acid and stearic acid. It is preferred to use anhydrous acidifiers. The acids will generally be present in amounts about 0.1 percent to about 2 percent, as needed to obtain a desired bulk pH condition when the compositions are used.

Products that are intended for application to the skin frequently are protected against microbial proliferation by the inclusion of a preservative component. Suitable preservatives for use in the present compositions include, without limitation, benzyl alcohol, methylparaben, propylparaben and benzethonium chloride. The preservative will typically be included in concentrations about 0.05 to about 5 percent, depending on the activity of the chosen ingredient. Benzyl alcohol also provides a pleasing scent.

Included within the scope of the present invention is a kit for treating an ectoparasite infestation, including a suitable container filled with a composition that can be applied to an area of the body to reduce or increase the temperature of the area, together with a mechanical device for removing ectoparasites after they are affected by the composition. For compositions that are in the form of a non-aerosol fluid, such as liquids, lotions and creams, the composition can be contained in a bottle or collapsible tube. Pressurized aerosol compositions can be contained in the customary dispensing canisters, such as: metal cans wherein the composition is present together with a propellant; containers in which the product is held in a polymeric bag for isolation from a surrounding propellant; and others; the canisters being fitted with suitable valves for dispensing the product. Many delousing combs are commercially available, being fabricated from plastic substances or metals, and any of these are suitable for inclusion in the kit. It is preferred

but not essential that the kit be made suitable for a single use, including sufficient composition for one application.

The invention will be further described with reference to the following examples, which are not intended to limit the scope of the claimed invention in any manner.

Example 1

Cream and lotion compositions for ectoparasite removal which generate heat upon contact with water are prepared by combining the following components:

No.	Ingredient	Wt. Percent
1	Sodium aluminosilicate	35
	Triethylene glycol	48
	Sodium lauryl sulfate	16
	PEG-180	1
2	Sodium aluminosilicate	65
	PEG-4	17
	Triethylene glycol	18
3	Sodium aluminosilicate	40
	Fumed silica	0.5
	Cetyl alcohol	0.2
	Dimethicone	1
	PEG-400	58.1
	Polyvinylpyrrolidone	0.1
	Stearic acid	0.1
4	Sodium-potassium aluminosilicate	40
	Fumed silica	0.5
	Cetyl alcohol	0.2
	Dimethicone	1

		PEG-400	58.1
		Polyvinylpyrrolidone	0.1
		Stearic acid	0.1
	5	Sodium-potassium aluminosilicate	45
		Heavy mineral oil	12
		Propylene glycol	12
		Glycerin	2
		Polysorbate 80	10
		Glyceryl stearate + PEG-100 stearate *	2
		Sorbitan laurate	10
		Methyl gluceth-20	5
		Dimethicone	2

*Arlacel™ 165, sold by Uniquema, New Castle, Delaware U.S.A.

	6	Sodium-potassium aluminosilicate	40
		PEG-400	25.3
		PEG-600	25.6
		Polyvinylpyrrolidone	0.1
		Dimethicone	1
		Cetyl alcohol	0.3
		Stearic alcohol	0.3
		Polysorbate 20	5
		Fumed silica	0.2
		Benzoic acid	2
		Methylparaben	0.13
		Propylparaben	0.07
	7	Sodium-potassium aluminosilicate	40
		PEG-400	24.2
		PEG-600	25.6
		Polysorbate 20	5

Benzyl alcohol	2
Dimethicone	1
Titanium dioxide	1
Benzoic acid	0.6
Cetyl alcohol	0.3
Stearic acid	0.3

Composition 6 is prepared as follows: (1) the PEG-400 is heated to about 60°C and stirred while the polyvinylpyrollidone is slowly sprinkled onto the liquid surface, then stirring is continued until a solution has been formed; (2) in a separate vessel, the PEG-600, cetyl alcohol and stearic acid are stirred and heated to about 60°C to form a solution; (3) the solution of step 1 is added to the solution of step 2 with thoroughly stirring, while maintaining the temperature about 60°C; (4) the benzoic acid, methylparaben and propylparaben are sequentially added with continued stirring and maintenance of the 60°C temperature condition, each component being completely dissolved before the next is added; (5) with continued stirring and temperature maintenance, the dimethicone, polysorbate 20 and fumed silica are added; and (6) the potassium aluminosilicate is added, heating is discontinued, and stirring is continued to assure a uniform dispersion as the mixture cools to ambient temperature.

