



(51) International Patent Classification:

C07D 233/78 (2006.01) A01N 53/00 (2006.01)
C07D 249/12 (2006.01)

(21) International Application Number:

PCT/JP2012/071937

(22) International Filing Date:

23 August 2012 (23.08.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

2011-182317 24 August 2011 (24.08.2011) JP

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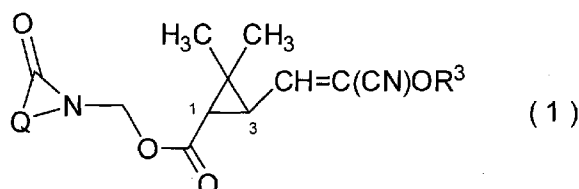
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: ESTER COMPOUND AND USE THEREOF



(57) Abstract: An ester compound represented by formula (1); wherein Q represents N(CH₂C≡CH)-CH₂-C*(=O) or N(CH₂C≡CH)-C(CH₃)=N* (where, * represents a binding position with N atom being adjacent to a carbonyl group); R³ represents a C1-C4 alkyl group; and a relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent at the 3-position of the cyclopropane ring is a trans configuration, has an excellent pest control effect.

DESCRIPTION

ESTER COMPOUND AND USE THEREOF

5 TECHNICAL FIELD

[0001]

The present invention relates to an ester compound and use thereof.

10 BACKGROUND ART

[0002]

Heretofore, various compounds have been synthesized to control pests (see, The Second series of pharmaceutical research and development, vol.18, ''Development of agrochemicals III'', page 493, Hirokawa Shoten, 1993).

[0003]

For example, a certain ester compound is described in JP-A-60-16962.

20 DISCLOSURE of INVENTION

[0004]

(PROBLEMS TO BE SOLVED BY INVENTION)

An object of the present invention is to provide a novel compound having an excellent pest control effect.

25 (MEANS TO SOLVE PROBLEMS)

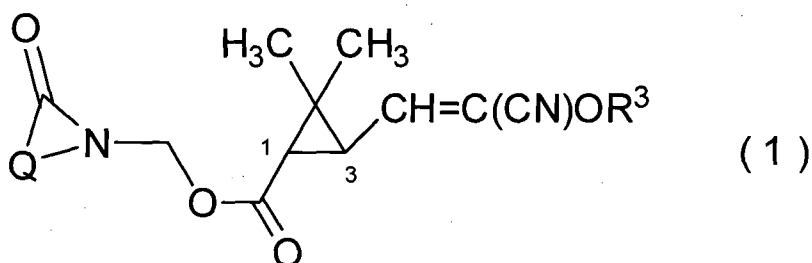
[0005]

The present inventors have intensively studied and found that an ester compound represented by formula (1) shown below has an excellent pest control effect, and led to the present invention.

[0006]

That is, the present invention is directed to the following inventions:

[1] An ester compound represented by formula (1):



wherein

Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ or $N(CH_2C\equiv CH)-C(CH_3)=N^*$ (where, * represents a binding position with N atom being adjacent to a carbonyl group);

R^3 represents a C1-C4 alkyl group; and

a relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent at the 3-position of the cyclopropane ring is a trans configuration,

(hereinafter, referred to as the compound of the present invention);

[1-2] The ester compound according to [1], wherein R^3

represents a C1-C3 alkyl group;

[2] The ester compound according to [1] or [1-2], wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$;

[3] The ester compound according to [1] or [1-2], wherein
5 Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$;

[4] The ester compound according to any one of [1] to [3] or [1-2], wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration in formula (1);

10 [5] The ester compound according to any one of [1] to [4] or [1-2], wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in the E configuration or a mixture of E configuration and Z configuration, and the proportion of the E configuration is
15 50% or more in formula (1);

[6] The ester compound according to any one of [1] to [5] or [1-2], wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in the E configuration in formula (1);

20 [7] The ester compound according to any one of [1] to [6], wherein R^3 represents methyl group in formula (1);

[8] The ester compound according to any one of [1] to [6], wherein R^3 represents ethyl group in formula (1);

[9] The ester compound according to any one of [1] to [6],
25 wherein R^3 represents isopropyl group in formula (1);

[10] The ester compound according to any one of [1] to [6], wherein R³ represents tert-butyl group in formula (1);

[11] A pest control agent comprising the ester compound according to any one of [1] to [10] or [1-2] and an inert carrier;

[12] A method of controlling pests, which comprises the step of applying an effective amount of the ester compound according to any one of [1] to [10] or [1-2] to pests or a place where pests inhabit;

[13] A method of controlling pests, which comprises the step of applying an effective amount of the ester compound according to any one of [1] to [10] or [1-2] to cockroaches or a place where cockroaches inhabit;

[14] The method according to [13], wherein the cockroach is American cockroach (*Periplaneta americana*);

[15] The method according to [13], wherein the cockroach is German cockroach (*Blattella germanica*);

[16] A method of controlling pests, which comprises a step of spraying an effective amount of the ester compound according to any one of [1] to [10] or [1-2] to cockroaches or a place where cockroaches inhabit;

[17] The method according to [16], wherein the cockroach is American cockroach (*Periplaneta americana*); and

[18] The method according to [16], wherein the cockroach is German cockroach (*Blattella germanica*).

