

TITLE**INSECT REPELLENT COMPOSITIONS COMPRISING
DIHYDRONEPETALACTONE, AN ALCOHOL AND AN ESTER**

This application claims the benefit of U.S.
Provisional Application No. 60/624,579, filed on
November 3, 2004, which is incorporated in its entirety
10 as a part hereof for all purposes.

Technical Field

The present invention relates to the field of
15 insect repellency, and the use of dihydronepetalactone
stereoisomers generally as repellent materials.

Background

20 Repellent substances generally cause insects to be
driven away from, or to reject, otherwise insect-
acceptable food sources or habitats. Most known
repellents are only mildly toxic. A few of the known
repellents, in fact, are not active poisons at all but
25 rather prevent damage to plants/animals or articles of
manufacture by making insect food sources or living
conditions unattractive or offensive. Most current
commercial insect repellents contain the synthetic
chemical *N,N*-diethyl-*m*-toluamide (DEET) as their
30 primary active ingredient. For instance, repellents
sold under the major commercial brand names such as
Off!®, Deep Woods Off!®, and Cutter® are all DEET based
products and comprise 85% of insect repellent sales
(Consumer Reports Buying Guide, 1994 Special Year- End
35 Issue). Further, Consumer Reports tests indicated that
products with the highest concentration of DEET lasted
the longest against mosquitoes.

Despite being an effective repellent, however, this compound has certain drawbacks. Specifically, it possesses an unpleasant odor and imparts a greasy feel to the skin. Although it has recently been re-

5 registered for use in the US by the EPA, concerns have been raised as to its safety, particularly when applied to children [Briassoulis, G.; Narlioglou, M.; Hatzis, T. (2001) *Human & Experimental Toxicology* 20(1), 8-14]. Studies have demonstrated that high concentrations of

10 DEET may give rise to allergic or toxic reactions in some individuals. Other disadvantages associated with DEET include that it (1) is a synthetic chemical having a limited spectrum of activity; (2) is a powerful plasticizer and will dissolve or mar many plastics and

15 painted surfaces; and (3) plasticizes the inert ingredients typically used in topical formulations in order to lengthen the time of effectiveness. This leads to DEET formulations with low user acceptability.

20 As a result of the above limitations, DEET-free products with repellent activity are finding favor with consumers, and demand for compositions containing natural products (versus synthetic chemicals such as DEET) is increasing. These DEET-free repellent

25 compounds require a combination of excellent repellency, high residual activity and relatively little or no toxicity to humans (or pets) and the environment. In response to these consumer demands, there is an on-going need to develop new repellent

30 compounds, which can be obtained from, or synthesized from, natural plant materials and which are pleasant to use.

Many plant species produce essential oils

35 (aromatic oils) that are used as natural sources of insect repellent and fragrant chemicals [Hay, R.K.M., Svoboda, K.P., *Botany*, in "Volatile Oil Crops: their biology, chemistry and production"; Hay, R.K.M.,

Waterman, P.G. (eds.); Longman Group UK Limited (1993)]. Citronella oil, known for its general repellence towards insects, is obtained from the graminaceous plants *Cymbopogon winterianus* and *C. nardus*. Examples of plants used as sources of fragrant chemicals include *Melissa officinalis* (Melissa), *Perilla frutescens* (Perilla), *Posostemon cablin* (Patchouli) and various *Lavandula* spp. (Lavender). All of these examples of plants yielding oil of value to the fragrance industry are members of the Labiatae (Lamiaceae) family. Plants of the genus *Nepeta* (catmints) are also members of this family, and produce an essential oil, which is a minor item of commerce. This oil is very rich in a class of monoterpenoid compounds known as iridoids [Inouye, H. *Iridoids. Methods in Plant Biochemistry* 7:99-143 (1991)], more specifically the methylcyclopentanoid nepetalactones [Clark, L.J. et al. *The Plant Journal*, 11:1387-1393 (1997)] and derivatives.

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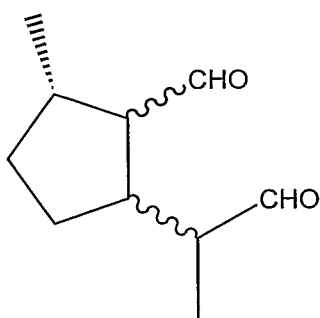
Iridoid monoterpenoids have long been known to be effective repellents to a variety of insect species [Eisner, T. *Science* 146:1318-1320 (1964); Eisner, T. *Science* 148:966-968 (1965); Peterson, C. and J. Coats, *Pesticide Outlook* 12:154-158 (2001); and Peterson, C. et al. *Abstracts of Papers American Chemical Society*, (2001) 222 (1-2): AGRO73]. U.S. Patent 4,663,346 discloses insect repellants with compositions containing bicyclic iridoid lactones (e.g., iridomyrmecin). Further, U.S. Patent 4,869,896 discloses use of these bicyclic iridoid lactone compositions in potentiated insect repellent mixtures with DEET.

Formal studies concerning the repellency of dihydronepetalactones, a class of iridoid monoterpenoids derived from nepetalactones (shown in Figure 1), have been much less conclusive and have

failed to teach or imply that these compounds exert a repellent effect on the common insect pests of human society. For example, a study of the composition of the secretion from anal glands of the ant *Iridomyrmex*
5 *nitidus* showed that isodihydronepetalactone was present in appreciable amounts, together with isoiridomyrmecin [Cavill, G.W.K., and D.V. Clark. *J. Insect Physiol.* 13:131-135 (1967)]. Although isoiridomyrmecin was known at the time to possess good 'knockdown'
10 insecticidal activity, no evidence was provided in support of a similar activity for isodihydronepetalactone, and no investigation of this compound's repellent effect (as distinct from insecticidal activity) was made.

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In a later publication by Cavill, G.W.K., et al. [*Tetrahedron* 38:1931-1938 (1982)], the presence of dihydronepetalactones in the defensive secretion of an ant was again reported, but the authors concluded that
20 the compound iridodial, rather than a dihydronepetalactone, was the basic repellent constituent.



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Iridodial

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Most recently, Jefson, M., et al. [*J. Chemical Ecology* 9:159-180 (1983)] described the repellent effect of dihydronepetalactone. Initial repellency caused by the undiluted compound was measured with respect to the ant species *Monomorium destructor* during feeding. After 25 seconds of exposure to the pure dihydronepetalactone, approximately 50-60% of the ants ceased to feed. However, further analyses of the repellency over a longer time course were not presented, nor were analyses with anything other than the pure undiluted compound. Repellency observed over such short periods of time (seconds) with concentrated chemicals is insufficient to allow prediction of efficacy in practical applications such as in topical insect repellents.

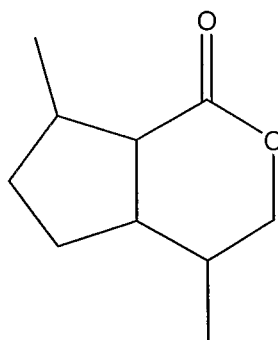
There is consequently a continuing need for a biologically based compound having improved insect repellent properties (with respect to DEET) and which is substantially non-toxic or only mildly toxic to humans. Preferred repellents will have activity against a wide variety of insects, including biting insects, wood-boring insects, noxious insects, household pests, and the like. Applicants have found that dihydronepetalactones, and compositions thereof, perform well as a new class of effective insect repellent compounds without the disadvantageous properties characteristic of prior-art compositions.

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Summary

One embodiment of this invention is an insect repellent composition or article that contains a dihydronepetalactone, or a mixture of dihydronepetalactone stereoisomers, represented by the general formula:

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Another embodiment of this invention is a process for fabricating an insect repellent composition or an insect repellent article of manufacture by providing as the composition or article, or incorporating into the composition or article, a dihydronepetalactone, or a mixture of dihydronepetalactone stereoisomers, as described above.

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Yet another embodiment of this invention is the use of a dihydronepetalactone, or a mixture of dihydronepetalactone stereoisomers, as described above, or a composition thereof, as an insect repellent; and thus an embodiment in which, in a method of repelling insects, the insects are exposed to a dihydronepetalactone, or a mixture of dihydronepetalactone stereoisomers, or a composition thereof, as described above.

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Yet another embodiment of this invention is a formulated insect repellent composition that includes a dihydronepetalactone, or a mixture of dihydronepetalactone stereoisomers, as described above and one or more of a carrier, an adjuvant and an additive.

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Brief Description of the Drawings

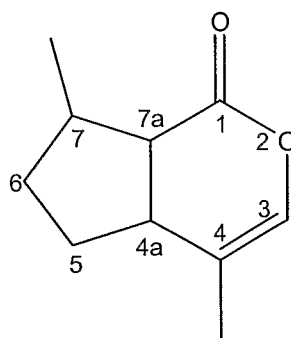
Figure 1 shows the chemical structures of the naturally occurring iridoid (methylcyclopentanoid) nepetalactones.

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Detailed Description

A nepetalactone" is a compound having the general structure:

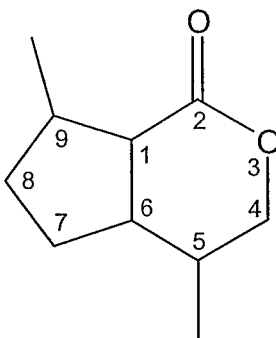
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Four chiral centers are present within the methylcyclopentanoid backbone of nepetalactone at carbons 4, 4a, 7 and 7a as shown above; (7S)-
nepetalactones are produced by several plants and
insects. Dihydronepetalactones are known as minor
constituents of the essential oils of several labiate
plants of the genus *Nepeta* (Regnier, F.E., et al.
(1967) *Phytochemistry* 6:1281-1289; DePooter, H.L., et
al. (1988) *Flavour and Fragrance Journal* 3:155-159;
Handjieva, N.V. and S.S. Popov (1996) *J. Essential Oil
Res.* 8:639-643). Dihydronepetalactones are defined by
Formula 1:

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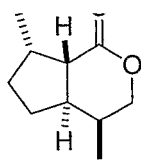
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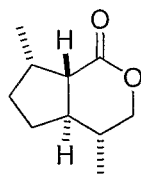
Formula I

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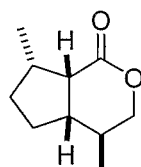
wherein 1, 5, 6 and 9 indicate the four chiral centers of the molecule and the structure encompasses all possible stereoisomers of dihydronepetalactone. The structures of dihydronepetalactone stereoisomers that
10 may be derived from (7*S*)-nepetalactones are shown below.