Composition 7 is prepared by: (1) homogenizing a portion of the PEG-400 and the titanium dioxide to produce a uniform dispersion, then adding the remaining PEG-400 and thoroughly mixing; (2) heating the PEG-600 to about 65°C and then adding the benzoic acid, cetyl alcohol and stearic acid, with continuous mixing; (3) adding the dispersion of step 1 to the step 2 mixture and mixing to uniformity; (4) adding the polysorbate 20 and mixing; (5) adding the aluminosilicate and mixing until a uniform dispersion is obtained, then allowing the composition to cool to about 50°C with slow stirring; (6) adding the dimethicone and benzyl alcohol, with mixing to obtain uniformity; (7) passing the composition through a colloid mill set to have a gap of about 50 μm; and (8) cooling the composition to ambient temperature.

Example 2

Some compositions of the preceding example are tested to determine the increases in temperature that can be obtained by mixing them with water. A portion of a

composition is placed in a foamed polystyrene cup, the desired amount of water is added and the temperature of the mixture is recorded as a function of time, while the mixture is being stirred. All materials used are initially equilibrated to a room temperature of about 24°C, or are initially at a temperature about 32°C, simulating that of the human scalp. The following results are obtained:

Composition Number	Composition Weight, grams	Water Weight, grams	Time, seconds	Temperature, °C
3	25	1	0	32
			30	55
			60	53
			90	49
			120	47
			150	50
			180	48
4	30	1	0	32
			10	50
			20	55
			30	56
			40	56
			50	54
			60	52
			90	50
			120	53
			180	45
6	25	5	0	24
			15	50
			30	63
			45	65
			60	64

			75	61
			90	60
			105	59
			120	57
			180	52
			240	49
			300	46

Example 3

A pressurized aerosol composition which generates heat upon contact with water is prepared by combining the following components, and sealing the mixture in an aerosol canister equipped with a dispensing valve.

Ingredient	Wt. Percent
Sodium aluminosilicate	47
Propylene glycol	43.2
Emulsifying wax NF *	1.9
Oleth-2	1.9
Methyl gluceth-20	1.9
Isobutane	6

* Polawax A-31 sold by Croda, Inc. of Parsippany, New Jersey U.S.A.

Example 4

Pressurized aerosol compositions for ectoparasite removal, which can produce low temperatures when dispensed, are prepared by combining the listed components. When dispensed through an aerosol valve into a foamed polystyrene cup, the indicated temperatures are observed. The compositions can be applied to ectoparasite-infested areas to immobilize the pests.

No.	Ingredient	Wt. Percent	°C
1	n-Butane	50.63	-12
	Cocoa butter	1.5	
	PEG-1450	0.5	
	Glycerin	12.5	
	Propylene glycol + Glyceryl oleate *	1.5	
	Zinc oxide	1.5	
	White petrolatum	13.37	
	Stearalkonium hectorite **	1	
	Water	17.5	

* Arlacel™ 186 sold by Uniqema, New Castle, Delaware U.S.A.

** Bentone™ 27CG sold by Rheox, Inc., Hightstown, New Jersey U.S.A.

2	Isopentane	35	-8
	Alcohol SD-40-2	12	
	Cetearyl alcohol + Ceteareth-20 *	3	
	Isobutane	35	
	Water	15	

* Promulgen™ D sold by Amerchol Corporation, Edison, New Jersey U.S.A.

3	Dimethyl ether	30.88	0
	Dimethicone, 350 centistokes	1	
	Glycerin	16.5	
	Propylene glycol + Glyceryl oleate *	5	
	Sono Jell™ **	4.5	
	Zinc oxide	2	
	Petrolatum	20	
	Stearalkonium hectorite ***	1	
	Water	19.12	

* Arlacel™ 186 sold by Uniqema, New Castle, Delaware U.S.A.

** Petrolatum, sold by Crompton, Greenwich, Connecticut U.S.A.

*** Bentone™ 27CG sold by Rheox, Inc., Hightstown, New Jersey U.S.A.

Example 5

Composition 6 of preceding Example 1 is tested with human subjects infested with *Pediculus humanus* var *capitis*, to measure its efficacy as an agent for pest removal. In the test, 30 subjects are initially inspected to verify the presence of a head lice infestation and then are treated as follows: the hair is wetted thoroughly with warm water, the composition is applied in amounts of 100 grams (for subjects having hair between about 10 to 20 cm in length) or 200 grams (for subjects having hair lengths between about 20 to 30 cm in length) and massaged throughout the hair for a few minutes, then the composition is allowed to remain on the hair undisturbed for about ten minutes while lice mobility is evaluated. Without removing the composition, the hair is combed, first with a wide-toothed comb to eliminate hair tangling and remove lice and then with a metal-toothed lice comb to remove lice and nits. The combs are wiped and rinsed as needed to eliminate comb tooth clogging by the composition. After the combing procedure, the subjects' hair is washed with a gentle shampoo and dried with a towel, then an inspection is performed to determine if any lice and nits remain on the subject.

After 7 to 10 days, the subjects are again inspected to determine the presence of lice and nits, and then the entire treatment of the preceding paragraph is repeated. At 14 days following the first treatment (the end of the study), the subjects are inspected to detect any remaining lice or nits.