(EFFECT OF INVENTION)

[0007]

The compound of the present invention has an excellent
5 pest control effect and is therefore useful as active
ingredient for a pest control agent.

MODE FOR CARRYING OUT THE INVENTION

[0008]

10 Hereinafter, the present invention is explained in
detail.

[0009]

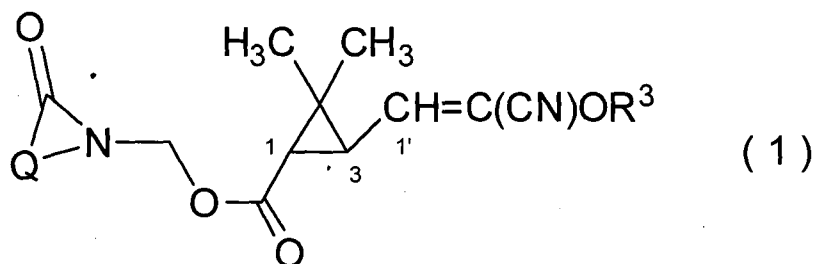
The substituent to be used in the present invention is
exemplified as follows:

15 Examples of the C1-C4 alkyl group to be used herein
include methyl group, ethyl group, propyl group, isopropyl
group, butyl group, isobutyl group and tert-butyl group.

[0010]

In the compound of the present invention, there are
20 isomers derived from two asymmetric carbon atoms at the 1-
position and the 3-position of the cyclopropane ring, and
isomers derived from the double bond present on the
substituent at the 3-position of the cyclopropane ring.
Each isomer having pest control activity or a mixture of
25 those isomers in an arbitrary ratio is included in the

present invention.

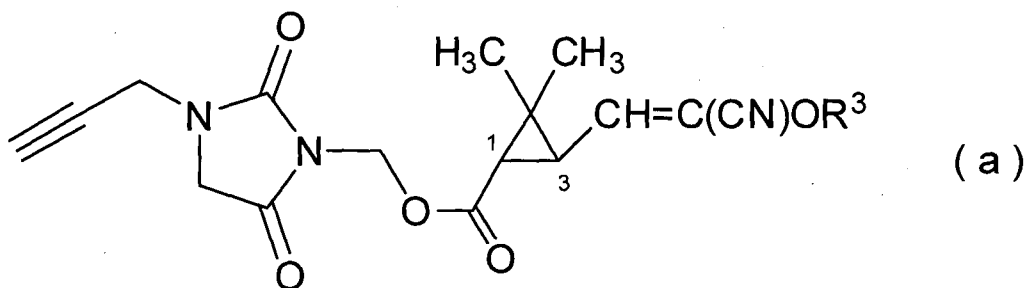


[0011]

Examples of the compound of the present invention include the following compounds.

5 [0012]

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$, that is, a compound represented by formula (a):

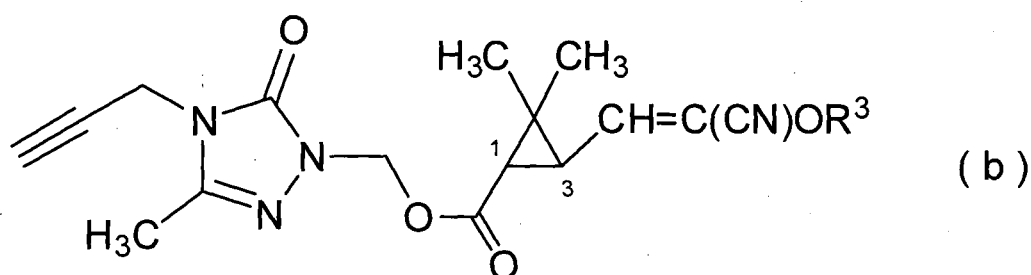


wherein R^3 represents the same meanings as defined above,
 10 and a relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent at the 3-position of the cyclopropane ring is a trans configuration;

[0013]

15 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$, that is, a compound

represented by formula (b):



wherein R^3 represents the same meanings as defined above,
and a relative configuration between the substituent at the
1-position of the cyclopropane ring and the substituent at
5 the 3-position of the cyclopropane ring is a trans
configuration;