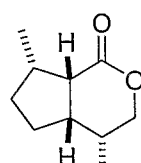
(1S,5S,9S,6R)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



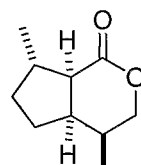
(1S,9S,5R,6R)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



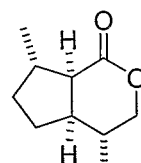
(1S,5S,9S,6S)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



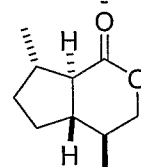
(1S,9S,6S,5R)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



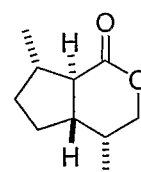
(9S,5S,1R,6R)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



(9S,1R,5R,6R)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



(9S,6S,1R,5S)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one



(9S,6S,1R,5R)-5,9-dimethyl-3-oxabicyclo[4.3.0]nonan-2-one

The term "dihydronepetalactones" or "dihydronepetalactone mixtures" refers to any mixture of dihydronepetalactone stereoisomers. The molar or mass composition of each of these isomers relative to the whole dihydronepetalactone composition can be

variable. Dihydronepetalactones are abbreviated as "DHN".

5 A dihydronepetalactone will be understood to encompass any and all dihydronepetalactone stereoisomers and mixtures thereof, unless a particular isomer or mixture is specified. When dihydronepetalactone is prepared from a naturally occurring source of nepetalactone some variation in
10 molar concentration of stereoisomers is expected. Preparation from a naturally occurring source is, however, a preferred method of preparation.

Dihydronepetalactones are reported in the
15 literature as minor constituents of the essential oils of several labiate plants of the genus *Nepeta* [Regnier, F.E., et al., *Phytochemistry* 6:1281-1289 (1967); DePooter, H.L., et al., *Flavour and Fragrance Journal* 3:155-159 (1988); Handjieva, N.V. and S.S. Popov, *J. Essential Oil Res.* 8:639-643 (1996)]. Additionally,
20 dihydronepetalactones have been identified as constituents of the defensive secretions of certain insects, including rove beetles [Jefson, M., et al., *J. Chem. Ecol.* 9:159-180 (1983)] and ants, specifically
25 *Iridomyrmex* species [Cavill, G.W.K. and D.V. Clark. *J. Insect Physiol.* 13:131-135 (1967)]. In those species that possess dihydronepetalactones, it has been proposed that they are biosynthetically derived from the iridoid monoterpene iridodial.

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The chemical synthesis of dihydronepetalactones and their related iridoid monoterpenoid compounds has been described and found to be conducted in a variety of ways. The following are useful references relating
35 to synthesis:

- 1) Abelman, M.M. et al. *J. Am. Chem. Soc.* 104(14):4030-2 (1982)

- 2) Fleming, I. and N.K. Terrett. *Tetrahedron Lett.* 25(44): 5103-5104 (1984); *J. Chem. Soc., Perkin Trans.* 1:2645-2650 (1998).
- 3) Lee, E. and C.H. Yoon. *J. Chem. Soc., Chem. Commun.* 4: 479-81 (1994).
- 4) Nagata, H. and K. Ogasawara. *Tetrahedron Lett.* 40(36): 6617-6620 (1999).
- 5) Nangia, A. et al. *Tetrahedron Lett.* 35(22): 3755-8 (1994).
- 6) Tanimori, S. and M. Nakayama. *Agric. Biol. Chem.* 55(4): 1181-1184 (1991).
- 7) Uyehara, T. et al. *J. Chem. Soc., Chem. Commun.* 2:113-14 (1989); *Tennen Yuki Kagobutsu Toronkai Koen Yoshishu* 32: 441-6 (1990); *J. Org. Chem.* 57(11): 3139-3145 (1992).
- 8) Wolinsky, J. and E.J. Eustace. *J. Org. Chem.* 37(21): 3376-8 (1972).
- 9) Wolinsky, J. and D.L. Nelson. *Tetrahedron* 25(17): 3767-74 (1969).

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Regnier et al, op.cit., discloses the preparation of DHN from nepetalactone by the catalyzed hydrogenation of nepetalactone isolated from the essential oils of plants of the genus *Nepeta* (catmints). One preferred and convenient method for synthesis of dihydronepetalactone is thus by hydrogenation of nepetalactone obtained in relatively pure form from the essential oils isolated by various means from plants of the genus *Nepeta* (catmints).

Catalysts such as platinum oxide and palladium supported on strontium carbonate give dihydronepalactone in 24-90% yields (Regnier et al. op.cit.).

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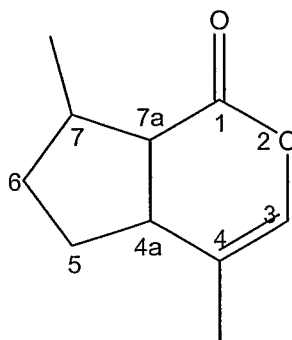
The preferred process for producing the dihydronepetalactones represented by Formula I in the present invention, therefore, is by hydrogenation of nepetalactones from plants with oils of defined

nepetalactone stereoisomer content, an industrially advantageous approach in terms of production cost and its biological basis. Other processes are as disclosed in U.S. 03/225,290 (WO 03/84946), which is incorporated in its entirety as a part hereof for all purposes.

Methods for isolation or extraction of essential oils include without limitation steam distillation, organic solvent extraction, microwave-assisted organic solvent extraction, supercritical fluid extraction, mechanical extraction and enfleurage (initial cold extraction into fats followed by organic solvent extraction).

The essential oils isolated from different *Nepeta* species are well known to possess different proportions of each naturally occurring stereoisomer of nepetalactone (Regnier et al. op. cit.; DePooter, et al. op.cit.; Handjieva et al op.cit.). Thus DHN prepared from oil derived from any *Nepeta* species will necessarily be a mixture of stereoisomers thereof, the constitution of that mixture depending upon the particular species of *Nepeta* from which it is derived.

As discussed herein above, four chiral centers are present within the methylcyclopentanoid backbone of the nepetalactone at carbons 4, 4a, 7 and 7a as shown:



A total of eight pairs of dihydronepetalactone enantiomers are possible after hydrogenation of nepetalactone. Of these, the naturally occurring stereoisomers described thus far are (9*S*)-
5 dihydronepetalactones. Preferred repellent materials in accordance with the present invention include a mixture of any or all of the possible stereoisomers of dihydronepetalactone. More preferred repellent materials include a mixture of (9*S*)-
10 dihydronepetalactones. Most preferred are (9*S*)- dihydronepetalactone stereoisomers derived from (7*S*)- nepetalactones. This includes the compounds commonly known as *cis,trans*-nepetalactone, *cis,cis*- nepetalactone, *trans,cis*-nepetalactone, and
15 *trans,trans*-nepetalactone, as illustrated in Figure 1. The predominant stereoisomers produced by *N. cataria* (*cis,trans* and *trans,cis*-) are preferred.

Upon completion of the hydrogenation reaction, the
20 resulting mixture of isomer products may be separated by any conventional method (e.g., preparative liquid chromatography) to yield each highly purified pair of dihydronepetalactone diastereomers. This permits the use of various different diastereomers as are found to
25 be most effective against particular insects. It is preferable to isolate a specific nepetalactone isomer from a plant to convert to its corresponding pair of diastereomers by hydrogenation.

30 In addition to variation in nepetalactone stereoisomer content between different *Nepeta* species, intra-species variation is also known to exist. Plants of a given species may produce oils with different compositions depending on the conditions of their
35 growth or growth stage at harvest. In fact variation in oil composition independent of growth conditions or growth stage at harvest has been found in *Nepeta racemosa*, (Clark, L.J., et al. *op.cit.*). Plants of a

single species exhibiting different oil compositions are termed chemotypes. In *Nepeta racemosa*, chemotypes exhibiting marked differences in the proportion of different nepetalactone stereoisomers exist. Thus, the preferred process for producing specific dihydronepetalactone enantiomers is hydrogenation of an oil from a *Nepeta* chemotype known to contain specific nepetalactone stereoisomers.

Insects include any member of a large group of invertebrate animals characterized, in the adult state (non-adult insect states include larva and pupa) by division of the body into head, thorax, and abdomen, three pairs of legs, and, often (but not always) two pairs of membranous wings. This definition therefore includes a variety of biting insects (e.g., ants, bees, black flies, chiggers, fleas, green head flies, mosquitoes, stable flies, ticks, wasps), wood-boring insects (e.g., termites), noxious insects (e.g., houseflies, cockroaches, lice, roaches, wood lice), and household pests (e.g., flour and bean beetles, dust mites, moths, silverfish, weevils).

A host is any plant or animal affected by insects. Typically, hosts are considered to be insect-acceptable food sources or insect-acceptable habitats. An insect susceptible article is any item of commerce created by man, which is affected by insects. This may include buildings, furniture, and the like. Typically, these articles of manufacture are considered to be insect-acceptable food sources or insect-acceptable habitats.

The terms "insect repellent", "insect repellent composition" or "repellent composition" will refer to a compound or composition that deters insects from their preferred hosts or insect-suitable articles of manufacture. Most known repellents are not active poisons at all, but rather prevent damage to

plants/animals or articles of manufacture by making insect food sources or living conditions unattractive or offensive. Typically, an insect repellent is a compound or composition that can be either topically
5 applied to the host, or is a compound or composition that may be incorporated into an insect susceptible article to produce an insect repellent article that deters insects from the nearby 3- dimensional space in which the host or article exists. In either case, the
10 effect of the insect repellent is to drive the insects away from or to reject (1) the host, thereby minimizing the frequency of insect "bites" to the host; and/or (2) the insect susceptible article, thereby protecting the article from insect damage. Repellents may be in
15 the form of gases (olfactory), liquids, or solids (gustatory).