No live lice are visually detected on any subject immediately following either of the two treatments. Lice are partially to fully immobilized on 29 of the subjects (97%) during treatment, with lice falling from the hair of some subjects. During the treatment, lice are seen to cease movement and, under microscopic observation, have collapsed abdomens and an absence of noticeable peristalsis of the gut. Viable nits appear to swell during the treatment; this can facilitate their removal by combing. There are varying numbers of visible nits present on 23 subjects after the first treatment. Before the second treatment, 20 subjects have live lice in their hair, possibly due at least in part to hatching

of residual nits from the first treatment. At the end of the study (14 days following the first treatment), 26 of the subjects (87%) are determined to be completely free of lice and 27 of the subjects (90%) are completely free of viable nits.

Example 6

An *in-vitro* experiment is performed to study the action against head lice of Composition 7, described in preceding Example 1, and to compare that action with a commercially available pesticide lice treatment product, Maximum Strength RID™ Lice Killing Shampoo, sold by Bayer Corporation, Consumer Care Division, of Morristown, New Jersey U.S.A. and containing 4 wt. percent piperonyl butoxide and pyrethrum extract equivalent to 0.33 wt. percent pyrethrins as the active ingredients.

The experiment uses head lice captured from human subjects between the ages of 2 and 65, each of whom have at least five live lice and have not used any lice treatment within the previous fourteen days. After capture the lice are placed together in a petri dish that is stored in an incubator set at 32°C and, within two hours after capture, lice are removed and immersed in test treatments of either: (1) a water control; (2) Composition 7 from Example 1; or (3) the RID™ product.

For the control treatment, a small weighing boat is placed onto a petri dish and 100 µL of water are added to the boat. The harvested lice-containing dish is removed from the incubator and several cut strands of human hair, having lengths about 12.7 mm, are added. After sufficient time for lice to attach to the hair, strands having a total of five attached lice are removed and placed into the water of the weighing boat, then an additional 1 mL of 32°C water is added. After 5 minutes of immersion, the hair strands having lice are removed and examined under a microscope to assess viability of each louse (as indicated by movement, gut motility and an ability to grasp hair strands), then the strands and lice are transferred to a clean petri dish, the dish is placed into the incubator, and the microscopic examination and incubation are repeated at intervals for up to about six or twenty-four hours, or until at least one of the five lice dies.

For the Composition 7 testing, small weighing boats are placed onto petri dishes and 100 µL of water at 32°C are added to the boats. Strands of hair having a total of five attached lice are transferred to the water in each weighing boat, as described in the preceding paragraph. A syringe is used to add 1 mL of the Composition 7 to the weighing

boats, and the composition is mixed with the water by gentle stirring. After a pre-designated time between 10 minutes and six hours, the lice from a boat are removed and examined under a microscope to assess viability of each louse, the lice are rinsed with a gentle stream of 32°C water for one minute, placed into a clean petri dish and the dish is placed into the 32°C incubator. The microscopic observation and incubation are repeated at 30 minute intervals for at least six hours.

The RID™ product is tested by transferring five dry incubated lice to a small weighing boat in a clean petri dish and adding sufficient undiluted RID™ product to cover the lice. After ten minutes, the lice are removed from the weighing boat and are observed under a microscope to assess their viability. The lice are then briefly immersed in and rinsed with 32°C water, and subsequently placed into a clean petri dish which is incubated. Lice are subsequently removed from the incubator and examined for viability at 30-minute intervals, for at least six hours.

The water control exhibits a lice mortality of less than 20 percent after six hours and shows statistical inferiority to the other treatments. With the RID™ product, mortality rates of 30 to 67 percent are observed. For Composition 7, mortality is: 60 percent after ten minutes exposure; more than 80 percent after twenty minutes exposure; between 85 and 100 percent after sixty minutes; and 100 percent after 360 minutes. There is no statistically significant difference in mortality between 60 and 360 minutes, for the Composition 7 treatment.

Mortality of lice treated with Composition 7 for 20, 30 or 60 minutes is statistically higher than the mortality observed at one hour following the RID™ product treatment. The twenty minute treatment with Composition 7 causes higher mortality than is seen for the RID™ treatment at each of 1, 2 and 3 hour observations; the thirty minute treatment with Composition 7 causes higher mortality than is observed for the RID™ treatment at each of the 1, 2, 3 and 4 hour observations; and the sixty minute treatment with Composition 7 causes higher mortality at each observation than is observed for the RID™ treatment at the 1, 2, 3, 4, 5, and 6 hour observations.