[0014]

A compound represented by formula (1), wherein an
absolute configuration at the 1-position of the
10 cyclopropane ring is an R configuration;

A compound represented by formula (1), wherein a
double bond present on the substituent at the 3-position of
the cyclopropane ring is in the E configuration or a
mixture of E configuration and Z configuration, and the
15 proportion of the E configuration is 50% or more;

A compound represented by formula (1), wherein a
double bond present on the substituent at the 3-position of
the cyclopropane ring is in the E configuration;

A compound represented by formula (1), wherein an
20 absolute configuration of the 1-position of the

cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in the E configuration or a mixture of E configuration and Z configuration, and the proportion of the E configuration is 50% or more;

A compound represented by formula (1), wherein the absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration;

[0015]

A compound represented by formula (1), wherein Q represents $\text{N}(\text{CH}_2\text{C}\equiv\text{CH})-\text{CH}_2-\text{C}^*(=\text{O})$;

A compound represented by formula (1), wherein Q represents $\text{N}(\text{CH}_2\text{C}\equiv\text{CH})-\text{CH}_2-\text{C}^*(=\text{O})$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration;

A compound represented by formula (1), wherein Q represents $\text{N}(\text{CH}_2\text{C}\equiv\text{CH})-\text{CH}_2-\text{C}^*(=\text{O})$, and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration, and the proportion of the E configuration is 50% or more;

A compound represented by formula (1), wherein Q represents $\text{N}(\text{CH}_2\text{C}\equiv\text{CH})-\text{CH}_2-\text{C}^*(=\text{O})$ and a double bond present

on the substituent at the 3-position of the cyclopropane ring is in E configuration;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$, and an absolute
5 configuration at the 1-position of the cyclopropane ring is an R configuration and the double bond of the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration, and the proportion of the E configuration is
10 50% or more;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration, and a double bond present on the
15 substituent at the 3-position of the cyclopropane ring is in E configuration;

[0016]

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$;

20 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration;

A compound represented by formula (1), wherein Q
25 represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an double bond present

on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration, and the proportion of the E configuration is 50% or more;

5 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration;

10 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z
15 configuration, and the proportion of the E configuration is 50% or more;

20 A compound of represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration, and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration;

[0017]

25 A compound represented by formula (1), wherein R^3 represents a C1-C3 alkyl group;

A compound represented by formula (1), wherein R^3 represents methyl group;

A compound represented by formula (1), wherein R^3 represents ethyl group;

5 A compound represented by formula (1), wherein R^3 represents isopropyl group;

A compound represented by formula (1), wherein R^3 represents tert-butyl group;

[0018]

10 A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and R^3 represents methyl group;

15 A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents methyl group;

20 A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration and R^3 represents methyl group;

25 A compound represented by formula (1), wherein an absolute configuration at the 1-position of the

cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R³ represents methyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R³ represents methyl group;

[0019]

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and R³ represents ethyl group;

A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R³ represents ethyl group;

A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration and R³

represents ethyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R³ represents ethyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R³ represents ethyl group;

[0020]

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and R³ represents isopropyl group;

A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R³ represents isopropyl group;

A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents isopropyl group;

5 A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E
10 configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane
15 ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the
20 cyclopropane ring is an R configuration and R^3 represents tert-butyl group;

A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of
25 E configuration and Z configuration and the proportion of

the E configuration is 50% or more, and R³ represents tert-butyl group;

A compound represented by formula (1), wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R³ represents tert-butyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R³ represents tert-butyl group;

A compound represented by formula (1), wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R³ represents tert-butyl group;

[0021]

A compound represented by formula (1), wherein Q represents N(CH₂C≡CH)-CH₂-C*(=O) and R³ represents methyl group;

A compound represented by formula (1), wherein Q represents N(CH₂C≡CH)-CH₂-C*(=O) and an absolute

configuration at the 1-position of the cyclopropane ring is an R configuration, and R³ represents methyl group;

A compound represented by formula (1), wherein Q represents N(CH₂C≡CH)-CH₂-C*(=O) and a double bond present
5 on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R³ represents methyl group;

10 A compound represented by formula (1), wherein Q represents N(CH₂C≡CH)-CH₂-C*(=O) and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R³ represents methyl group;

A compound represented by formula (1), wherein Q
15 represents N(CH₂C≡CH)-CH₂-C*(=O), and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration, and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z
20 configuration, and the proportion of the E configuration is 50% or more, and R³ represents methyl group;

A compound represented by formula (1), wherein Q represents N(CH₂C≡CH)-CH₂-C*(=O) and an absolute
25 configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the

substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents methyl group;