Some examples of well-known insect repellents include: benzil; benzyl benzoate; 2,3,4,5-bis(butyl-2-
20 ene) tetrahydrofurfural (MGK Repellent 11); butoxypolypropylene glycol; N-butylacetanilide; normal-butyl-6,6-dimethyl-5,6-dihydro-1,4-pyrone-2-carboxylate (Indalone); dibutyl adipate; dibutyl phthalate; di-normal-butyl succinate (Tabatrex); N,N-diethyl-meta-
25 toluamide (DEET); dimethyl carbate (*endo,endo*)-dimethyl bicyclo[2.2.1]hept-5-ene-2,3-dicarboxylate); dimethyl phthalate; 2-ethyl-2-butyl-1,3-propanediol; 2-ethyl-1,3-hexanediol (Rutgers 612); di-normal-propyl isocinchomeronate (MGK Repellent 326); 2-
30 phenylcyclohexanol; p-methane-3,8-diol, and normal-propyl N, N- diethylsuccinamate. Standard repellents for mosquitoes, ticks, and the like are citronella oil (discussed below), dimethyl phthalate, normal-butylmesityl oxide oxalate and 2-ethyl hexanediol-1,3
35 (See, Kirk-Othmer Encyclopedia of Chemical Technology, 2nd Ed., Vol. 11: 724-728; and The Condensed Chemical Dictionary, 8th Ed., p 756).

An insect repellent is any compound or composition that deters insects from a host. It will be appreciated that such usage makes no distinction among compounds that have highly ephemeral effects as
5 compared to those that exhibit long-term beneficial effects, and/or those that require very high surface concentrations before there is an observable effect on insect behavior.

10 The term "insect repellent" thus indicates a compound or composition conferring on a host protection from insects when compared to no treatment at all. Protection desirably results in a statistically significant reduction in numbers of insects, and may,
15 for example, be usefully determined by measuring mean complete protection time ("CPT") in tests in which insect behavior toward treated animals, including humans, and treated inanimate surfaces is observed. Mean CPT refers to the mean length of time over
20 repetitions of tests in which the time before the first landing, probing or biting (in the case of a biting insect) or crawling (in the case of a crawling insect such as a tick or chigger) on a treated surface is observed [see e.g. US EPA Office of Prevention,
25 Pesticides and Toxic Substances product performance test guidelines OPPTS 810.3700; and Fradin, M.S., Day, J.F. (2002) New England Journal of Medicine 347, 13-18]. In one exemplary embodiment of this invention, the insect repellent composition hereof has a mean CPT
30 that is statistically indistinguishable from that of DEET. In the test in which this condition of the respective mean CPT performances of a DHN composition and DEET are shown to be statistically

indistinguishable, the test conditions (including amounts of active ingredients) utilized must of course be identical, or, if not identical, must differ only in ways that do not prevent utilization of the results for the purposes of documenting the existence of the condition described.

As noted above, DHN compares favorably in performance with DEET. Moreover, DHN is advantageously prepared from naturally occurring nepetalactone derived from plants whereas DEET, and many other insect repellents, are not prepared from natural sources - an important consumer consideration when choosing an effective repellent. Preparation from natural sources also offers the potential for low production costs.

A useful property of DHN is that it provides a considerable improvement over the odor of DEET while exhibiting effective insect repellency. The DHN compounds and compositions of this invention possess a pleasant fragrance. The fragrance notes of the DHN materials make them useful in imparting, altering, augmenting or enhancing the overall olfactory component of an insect repellent composition or article, for example, by utilizing or moderating the olfactory reaction contributed by one or more other ingredients in the composition. Specifically, the DHN compositions of the invention may be utilized to either mask or modify the odor contributed by other ingredients in the formulation of the final repellent composition or article, and/or to enhance consumer appeal of a product by imparting a characteristic perfume or aroma.

In addition to the chemical compounds and compositions as described above, a variety of effective insect repellents contain essential oils and/or active ingredients of essential oils. "Essential oils" are defined as any class of volatile oils obtained from plants possessing the odor and other characteristic properties of the plant. Examples of repellent compounds that are essential oils include: almond bitter oil, anise oil, basil oil, bay oil, caraway oil, cardamom oil, cedar oil, celery oil, chamomile oil, cinnamon oil, citronella oil, clove oil, coriander oil, cumin oil, dill oil, eucalyptus oil, fennel oil, ginger oil, grapefruit oil, lemon oil, lime oil, mint oil, parsley oil, peppermint oil, pepper oil, rose oil, spearmint oil (menthol), sweet orange oil, thyme oil, turmeric oil, and oil of wintergreen. Examples of active ingredients in essential oils are: citronellal, methyl salicylate, ethyl salicylate, propyl salicylate, citronellol, safrole, and limonene.

20

In contrast to an insect repellent, an insecticide is a compound or mixture that is capable of poisoning an insect via its oral ingestion, by contact with the insect cuticle, or by fumigant action through the air. Thus, an insecticide is a type of pesticide designed to control insect life that is harmful to man (i.e., directly harmful as disease vectors, or indirectly harmful by destruction of crops, food products, or textile fabrics). Several well-known insecticides include: inorganic compounds (such as arsenic, lead and copper); naturally occurring organic compounds (such as rotenone, pyrethrins, nicotine, copper naphthenate and petroleum derivatives); and synthetic organic compounds (such as DDT, dieldrin, endrin, chlordane, lindane, para-dichlorobenzene and parathion).

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A potentiated insect repellent composition is a repellent composition that produces a result

substantially in excess of that which reasonably could be expected or predicted from the known effect of the components either alone or additively. In the present invention, a potentiated insect repellent composition will typically include dihydronepetalactones or a mixture thereof, and at least one other insect repellent compound that is not itself dihydronepetalactone (sometimes referred to as a non-dihydronepetalactone insect repellent compound).

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An insect repellent composition can be used as a component of an insect repellent article, wherein an insect repellent article is an article of manufacture possessing insect repellency that is enhanced, altered, or augmented by the presence thereon or therein of an insect repellent composition. As used herein with respect to insect repellency, the terms "alter" and "modify" in their various forms refer to a means of supplying or imparting insect repellency to a composition, or augmenting the existing insect repellency characteristics where natural repellency is deficient in some regard, or supplementing the existing insect repellency to modify its quality, or character. The term "enhance" is intended to mean the intensification (without effecting a change in kind or quality of repellency) of one or more repellency properties in an insect repellent composition or insect repellent article.

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The dihydronepetalactones of the present invention possess unique properties of insect repellency and are particularly effective against a wide spectra of common insect pests, including biting insects, wood-boring insects, noxious insects, and household-pests, and other insects that interfere with human society. These insects include a variety of biting insects (e.g., ants, bees, black flies, chiggers, fleas, green head flies, mosquitoes, stable flies, ticks, wasps, horn

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flies), wood-boring insects (e.g., termites), noxious insects (e.g., houseflies, cockroaches, lice, roaches, wood lice), and household pests (e.g., flour and bean beetles, dust mites, moths, silverfish, weevils). In the case of mosquitoes, which convey pathogenic microbes, these repellent properties are additionally effective for preventing infection with such diseases.

One property that is important to overall insect repellency is surface activity, as most (if not all) repellents contain both polar and non-polar regions in their structure. A second property is volatility. Insect repellents form an unusual class of compounds where evaporation of the active ingredient from the host's skin surface or from the insect repellent article is necessary for effectiveness, as measured by the host's protection from insect bites or the article's protection from insect damage. In the case of a topical insect repellent, a certain minimum concentration of repellent is needed in the air space directly above the skin surface of the host in order to repel insects, and this concentration is a measure of the potency of the repellent. However, evaporation rate is also affected by the rate of skin absorption-- in most cases, penetration into and through the skin is an undesirable mode of loss of compound from the skin surface. Similar considerations must be made for insect repellent articles, concerning the minimum concentration of repellent required in the three-dimensional air space surrounding the article itself.

A variety of strategies are available to researchers attempting to balance these properties of evaporation (and, optionally, penetration). First, it is possible to find a single active ingredient having the right balance of physical properties. Alternatively, the active ingredient could be formulated with polymers and inert ingredients added to

the active ingredient for the purpose of modifying the persistence of the active ingredient on the host's skin surface or within the insect repellent article.

However, adding inert ingredients to the active
5 ingredient limits the number of molecules of active ingredient on the surface of the repellent film or article. Since a molecule must be on the surface in order to evaporate, the evaporation rate is lowered. This carries with it the negative consequence of
10 diluting the concentration of active ingredient that can be applied to the host's skin surface or that is present on the surface of an insect repellent article. This, in turn, reduces the overall potency of a formulation containing inert ingredients. In a third
15 alternative, the active ingredient can be contained in microcapsules to control rates of loss from the host's skin surface or insect repellent article. Finally, another technique of limiting the evaporation rate of active ingredient is to synthesize a precursor
20 molecule, which slowly disintegrates on the skin surface or insect repellent article to release the active ingredient.

For example, release of the active ingredient may
25 be, for example, by sub-micron encapsulation, in which the active ingredient is encapsulated (surrounded) within a skin nourishing protein just the way air is captured within a balloon. The protein may be used at, for example, a 20% concentration. An application of
30 repellent contains many of these protein capsules that are suspended in either a water-based lotion, or water for spray application. After contact with skin the protein capsules begin to breakdown releasing the encapsulated dihydronepetalactone. The process
35 continues as each microscopic capsule is depleted then replaced in succession by a new capsule that contacts the skin and releases its active ingredient. The process may take up to 24 hours for one application.