Composition 7 immobilizes 99.4 percent of the lice at all of the test times. Lice detach from hair shafts almost immediately upon exposure to Composition 7 and become immobile; only 2.3 percent of the lice remain attached after mixing of the composition and water is complete. From microscopic examination, it is seen that: blood is present in the lice digestive tract, so mortality is not being caused by starvation, many of the lice have

shrunken abdomen, indicating some dehydration, but do not have a shrunken cuticle such as results from dehydration by strong agents such as 70 percent isopropanol; and the gradual decline in lice viability indicates that the lice are being affected in a physical manner, rather than in a toxic manner.

Since exposure to the diluted Composition 7 promptly renders lice unable to grasp a hair shaft, they can be substantially completely removed from the body by a thorough water rinse. However, it probably will be necessary to use a lice comb to remove nits.

From this description of specific embodiments of the invention, it will be appreciated that the present invention is not limited to those precise embodiments and that various changes and modifications can be effected therein by one of ordinary skill in the art, without departing from the scope or spirit of the invention as defined by the appended claims. In addition, certain theories have been proposed to enhance the understanding of the invention, but it is not intended to restrict the invention to any particular theory of operation.

WHAT IS CLAIMED IS:

1. A method for treating an ectoparasite infestation of an area of a human or animal body, comprising applying a fluid composition that establishes a temperature environment in the area to cause ectoparasites to become immobile or killed, and subsequently removing the ectoparasites from the area.

2. The method of claim 1, wherein the ectoparasites comprise *Pediculus humanus* var *capitis*.

3. The method of claim 1, wherein the ectoparasites comprise *Pediculus humanus* var *corporis*.

4. The method of claim 1, wherein the ectoparasites comprise *Pediculus humanus* var *pubis*.

5. The method of claim 1, wherein the ectoparasites comprise fleas, ticks or mites.

6. The method of claim 1, wherein temperatures below about 30°C are established.

7. The method of claim 1, wherein temperatures at least 37°C are established.

8. The method of claim 1, wherein temperatures about 37°C to about 55°C are maintained for sufficient time to kill or immobilize ectoparasites.

9. The method of claim 1, wherein immobilized or killed ectoparasites are removed by combing.

10. A method for treating an ectoparasite infestation of an area of a human or animal body, comprising applying to the area a substantially anhydrous fluid composition containing a particulate water-insoluble inorganic substance which reacts exothermically with water.

11. The method of claim 10, wherein the ectoparasites comprise *Pediculus humanus* var *capitis*.

12. The method of claim 10, wherein the ectoparasites comprise *Pediculus humanus* var *corporis*.

13. The method of claim 10, wherein the ectoparasites comprise *Pediculus humanus* var *pubis*.

14. The method of claim 10, wherein the ectoparasites comprise fleas, ticks or mites.

15. The method of claim 10, wherein the ectoparasites are removed by combing.

16. The method of claim 10, wherein the composition is applied to a previously moistened area.

17. The method of claim 10, wherein an active ingredient in the composition comprises a particulate substantially anhydrous silica, aluminosilicate, alkali metal oxide or a combination of any two or more thereof.

18. The method of claim 10, wherein an active ingredient in the composition comprises a particulate substantially anhydrous aluminosilicate.

19. The method of claim 10, wherein the composition is in the form of a lotion, cream, foam or pressurized aerosol.

20. A substantially anhydrous fluid composition containing a particulate water-insoluble inorganic substance which reacts exothermically with water, the inorganic substance being present in a concentration sufficient to create localized temperatures causing ectoparasites to become immobile or killed, when the composition is applied to a moist area of the body of an animal or human.

21. The composition of claim 20, wherein the inorganic substance comprises a substantially anhydrous silica, aluminosilicate, alkali metal oxide or any combination of two or more thereof.

22. The composition of claim 20, wherein the composition is in the form of a lotion, cream, foam or pressurized aerosol.

23. A kit for treating an ectoparasite infestation of the body, comprising a delousing comb and a container having therein the composition of claim 20.

24. A substantially anhydrous fluid composition for ectoparasite removal, comprising about 30 to about 50 weight percent of a substantially anhydrous silica, aluminosilicate, alkali metal oxide or combination of two or more thereof and about 30 to about 60 weight percent of a light or heavy mineral oil, glycol or glycerol.

25. The composition of claim 24, wherein the aluminosilicate comprises a zeolite.

26. A kit for treating an ectoparasite infestation of the body, comprising a delousing comb and a container having therein the composition of claim 24.

27. Use of a particulate water-insoluble inorganic substance which reacts exothermically with water to prepare a substantially anhydrous fluid composition for treatment of an ectoparasite infestation.

28. The use of claim 27, wherein the inorganic substance comprises a substantially anhydrous silica, aluminosilicate, alkali metal oxide or any combination of two or more thereof.

29. The use of claim 28, wherein the aluminosilicate comprises a zeolite.

30. The use of any of claims 27-29, wherein the composition is in the form of a lotion, cream, foam or pressurized aerosol.