Because protein's adherence to the skin is so effective, these formulas are very resistant to perspiration (sweat-off), and water. When applied they are dry and comfortable with no greasiness. This
5 system results in very effective protection, but it is only effective when used on skin because clothing does not have the capability to release the proteins. An alternative system uses a polymer to encase the repellent, which slows down early evaporation leaving
10 more dihydronepetalactone available for later evaporation. This system can often increase a repellent's length of effectiveness by 25% to 50% over comparable non-entrapped products, but often feels greasy because of the presence of the polymer. In
15 another alternative, a synergist is used to keep stimulating the evaporation of the dihydronepetalactone in the composition.

Regardless of the particular strategy applied to
20 control volatility of an insect repellent, each repellent must have a minimum effective evaporation rate (MEER) from the skin surface or insect repellent article to maintain the necessary minimum concentration of repellent in the air space directly above the skin
25 surface/article for effective insect repellency. An evaporation rate greater than the minimum effective evaporation rate (MEER) results in a significant and undesirable mode of loss. The issue is further complicated, however, since the MEER will change as a
30 function of conditions in the field. Both the avidity or biting tendency of an insect and the concentration of insects in the host's environment must be considered. For example, as the avidity of mosquitoes increases, a higher MEER will be required. In an
35 environment having a low concentration of mosquitoes where those mosquitoes are not hungry, the MEER could be as low as 2, or more commonly, 5 or 6. In contrast, in an environment having a high concentration of hungry

mosquitoes, the MEER might be as high as 12-15.
Preferred in the present invention are insect
compositions wherein the skin surface evaporation rate
is at least equal to a minimum effective evaporation
5 rate over a period of time where a preferred period of
time is about 5 hours.

The effectiveness of DHN or any insect repellent
depends upon the surface concentration of the active
10 ingredient on the host surface to which it is applied.
Many compounds known in the art to exhibit insect
repellency do so, however, only in relatively
concentrated form. See, for example, McGovern et al in
U.S. 4,416, 881, which discloses the use of repellent
15 concentrations of 6.25-25%. In other situations
representative of the art, it is often found that
concentrations of DEET much below 1% require repeated
application to achieve an effective surface
concentration, yet concentrations above 30% result in
20 excessive surface concentration, which is both wasteful
and conducive to the production of undesirable side
effects. A further advantage of this invention is
consequently that DHN not only provides effective
insect repellency at concentrations similar to those
25 employed for DEET, DHN may be employed at
concentrations up to and including neat DHN (i.e. the
composition hereof may, if desired, contain 100% by
weight DHN). The property of effective repellency in
DHN provides many options for economical utilization of
30 the DHN active ingredient over a wide range of levels
of concentration.

In one embodiment of this invention, DHN is
incorporated in effective amounts into a composition
35 suitable for application to a host plant or animal,
preferably to human skin. Suitable compositions
include DHN and a vehicle or a carrier, preferably an
alcohol such as iso-propyl alcohol, a lotion such as

one of the numerous skin creams known in the art, or a silicaceous clay. Preferably the DHN is present in the insect repellent composition of the invention at a concentration of about 0.1% to 30% by weight, preferably about 0.5% to 20% by weight, and most preferably about 1% to 15% by weight.

In this invention, a variety of carriers or diluents for the above-disclosed dihydronepetalactones can be used. The carrier allows the formulation to be adjusted to an effective concentration of repellent molecules. When formulating a topical insect repellent, preferably, the repellent molecules are mixed in a dermatologically acceptable carrier. The carrier may further provide water repellency, prevent skin irritation, and/or soothe and condition skin. Factors to consider when selecting a carrier(s) for any formulation of insect repellent include commercial availability, cost, repellency, evaporation rate, odor, and stability. Some carriers can themselves have repellent properties.

For the present invention, the specific choice of a carrier, if any, to be utilized in achieving the desired intimate admixture with the final product can be any carrier conventionally used in insect repellent formulations. The carrier, moreover, should preferably also be one that will not be harmful to the environment. Accordingly, the carrier can be any one of a variety of commercially available organic and inorganic liquid, solid, or semi-solid carriers or carrier formulations usable in formulating insect repellent products. For example the carrier may include silicone, petrolatum, lanolin or many of several other well-known carrier components.

Examples of organic liquid carriers include liquid aliphatic hydrocarbons (e.g., pentane, hexane, heptane,

nonane, decane and their analogs) and liquid aromatic hydrocarbons. Examples of other liquid hydrocarbons include oils produced by the distillation of coal and the distillation of various types and grades of
5 petrochemical stocks, including kerosene oils, which are obtained by fractional distillation of petroleum. Other petroleum oils include those generally referred to as agricultural spray oils (e.g., the so-called light and medium spray oils, consisting of middle
10 fractions in the distillation of petroleum and which are only slightly volatile). Such oils are usually highly refined and may contain only minute amounts of unsaturated compounds. Such oils, moreover, are generally paraffin oils and accordingly can be
15 emulsified with water and an emulsifier, diluted to lower concentrations, and used as sprays. Tall oils, obtained from sulfate digestion of wood pulp, like the paraffin oils, can similarly be used. Other organic liquid carriers can include liquid terpene hydrocarbons
20 and terpene alcohols such as alpha-pinene, dipentene, terpineol, and the like.

Other carriers include silicone, petrolatum, lanolin, liquid hydrocarbons, agricultural spray oils,
25 paraffin oil, tall oils, liquid terpene hydrocarbons and terpene alcohols, aliphatic and aromatic alcohols, esters, aldehydes, ketones, mineral oil, higher alcohols, finely divided organic and inorganic solid materials.

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Still other liquid carriers can include organic solvents such as aliphatic and aromatic alcohols, esters, aldehydes, and ketones. Aliphatic monohydric alcohols include methyl, ethyl, normal-propyl,
35 isopropyl, normal-butyl, sec-butyl, and tert-butyl alcohols. Suitable alcohols include glycols (such as ethylene and propylene glycol) and pinacols. Suitable polyhydroxy alcohols include glycerol, arabitol,

erythritol, sorbitol, and the like. Finally, suitable cyclic alcohols include cyclopentyl and cyclohexyl alcohols.

5 Conventional aromatic and aliphatic esters, aldehydes and ketones can be used as carriers, and occasionally are used in combination with the above-mentioned alcohols. Still other liquid carriers include relatively high-boiling petroleum products such
10 as mineral oil and higher alcohols (such as cetyl alcohol). Additionally, conventional or so-called "stabilizers" (e.g., tert-butyl sulfinyl dimethyl dithiocarbonate) can be used in conjunction with, or as a component of, the carrier or carriers comprising the
15 compositions of this invention.

 Solid carriers, which can be used in the compositions of the present invention include finely divided organic and inorganic solid materials.
20 Suitable finely divided solid inorganic carriers include siliceous minerals such as synthetic and natural clay, bentonite, attapulgite, fuller's earth, diatomaceous earth, kaolin, mica, talc, finely divided quartz, and the like, as well as synthetically prepared
25 siliceous materials, such as silica aerogels and precipitated and fume silicas. Examples of finely divided solid organic materials include cellulose, sawdust, synthetic organic polymers, and the like. Examples of semi-solid or colloidal carriers include
30 waxy solids, gels (such as petroleum jelly), lanolin, and the like, and mixtures of well-known liquid and solid substances which can provide semi-solid carrier products, for providing effective repellency within the scope of the instant invention.

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 Other carriers suitable for use in a composition of this invention, in addition to water, include one or more of the following:

- Acetone
- C10~C18 Triglycerides
- C12~C18 Acid Triglycerides
- Dipropyl, Dibutyl, Diisocetyl, Diisopropyl or
- 5 Dimethyl Oxalate
- Cyclo(ethoxy)methicone
- Amyl, Methyl, Butyl, Ethyl, Ethoxyethanol, Ethoxydiglycol or Tetrahydrofurfuryl Acetate
- Ethoxydiglycol
- 10 •Kerosene
- Ethoxyethanol
- Diacetin
- Benzyl, Diacetone, Denatured ethyl, Tetrahydrofurfuryl or Oleyl Alcohol
- 15 •Benzyl Benzoate or Laurate
- Ethylene Carbonate
- Ethyl Hexanediol
- Oil of Bertholletia Excelsa Nut, Carthamus Tinctorius, Helianthus Annuus, Ricinus Communis,
- 20 Aleurites Moluccana, Linum Usitatissimum, Cocos Nucifera, Zea Mays, Pinus Palustris, Sesamum Indicum, Glycine Soja, Helianthus Annuus, Prunus Amygdalus Dulcis, Olea Europaea, Elaeis Guineensis, Prunus Persica Kernel, Cucurbita Pepo, Brassica Campestris,
- 25 Oryza Sativa, Oryza Saliva, Carthamus Tinctorius, Juglans Regia or Triicum Vulgare
- Dibutyl Phthalate or Sebacate
- Furfural
- Butoxy-diglycol, -propanol or -ethanol
- 30 •Diethoxyethyl Succinate
- Diethyl Oxalate, Phthalate, Sebacate or Succinate
- n- or t-Butyl, Hexyl or Isopropyl Alcohol
- Glycofurol
- Gycol
- 35 •Butylene, Hexylene, Diethylene, Dipropylene, Pentylene, Propylene or Triethylene Glycol
- C6~C20 linear, branched or cyclic alkane, alkanol or alkane polyol

- Butyloctanol
- Dihexyl, Diisobutyl, Diisodecyl, Ditridecyl, Dibutyl, Diisocetyl, Diisopropyl, Dipropyl or Diisoponyl Adipate
- 5 •Butyrolactone
- 1,2,6-Hexanediol
- Caprylic, Capric, Lauric or Stearic Triglyceride
- Isoamyl, Isobutyl, Isopropyl or Propyl Acetate
- Isobutoxypropanol
- 10 •Diisopropyl Sebacate
- Dimethoxydiglycol
- Isobutyl, Methyl or Stearyl Benzoate
- Isopropyl Laurate, Myristate, Palmitate or Stearate
- Octyl, Lauryl, Myristyl, Palmitoyl or Stearyl Benzoate
- 15 •Dimethyl Phthalate, Glutarate, Maleate, Adipate or Succinate
- Dimethyl Sulfone
- Dimethyl Ether
- Dimethyl Isosorbide
- 20 •Dioctyl Sebacate, Adipate, Phthalate or Succinate
- Methylethylketone
- 3-Methoxybutanol
- Dipentene
- Methoxydiglycol
- 25 •Diphenyl Methane
- Methoxy-ethanol, -isopropanol or -methylbutanol
- C4~C400 polyethylene, polypropylene, polyethylene/ether or polypropylene/ether glycol
- Perfluorodecalin
- 30 •Methylal
- Perfluorotetralin
- Pheroxyisopropanol
- Phenylpropanol
- Methyl Hexyl Ether
- 35 •Methylpropanediol
- Methyl Pyrrolidone
- Methyl Butyl Ketone
- Thiolanediol

- Toluene
- Propanediol
- Triacetin
- Tributyl Citrate
- 5 •Tributylcresylbutane
- Propylene Carbonate
- Tricaprin
- Tricaprylin
- Trichloroethane
- 10 •Triheptanoin
- Trihydroxystearin
- Triisononanoin
- Triisostearin
- Trilaurin
- 15 •Trilinolein
- Trilinolenin
- Trimethylhexanol
- Trimyristin
- Trioctanoin
- 20 •Triolein
- Tripalmitin
- Trisebacin
- Tristearin
- Triundecanoin
- 25 •Xytene

In addition to the above-mentioned materials, such as the liquid hydrocarbons, the carrier can contain conventional emulsifying agents which can be used for causing the dihydronepetalactone compounds to be dispersed in, and diluted with, water for end-use application.

Insect repellent compositions of the present invention containing the dihydronepetalactones may also contain adjuvants known in the art of personal care product formulations, such as thickeners, buffering agents, chelating agents, preservatives, fragrances,

antioxidants, gelling agents, stabilizers, surfactants, emollients, coloring agents, aloe vera, waxes, other penetration enhancers and mixtures thereof, and therapeutically or cosmetically active agents.

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Additionally, the compositions of the present invention may also contain other adjuvants such as one or more therapeutically or cosmetically active ingredients. Exemplary therapeutic or cosmetically active ingredients useful in the compositions of the invention include fungicides, sunscreens, sunblocking agents, vitamins, tanning agents, plant extracts, anti-inflammatory agents, anti-oxidants, radical scavenging agents, retinoids, alpha-hydroxy acids, emollients, antiseptics, antibiotics, antibacterial agents or antihistamines, and may be present in an amount effective for achieving the therapeutic or cosmetic result desired.

Additionally, the compositions of this invention may contain one or more other additives such as an antioxidant, an emulsion stabilizer, a preservative, a propellant, an emollient, a sunscreen agent, a surfactant, an emulsifying agent, a solubilizing agent and/or an ultraviolet light absorber. Examples of materials that may function as such additives are set forth below.

The compositions of this invention may include one or more materials that may function as an antioxidant, such as reducing agents and free radical scavengers. Suitable materials that may function as an antioxidant include one or more of the following:

- Acetyl Cysteine
- Ascorbic Acid
- Ascorbyl Palmitate or Stearate
- t-Butyl Hydroquinone

- Cysteine
- Diamylhydroquinone
- Dicetyl, Dilauryl, Dimyristyl, Distearyl or
Ditridecyl Thiodipropionate
- 5 •Erythorbic Acid
- 2-Ethylhexyl, Lauryl, Myristyl, Palmitoyl or Stearyl
4-methoxycinnamate
- Ethyl Ferulate
- Ferulic Acid
- 10 •Hydroquinone
- p-Hydroxyanisole
- Hydroxylamine Sulfate
- Magnesium Ascorbate
- Magnesium Ascorbyl Phosphate
- 15 •Octyl Gallate
- Octyl, Lauryl, Myristyl, Palmitoyl or Stearyl
Salicylate
- Octocrylene
- Phloroglucinol
- 20 •Polyethylene glycol ether of tocopherol
- Potassium Ascorbyl Tocopheryl Phosphate
- Potassium Sulfite
- Propyl Gallate
- Rutin
- 25 •Sodium Ascorbate
- Sodium Erythorbate
- Sodium Sulfite
- Sodium Thloglycolate
- Sorbityl Furfural
- 30 •Tertiary butyl 4-methoxy phenol
- Thiodiglycol
- Thiodiglycolamide
- Thioglycolic Acid
- Thiolactic Acid
- 35 •Thiosalicylic Acid
- Tocopherol
- Tocopheryl Acetate
- Tocopheryl Linoleate

- Tocopheryl Nicotinate
- Tocopheryl Succinate
- Tris (Nonylpheny) Phosphite

5 The compositions of this invention may also include one or more materials that may function as an emulsion stabilizer. These materials would not act as primary emulsifiers, but would prevent or reduce the coalescence of emulsified droplets. This could be
10 accomplished, for example, by modifying the continuous or the disperse phase of the emulsion through electrical repulsion, from changes in viscosity, or from film formation on the droplet surface. Suitable materials that may function as an emulsion stabilizer
15 include one or more of the following:

- Cetyl Alcohol
- Montmorillonite
- Aluminum Caprylate, Stearate, Laurate, Palmitate,
20 Lanolate or Myristate
- C₁₅~C₁₈ Glycol
- Dodecylhexadecanol
- H(OCH₂CH₂)_nOH where n = 350 to 160,000
- Pectin
- 25 •Glucose Pentaacetate
- Glycol Oleate, Palmitate, Stearate or Ricinoleate
- (Alkyl)cellulose
- Hydroxyalkyl (alkyl)cellulose
- Calcium Laurate, Myristate or Stearate
- 30 •C₁₀~C₅₀ alcohol such as cetyl, myristyl, stearyl, tallow or lauryl alcohol
- Polyvinyl Acetate
- Lanolin
- Styrene/maleic anhydride copolymer
- 35 •Xanthan gum

 The compositions of this invention may also include one or more materials that may function as a

preservative, which would prevent or retard microbial growth and thus protect the composition (or products made therefrom) from spoilage or from inadvertent contamination by the consumer during use. Suitable materials that may function as a preservative include one or more of the following:

- Ammonium Benzoate or Propionate
- Chloroxy enol
- 10 •Isobutylparaben
- o, m or p-Cresol
- Isodecylparaben
- Benzoic Acid
- Isopropyl Cresol, Paraben or Sorbate
- 15 •Benzotriazole
- Benzyl Alcohol
- Magnesium Benzoate
- Benzylparaben
- Dehydroacetic Acid
- 20 •Magnesium Propionate
- 5-Bromo-5-Nitro-1,3-Dioxane
- Diazolidinyl Urea
- Magnesium Salicylate
- 2-Bromo-2-Nitropropane-1,3-Diol
- 25 •Dibromopropamide Diisothionate
- Butyl Benzoate
- Dimethyl Hydroxymethyl Pyrazole
- Butylparaben
- Dimethylol Ethylene Thiourea
- 30 •Calcium Benzoate, Salicylate, Sorbate, Paraben or Propionate
- Dimethyl Oxazolidine
- Methyl Hydroxyl Hydantoin
- Methyldibromo Glutaronitrile
- 35 •Methylisothiazolinone
- Methylparaben
- Ethylparaben
- Chlorhexidine Diacetate, Digluconate or Dihydrochloride

- Formaldehyde
- Glutaral
- Glyoxal
- Chloroacetamide
- 5 •Hexamidine
- Chlorobutanol
- Hexamidine Diparaben
- Phenol
- p-Chloro-m-Cresol
- 10 •Hexamidine Paraben
- Octyl, Lauryl, Myristyl, Palmitoyl or Stearyl Salicylate
- Octyl, Lauryl, Myristyl, Palmitoyl or Stearyl Benzoate
- Octocrylene
- 15 •Phenoxyethanol
- Chlorophene
- 4Hydroxybenzoic Acid
- Phenoxyethylparaben
- P-Chlorophenol
- 20 •Hydroxymethyl Dioxoazabicyclooctane
- Phenoxyisopropanol
- Chlorothymol
- Imidazolidinyl Urea
- Phenyl Benzoate
- 25 •Phenyl Mercuric Acetate, Benzoate, Borate, Bromide or Chloride
- Potassium Salicylate, Sorbate, Benzoate, Propylparaben, Butylparaben, Ethylparaben, Methylparaben, Paraben, Phenoxide, o-Phenylphenate
- 30 or Propionate
- Propionic Acid
- Propyl Benzoate
- Phenylparaben
- Propylparaben
- 35 •o-Phenylphenol.
- Silver Borosilicate
- Silver Magnesium Aluminum Phosphate
- Sorbic Acid

- Sodium Hydroxymethylglycinate, Methylparaben, Paraben, Phenolsulfonate, Phenoxide, o-Phenylphenate, Propionate, Propylparaben, Pyrithione, Salicylate, Sorbate, Benzoate,
- 5 Butylparaben, p-Chloro-m-Cresol, Dehydroacetate, Ethylparaben, Formate or Hydroxymethane Sulfonate
- Zinc Pyrithione

The compositions of this invention may also
10 include one or more materials that may function as a propellant, which are chemicals used for expelling products from pressurized containers (aerosols). The functionality of a propellant depends on its vapor pressure at ambient temperature and its compressibility. Liquids
15 or gases can be used as propellants as long as the pressure developed within the container is safely below the container's bursting pressure under normal storage and use conditions. Suitable materials that may function as a propellant include one or more of the
20 following:

- Butane
- CH₃CClF₂
- Nitrogen
- 25 •Carbon Dioxide
- CH₃CF₂
- Nitrous Oxide
- Dimethyl Ether
- Isobutane
- 30 •Pentane
- Ethane
- Isopentane
- Propane
- CH₃CHF₂

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The compositions of this invention may also include one or more materials that may function as an emollient, which is a cosmetic ingredient that maintains the

soft, smooth, and pliable appearance of skin. The purpose of an emollient is to remain on the skin surface or in the stratum corneum to act as a lubricant, to reduce flaking, and to improve the skin's appearance. Suitable materials that may function as an emollient include one or more of the following:

- Acetylated Lanolin or Lanolin Alcohol
- Bisphenylhexamethicone
- 10 •Bertholletia Excelsa Nut Oil
- Caprylic/Capric Glycerides
- Butoxyethyl Stearate
- Caprylic/Capric/Succinic Triglyceride
- Acetylated Sucrose Distearate
- 15 •Acetyl Trihexyl Citrate
- Butyl Isostearate, Myristate, Oleate or Stearate
- Caprylyl Glycol
- Acetyl Trioctyl Citrate
- Cetearyl Octanoate or Palmitate
- 20 •Prunus Armeniaca Kernel Oil
- Cetyl Acetate, Caprylate, Lactate, Laurate, Octanoate or Oleate
- Arachidyl Propionate
- C14-C15 Alcohols
- 25 •Cetyl arachidol
- Argania Spinosa Oil
- C12-C28 Alkyl Acetate, Benzoate or Lactate or Octanoate
- Persea Gratissima Oil
- 30 •Orbignya Oleifera Oil
- Melissa Officinalis Seed Oil
- C24-C28 Alkyl Methicone
- C12-C13 Alkyl Octanoate
- Cetyl Glycol, Glycol Isostearate or Glycol Palmitate
- 35 •Benzyl Laurate
- Bis-Diglyceryl Polyacyladipate-1 or -2
- Camellia Kissi Oil

- Isostearyl, Myristyl, Lauryl, Isocetyl, Pentadecyl, Oleyl, Tridecyl or Undecyl Alcohol
- Isostearyl Glyceryl Ether
- Isostearyl Benzoate, Lactate, Neopentanoate,
- 5 Octanoate, Palmitate or Myristate
- Methyl Stearate
- Rosa Moschata Seed Oil
- Hydroxycetylisostearate
- Isatis Tinctoria Oil
- 10 •Isoamyl Laurate
- Isobutyl Myristate, Palmitate, Pelargonate or Stearate
- Isopropyl Laurate, Myristate, Palmitate or Stearate
- Isotridecyl Isononanoate
- Myristyl Isostearate, Lactate, Neopentanoate,
- 15 Octanoate or Propionate
- Actinidia Chinensis Seed Oil
- Isocetyl Isodecanoate, Palmitate or Stearate
- Lanolin
- Lanolin Oil or Wax
- 20 •Isodecyl Citrate, Hydroxystearate, Laurate, Myristate, Neopentanoate, Palmitate or Stearate
- Neopentyl Glycol Dicaprylate, Dicaprate, Dilaurate or Dioctanoate
- Nonyl Acetate
- 25 •Lauryl Glycol
- Octyl Acetoxystearate
- Lauryl Isostearate or Lactate
- Octyldecanol
- Octyldodecanol
- 30 •Octyldodecyl Benzoate, Lactate, Neopentanoate or Octanoate
- Octyl, Lauryl, Myristyl, Palmitoyl or Stearyl Benzoate Isohexadecane
- Methyl Benzoate, Caproate, Caprylate, Caprate or
- 35 Glucose Dioleate
- Isohexyl Neopentanoate, Palmitate or Laurate
- Octyl Hydroxystearate, Laurate, Isopalmitate, Isostearate, Myristate, Neopentanoate, Oleate,

- Palmitate or Stearate
- Methyl Glucose Isostearate, Laurate, Sesquicaprylate, Sesquicaprate, Sesquilaurate or Sesquistearate
 - Isopropyl Hydroxycetyl Ether
 - 5 •Isopropyl Hydroxystearate, Isostearate, Lanolate, Laurate, Linoleate, Myristate or Oleate
 - 2-Oleamido-1,3-Octadecanediol
 - Oleyl Acetate, Lactate or Oleate
 - Methyl Hydroxystearate, Laurate, Isostearate,
 - 10 Myristate, Oleate, Palmitate or Pelargonate
 - Isopropyl Palmitate, Isopropyl or Stearate
 - Isosorbide Laurate
 - Passiflora Eduls Oil
 - Polyethylen Glycol Glycerides
 - 15 •Polyglyceryl Myristate, Oleate, Pentastearate or Ricinoleate
 - Polyglyceryl Oleyl Ether
 - Polyethylene Glycol Tricapryl Citrate, Tricetyl Citrate, Trilauryl Citrate, Trimyristyl Citrate or
 - 20 Tristearyl Citrate
 - Polyethylene Glycol Castor Oil
 - Pentaerythrityl Dioleate, Distearate, Stearate, Tetrabenzoate or Trioleate
 - Polyglyceryl Sesquioleate, Stearate, Tetraoleate,
 - 25 Tetrastearate, Caprate, Caprylate, Decalinoleate, Laurate or Isopalmitate
 - Propylene Glycol Hydroxystearate Stearate, Laurate, Linoleate, Myristate, Ricinoleate, Stearte, Oleate, Soyate or Caprylate
 - 30 •Propylene Glycol Myristyl Ether or Myristyl Ether Acetate
 - Sucrose Polyoleate, Polypalmate, Polystearate, Ricinoleate, Stearate, Triacetate, Polyaurate, Polylinoleate, Myristate, Oleate, Laurate or Palmitate
 - 35 •Polypropylene Glycol Lauryl, Cetyl, Stearyl, Oleyl or Pentaerythrityl Ether
 - Tridecyl Neopentanoate, Octanoate, Stearate or Isononanoate

- Stearyl Acetate, Benzoate or Lactate
- Stearyl Glycol Isostearate or Citrate
- Polypropylene Glycol/Polyethylene Glycol
- Trimethylolpropane or Propene
- 5 •Trioctyl Trimellitate
- Tris (Tributoxysiloxy)Methylsilane

The compositions of this invention may also include one or more materials that may function as a
10 sunscreen agent. Under 58 Fed. Reg. 28194 (May 12, 1993), a sunscreen active ingredient is defined as an "ingredient that absorbs at least 85 percent of the radiation in the UV range at wavelengths from 290 to 320 nanometers, but may or may not transmit radiation at
15 wavelengths longer than 320 nanometers." Suitable materials that may function as a sunscreen agent include one or more of the following:

- Aminobenzoic Acid ("PABA")
- 20 •Glyceryl Aminobenzoate (Glyceryl PABA)
- Oxybenzone (Benzophenone-3)
- Cinoxate
- Homosalate
- Octyl Dimethyl PABA
- 25 •Diethanolamine Methoxycinnamate
- 2-Ethylhexyl, Lauryl, Myristyl, Palmitoyl, or Stearyl 4-methoxycinnamate
- Lawsone with Dihydroxyacetone
- Phenylbenzimidazole Sulfonic Acid
- 30 •Menthyl Anthranilate
- Red Petrolatum
- Digalloyl Trioleate
- Octocrylene
- Sulisobenzene (Benzophenone-4)
- 35 •Dioxybenzone (Benzophenone-8)
- Octyl Methoxycinnamate
- Titanium Dioxide
- Ethyl 4-[bis(Hydroxypropyl)] Aminobenzoate (Ethyl

Dihydroxypropyl PABA)

- Octyl Salicylate
- Trolamine Salicylate

5 The compositions of this invention may also include one or more materials that may function as a surfactant, an emulsifying agent or a solubilizing agent. Such a material may be used to reduce surface tension, to form complex films on the surface of
10 emulsified droplets, to create a repulsive barrier on emulsified droplets to prevent their coalescence, to retard physical changes in emulsions throughout during shelf-life or to cause a solute to become part of a micelle formed by a surfactant. Suitable materials
15 that may function as a surfactant, an emulsifying agent or a solubilizing agent include one or more of the following:

- C50~C650 linear or branched dihydroxy
- 20 polyoxyethylene/polyoxypropylene block copolymer
- C50~C650 branched polyhydroxy
- polyoxyethylene/polyoxypropylene block copolymer of ethylene diamine
- C12~C330 ethoxylated alkyl phenol
- 25 •C16~C140 polyethylene glycol ether of C12~C60 alcohols
- Carboxylic acid esters of C12~C330 ethoxylated alkyl phenol
- Ester of C12~C40 Carboxylic Acid and C8~C40
- 30 Polyethylene Glycol
- Ester of Caprylic or Capric Triglyceride and C8~C40 Polyethylene Glycol
- Phosphoric acid esters of C12~C330 ethoxylated alkyl phenol
- 35 •Phosphoric acid esters and diesters of C16~C140 polyethylene glycol ether of C12~C60 alcohols
- Abietic Acid
- Calcium Stearoyl Lactylate

- Cetethyl Morpholinium Ethosulfate
- Cetrimonium Bromide, Chloride, Methosulfate or Tosylate
- Cetyl Alcohol
- 5 •Cetyl Dimethicone Copolyol
- Cetyl Glyceryl Ether/Glycerin Copolymer
- Cetyl Phosphate
- Cetearyl Glucoside
- Dextrin Behenate, Laurate, Myristate, Palmitate or
- 10 Stearate
- Dicetyl Phosphate
- Diethytlaminoethyl Laurate or Stearate
- Dimethyl Octynediol
- Dimyristyl Phosphate
- 15 •Glyceryl Arachidate, Behenate, Caprylate, Caprate, Cocoate, Erucate, Hydrogenated Rosinate, Hydroxystearate, Isopalmitate, Isostearate, Isotridecanoate/Stearate/Adipate, Lanolate, Laurate, Oleate, Linoleate, Linolenate, Oleate, Montanate,
- 20 Myristate, Palmitate, Stearate, Palmitoleate, Ricinoleate or Uridecylenate
- Glycol Octanoate
- Hydrogenated Lecithin
- Hydrogenated Palm Glyceride
- 25 •Hydroxycetyl Phosphate
- Hydroxyethyl Glyceryl Oleate and/or Stearate
- Lanolin
- Laurtrimonium Chloride
- Lauryl Phosphate
- 30 •Lecithin
- Mannitan Laurate or Oleate
- Myristoyl Methylalanine
- Palmitic Acid
- Octoxyglyceryl Behenate or Palmitate
- 35 •Pelargonic Acid
- Pentaerythrityl Stearate
- Phosphatidylcholine
- Potassium Laurate, Myristate, Oleate, Lauryl

- Hydroxypropyl Sulfonate, Cetyl Phosphate, Lauryl Sulfate, Palmate, Palmitate, Ricinoleate or Stearate
- Sodium Palmate, Palmitate, Phthalate Stearyl Amide, Ricinoleate, Stearate, Stearyl Sulfate, Trideceth
- 5 Sulfate, Tridecyl Sulfate, Undecylenate, Lauroyl Lactylate, Lauryl Phosphate, Myristate, Oleate, Oleoyl Lactylate, Behenoyl Lactylate, Caproyl Lactylate, Caprylate, Isostearyl Lactylate or Laurate
- Propylene Glycol Behenate, Caprylate,
- 10 Hydroxystearate, Isostearyl Laurate, Linoleate, Unolenate, Myristate, Oleate, Ricinoleate or Stearate
- Sorbitan Caprylate, Diisostearyl, Dioleate, Distearate, Isostearyl, Laurate, Oleate, Palmitate, Sesquiisostearyl, Sesquioleate, Sesquistearyl,
- 15 Stearate, Triisostearyl, Trioleate or Tristearate
- Raffinose Oleate
 - Stearic Acid
 - Stearyl Lactylic Acid
 - Stearyl Alcohol
- 20 •Sucrose Dilaurate, Distearate, Laurate, Myristate, Oleate, Palmitate, Polylaurate, Polylinoleate, Polyoleate, Polypalmate or Polystearate
- C32~C82 polyethylene glycol ether of behenyl alcohol
 - C20~C106 polyethylene glycol ether of cetyl alcohol
- 25 •C28~C80 polyethylene glycol ether of cetyl or oleyl alcohol
- C20~C70 polyethylene glycol ether of cetyl and/or stearyl alcohol
 - C20~C80 polyethylene glycol ether of cholesterol
- 30 •C16~C24 polyethylene glycol ether of decyl alcohol
- C40~C80 polyethylene glycol ether of dihydrocholesterol
 - C20~C60 polyethylene glycol ether of isocetyl alcohol
- 35 •C18~C30 polyethylene glycol ether of isodecyl alcohol
- C18~C40 polyethylene glycol ether of isolauryl alcohol

- C20~C120 polyethylene glycol ether of isostearyl alcohol
- C12~C120 polyethylene glycol ether of glyceril caprate, caprylate, laurate, myristate, oleate,
5 palmitate or stearate
- C14~C100 polyethylene glycol ether of lauryl alcohol
- C16~C24 polyethylene glycol ether of myristyl alcohol
- C20~C70 polyethylene glycol ether of oleyl alcohol
- 10 •C10~C100 polyethylene/polypropylene glycol ether of butyl alcohol
- C20~C106 polyethylene/polypropylene glycol ether of cetyl alcohol
- C20~C100 polyethylene/polypropylene glycol ether of
15 decyl alcohol
- C14~C100 polyethylene/polypropylene glycol ether of lauryl alcohol
- Carboxylic acid ester of C20~C120 polyethylene glycol ether of isostearyl alcohol
- 20 •Carboxylic acid esters of C14~C100 polyethylene glycol ether of lauryl alcohol
- Carboxylic acid ester of C16~C24 polyethylene glycol ether of myristyl alcohol
- Citric acid diesters of C14~C100 polyethylene glycol
25 ether of lauryl alcohol
- Isopropyl Laurate, Myristate, Palmitate or Stearate
- Lauric acid ester of C30~C120 polyethylene glycol ether of sorbitol
- Octyl, Lauryl, Myristyl, Palmitoyl or Stearyl
30 Salicylate
- Phosphoric acid ester of C20~C106 polyethylene glycol ether of cetyl alcohol
- Phosphoric acid ester of C20~C120 polyethylene glycol ether of isostearyl alcohol
- 35 •Phosphoric acid diesters of C14~C100 polyethylene glycol ether of lauryl alcohol
- Phosphoric acid esters and/or diesters of C20~C70 polyethylene glycol ether of oleyl alcohol

- Stearic acid ester of C15~C30 polyethylene glycol ether of glycerin
- Stearic acid ester of C20~C60 polyethylene glycol ether of isocetyl alcohol
- 5 •Stearic acid ester of C20~C120 polyethylene glycol ether of isostearyl alcohol
- Diethanolamine salt of phosphoric acid ester of C20~C106 polyethylene glycol ether of cetyl alcohol
- Diethanolamine salt of phosphoric acid ester of
- 10 C20~C70 polyethylene glycol ether of cetyl and/or stearyl alcohol
- Diethanolamine salt of Phosphoric acid ester of C20~C70 polyethylene glycol ether of oleyl alcohol
- Disodium salt of citric acid ester of C14~C100
- 15 polyethylene glycol ether of lauryl alcohol
- Disodium salt of phosphoric acid ester of C14~C100 polyethylene glycol ether of lauryl alcohol
- Disodium salt of phosphoric acid ester of C20~C70 polyethylene glycol ether of oleyl alcohol
- 20 •Monoethanolamine salt of phosphoric acid ester of C20~C70 polyethylene glycol ether of cetyl and/or stearyl alcohol
- C12~C120 polyethylene glycol diester of behenic, capric, caprylic, lauric, oleic, octanoic, palmitic
- 25 or stearic acid
- Polyesters of C6~C40 polyglycerin and behenic, capric, caprylic, lauric, oleic, octanoic, palmitic or stearic acid.

30 The compositions of this invention may also include one or more materials that may function as an ultraviolet light absorber to protect a product made from the composition from chemical or physical deterioration induced by ultraviolet light. UV

35 absorbers, like sunscreen agents, have the ability to convert incident ultraviolet radiation into less damaging infrared radiation (heat). Suitable materials

that may function as an ultraviolet light absorber include one or more of the following:

- Acetaminosalol
- 5 •3-Benzylidene Camphor
- Stilbenedisulfonate
- Allantoin PABA
- Disodium Distyrylbiphenyl Disulfonate
- Benzalpthalide
- 10 •Sulfonamide
- Drometrizole
- Benzophenone
- Benzylidene Camphor Sulfonic Acid
- Ethyl Dihydroxypropyl PABA
- 15 •Benzophenone substituted with one or more groups selected from hydroxyl, alkoxy, alkyl, halogen and sulfonate
- Benzyl Salicylate
- Ethyl Diisopropylcinnamate, Methoxycinnamate or
- 20 Urocanate
- Bumetrizole
- Ethyl PABA
- Butyl Methoxydibenzoylmethane
- Butyl PABA
- 25 •Etocrylene
- Cinoxate
- Ferulic Acid
- Glyceryl Octanoate Dimethoxycinnamate
- Di-t-Butyl Hydroxybenzylidene Camphor
- 30 •Glyceryl PABA
- Digalloyl Trioleate
- Glycol Salicylate
- Diisopropyl Methyl Cinnamate
- Isoamyl p-Methoxycinnamate
- 35 •Disodium Bisethylphenyl Triaminotriazine
- Isopropylbenzyl Salicylate
- Isopropyl Dibenzoylmethane
- Octyl Triazone

- Sodium Urocanate
- Isopropyl Methoxycinnamate
- PABA
- Menthyl Anthranilate or Salicylate
- 5 •Pentyl Dimethyl PABA
- Terephthaylidene Dicamphor Sulfonic Acid
- 4-Methylbenzylidene Camphor
- Phenylbenzimidazole Sulfonic Acid
- Titanium Dioxide
- 10 •Octocrylene
- Polyacrylamidomethyl Benzylidene Camphor
- TriPABA Panthenol
- Octrizole
- Potassium Methoxycinnamate
- 15 •Urocanic Acid
- Octyl Dimethyl PABA
- Potassium Phenylbenzimidazole Sulfonate
- Octyl Methoxycinnamate or Salicylate
- Sodium Phenylbenzimidazole Sulfonate

20

A formulated mixture of one or more carriers, adjuvants and/or additives may be selected from the members of the groups thereof contained in the lists set forth above. They may also be selected from a

25 subgroup of the members of the foregoing lists formed by omitting any one or more members from the whole groups as set forth in the above lists. As a result, a mixture of carriers, adjuvants and/or additives may in such instance not only be made from one or more members

30 selected from any subgroup of any size that may be formed by all the various different combinations of individual members from the whole groups as set forth in the above lists, but may also be made in the absence of members that have been omitted from the whole groups

35 to form the subgroup. The subgroup formed by omitting various members from the whole group in the list above may, moreover, be an individual member of a whole group such that a carrier, adjuvant and/or additive is

provided in the absence of all other members of the whole groups except the selected individual member.

5 Dihydronepetalactones may be utilized in the present invention individually or combined in any proportion. As is conventional in the art, the desired amount of an insect repellent composition to be added to a given insect susceptible article with properties of insect repellency is determined by the nature of the product and other factors. These factors include both
10 considerations of cost and the nature of the other ingredients in the insect repellent composition or repellent article, their amounts, and the desired repellency effect. In general, the composition of the repellent should contain sufficient amounts of active
15 insect repellent material to be efficacious in repelling the insect from the host over a prolonged period of time (preferably, for a period of at least several hours).

20

The amount of each dihydronepetalactone of Formula I or mixtures thereof in an insect repellent composition or repellent article that contains one or more of the carriers, adjuvants and/or additives as
25 described above will generally not exceed about 80% by weight based on the weight of the final product, however, greater amounts may be utilized in certain applications and this amount is not limiting. More preferably, a suitable amount of dihydronepetalactone
30 will be at least about 0.001% by weight and preferably about 0.01% up to about 50% by weight; and more preferably, from about 0.01% to about 20% weight percent, based on the weight of the composition or article. Specific compositions will depend on the
35 intended use.

The dihydronepetalactone repellent compositions of the present invention can be formulated without a

carrier and be effective. More often, however, the insect repellent composition will include a carrier and contain about 0.001-50% weight of the disclosed compounds, and such compound is usually in intimate
5 mixture with the carrier to bring the active material into position for repelling common insect pests, such as biting insects, wood-boring insects, noxious insects, household pests, and the like.

10 The compositions of the invention may be formulated and packaged so as to deliver the product in a variety of forms including as a solution, suspension, cream, ointment, gel, film or spray, depending on the preferred method of use. The carrier may be an aerosol
15 composition adapted to disperse the dihydronepetalactone into the atmosphere by means of a compressed gas.

Desirable properties of a topical insect repellent
20 article include low toxicity, resistance to loss by water immersion or sweating, low or no odor or at least a pleasant odor, ease of application, and rapid formation of a dry tack-free surface film on the host's skin. In order to obtain these properties, the
25 formulation for a topical insect repellent article should permit insect-infested animals (e.g., dogs with fleas, poultry with lice, cows with ticks, and humans) to be treated with an insect repellent composition of the present invention by contacting the skin, fur or
30 feathers of such an animal with an effective amount of the repellent article for repelling the insect from the animal host. Thus, dispersing the article into the air or dispersing the composition as a liquid mist or fine dust will permit the repellent composition to fall on
35 the desired host surfaces. Likewise, directly spreading of the liquid/semi-solid/solid repellent article on the host is an effective method of

contacting the surface of the host with an effective amount of the repellent composition.

Embodiments of the present invention which may be used as a topical insect repellent articles, include (but are not limited to): colognes, lotions, sprays, creams, gels, ointments, bath and shower gels, foam products (e.g., shaving foams), makeup, deodorants, shampoo, hair lacquers/hair rinses, and personal soap compositions (e.g., hand soaps and bath/shower soaps).

This invention also relates to the use of dihydronepetalactone mixtures as insect repellents in a variety of articles, which are susceptible to attack by insects. These outdoor consumable products will generally, but not necessarily, comprise an insect repellent composition of the invention, but will contain an effective amount of dihydronepetalactone. Typical articles that can be improved by the use of dihydronepetalactones and mixtures thereof include, but are not limited to: air fresheners, candles, other scented articles, fibers, sheets, cloth [e.g., for clothing, nettings (mosquito netting), and other fabrics], paper, paint, ink, clay, woods, furniture (e.g., for patios and decks), carpets, sanitary goods, plastics, polymers, and the like.

The dihydronepetalactone compositions of this invention may be blended with polymers, which may also involve a controlled release systems. Compatible polymers may or may not be biodegradable. Exemplary polymers are high-density polyethylene or low-density polyethylene, biodegradable thermoplastic polyurethanes, biodegradable ethylene polymers, and poly(epsilon caprolactone) homopolymers and compositions containing the same as disclosed in U.S. 4,496,467, U.S. 4,469,613 and U.S. 4,548,764.

Dihydronepetalactones are particularly advantageous for use as repellent materials in preparations of the present invention for a variety of reasons.

First, the compounds are cost effective to produce, an important consumer consideration when choosing an effective repellent. Many commercially available repellent products are only effective in relatively concentrated form, including as much as 5-30% (or more) repellent in a carrier, based on total weight. U.S. 4,416, 881 to McGovern et al., for example, discloses repellent concentrations of 6.25-25% repellent in a carrier.

Secondly, the compounds are known natural compounds, thus overcoming concerns raised against synthetic chemicals such as DEET as the primary active ingredient in repellent compositions.

Finally, in addition to the natural repellent properties of the dihydronepetalactone mixtures thus prepared, the compositions also possess a unique and pleasant fragrance. The fragrance notes of the subject compounds make them useful in imparting, altering, augmenting or enhancing the overall olfactory component of an insect repellent composition or article, for example, by utilizing or moderating the olfactory reaction contributed by one or more other ingredients in the composition. Specifically, the dihydronepetalactones of the invention or mixtures thereof may be utilized to either mask or modify the odor contributed by other ingredients in the formulation of the final repellent composition or article, and/ or to enhance consumer appeal of a product by imparting a characteristic perfume or aroma. It is expected that the pleasant fragrance of

dihydronepetalactones will possess much greater appeal to consumers than other insect repellent compounds, particularly DEET.

5 Dihydronepetalactones and their uses are also described in U.S. SN 10/349,865, filed January 23, 2003, which is incorporated in its entirety as a part hereof for all purposes.

10 Where the composition of this invention is stated or described as comprising, including, containing, having, being composed of or being constituted by certain components, it is to be understood, unless the statement or description
15 explicitly provides to the contrary, that one or more components in addition to those explicitly stated or described may be present in the composition. In an alternative embodiment, however, the composition of this invention may be stated or described as consisting
20 essentially of certain components, in which embodiment components that would materially alter the principle of operation or the distinguishing characteristics of the composition are not present therein. In a further alternative embodiment, the composition of this
25 invention may be stated or described as consisting of certain components, in which embodiment components other than impurities are not present therein.

 Where the indefinite article "a" or "an" is
30 used with respect to a statement or description of the presence of a component in the composition of this invention, it is to be understood, unless the statement or description explicitly provides to the contrary, that the use of such indefinite article does not limit
35 the presence of the component in the composition to one in number.

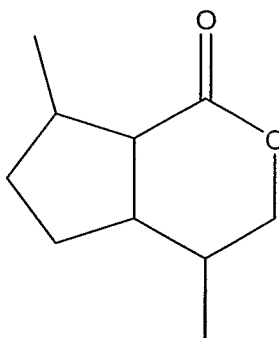
CLAIMS

What is claimed is:

5

1. An insect repellent composition comprising
(a) a dihydronepetalactone, or a mixture of
dihydronepetalactone stereoisomers, represented by the
general formula:

10



(b) an alcohol selected from a (i) $C_6 \sim C_{20}$ linear,
branched or cyclic alkanol and (ii) a $C_{10} \sim C_{50}$ alcohol,
15 and (c) an ester.

2. A composition according to Claim 1 further
comprising a $C_6 \sim C_{20}$ linear, branched or cyclic alkane
polyol.

20

3. A composition according to Claim 1 further
comprising a $C_4 \sim C_{400}$ polyethylene glycol.

4. A composition according to Claim 1 further
25 comprising a $C_4 \sim C_{400}$ polyethylene ether glycol.

5. A composition according to Claim 1 further
comprising a $C_{16} \sim C_{140}$ polyethylene glycol ether of a
 $C_{12} \sim C_{60}$ alcohol.

30

5. A composition according to Claim 1 further comprising a C₁₆~C₁₄₀ polyethylene glycol ether of a C₁₂~C₆₀ alcohol.

5 6. A composition according to Claim 1 further comprising a paraben.

7. A composition according to Claim 6 wherein the paraben is selected from the group consisting of
10 methylparaben, ethylparaben, propylparaben, isopropylparaben, butylparaben, isobutylparaben, isodecylparaben, benzylparaben and phenylparaben.

8. A composition according to Claim 1 further
15 comprising water.

9. A composition according to Claim 1 wherein the ester comprises an ester of a C₁₂~C₄₀ carboxylic acid and a C₈~C₄₀ polyethylene glycol.

20

10. A composition according to Claim 1 wherein the ester is selected from the group consisting of

(a) Amyl, Methyl, Butyl, Ethyl,
25 Ethoxyethanol, Ethoxydiglycol, Tetrahydrofurfuryl, Isoamyl, Isobutyl, Isopropyl or Propyl Acetate;

(b) Isobutyl, Methyl, Stearyl, Octyl, Lauryl, Myristyl or Palmitoyl Benzoate;

30

(c) Dimethyl Phthalate, Glutarate, Maleate, Adipate or Succinate;

(d) Octyl, Lauryl, Myristyl, Palmitoyl or
35 Stearyl Salicylate;

(e) Glycol Oleate, Palmitate, Stearate or Ricinoleate;

(f) Butyl Isostearate, Myristate or
Oleate;

5 (g) Cetyl Acetate, Caprylate, Lactate,
Laurate, Octanoate or Oleate;

(h) Isostearyl Benzoate, Lactate,
Neopentanoate, Octanoate, Palmitate or Myristate;
10

(i) Isoamyl Laurate;

(j) Isobutyl Myristate, Palmitate,
Pelargonate or Stearate;
15

(k) Isocetyl Isodecanoate, Palmitate or
Stearate;

(L) Isodecyl Citrate, Hydroxystearate,
20 Laurate, Myristate, Neopentanoate, Palmitate or
Stearate;

(m) Isopropyl Hydroxystearate, Isostearate,
Lanolate, Laurate, Linoleate, Myristate, Oleate,
25 Palmitate or Stearate;

(n) Methyl Hydroxystearate, Laurate,
Isostearate, Myristate, Oleate, Palmitate, Stearate or
Pelargonate;
30

(o) Polyglyceryl Myristate, Oleate,
Pentastearate or Ricinoleate;

(p) Stearyl Acetate, Benzoate or Lactate;
35

(q) Phosphoric acid esters and diesters of
C₁₆~C₁₄₀ polyethylene glycol ether of C₁₂~C₆₀ alcohols;

(r) Glyceryl Caprylate, Caprate, Hydroxystearate, Isopalmitate, Isostearate, Lanolate, Laurate, Oleate, Linoleate, Linolenate, Myristate, Palmitate, Stearate or Ricinoleate; and

5

(s) Propylene Glycol Hydroxystearate, Isostearate, Stearate, Laurate, Linoleate, Myristate, Ricinoleate, Oleate or Caprylate.

10

11. A composition according to Claim 1 formulated as a liquid.

12. A composition according to Claim 1 formulated as a lotion.

15