[0022]

A compound represented by formula (1), wherein Q
5 represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and R^3 represents ethyl group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute
configuration at the 1-position of the cyclopropane ring is
10 an R configuration, and R^3 represents ethyl group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and a double bond present
on the substituent at the 3-position of the cyclopropane
ring is in E configuration or a mixture of E configuration
15 and Z configuration and the proportion of the E
configuration is 50% or more, and R^3 represents ethyl
group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and a double bond present
20 on the substituent at the 3-position of the cyclopropane
ring is in E configuration and R^3 represents ethyl group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute
configuration at the 1-position of the cyclopropane ring is
25 an R configuration and a double bond present on the

substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents ethyl group;

5 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in
10 E configuration, and R^3 represents ethyl group;

[0023]

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and R^3 represents isopropyl group;

15 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q
20 represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents isopropyl
25 group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and R^3 represents tert-butyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is

an R configuration, and R^3 represents tert-butyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents tert-butyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents tert-butyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents tert-butyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the

substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents tert-butyl group;

[0024]

A compound represented by formula (1), wherein Q
5 represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and R^3 represents methyl group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute
configuration at the 1-position of the cyclopropane ring is
10 an R configuration, and R^3 represents methyl group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present
on the substituent at the 3-position of the cyclopropane
ring is in E configuration or a mixture of E configuration
15 and Z configuration and the proportion of the E
configuration is 50% or more, and R^3 represents methyl
group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present on
20 the substituent at the 3-position of the cyclopropane ring
is in E configuration, and R^3 represents methyl group;

A compound represented by formula (1), wherein Q
represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute
configuration at the 1-position of the cyclopropane ring is
25 an R configuration and a double bond present on the

substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents methyl group;

5 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in
10 E configuration, and R^3 represents methyl group;

[0025]

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and R^3 represents ethyl group;

15 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration, and R^3 represents ethyl group;

20 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents ethyl
25 group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents ethyl group;

5 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in
10 E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents ethyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute
15 configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents ethyl group;

[0026]

20 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute
25 configuration at the 1-position of the cyclopropane ring is

an R configuration, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents isopropyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in

E configuration, and R^3 represents isopropyl group.

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and R^3 represents ter-butyl group;

5 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration, and R^3 represents tert-butyl group;

10 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration or a mixture of E configuration and Z configuration and the proportion of the E configuration is 50% or more, and R^3 represents tert-butyl group;

15 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R^3 represents tert-butyl group;

20 A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in
25 E configuration or a mixture of E configuration and Z

configuration and the proportion of the E configuration is 50% or more, and R³ represents tert-butyl group;

A compound represented by formula (1), wherein Q represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$ and an absolute
5 configuration at the 1-position of the cyclopropane ring is an R configuration and a double bond present on the substituent at the 3-position of the cyclopropane ring is in E configuration, and R³ represents tert-butyl group.

[0027]

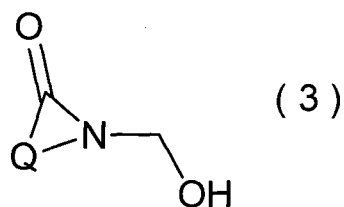
10 The method for preparing the compound of the present invention is described below.

[0028]

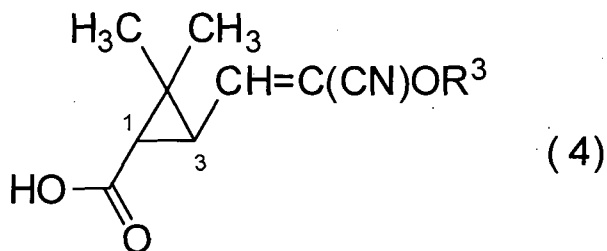
The compound of the present invention can be produced, for example, by the following processes.

15 (Production Process 1)

A process of reacting an alcohol compound represented by formula (3):



wherein Q represents the same meanings as described above, with a carboxylic acid compound represented by formula (4):



wherein R³ represents the same meanings as described above,
 and the relative configuration between the substituent at
 the 1-position of the cyclopropane ring and the substituent
 at the 3-position of the cyclopropane ring is a trans
 5 configuration,
 or a reactive derivative thereof.

[0029]

Examples of the reactive derivative include an acid
 halide of the carboxylic acid compound represented by
 10 formula (4), an acid anhydride of the carboxylic acid
 represented by formula (4), an ester of the carboxylic acid
 represented by formula (4) and the others. Examples of the
 acid halide include an acid chloride compound and an acid
 bromide compound, and examples of the ester include a
 15 methyl ester, an ethyl ester and the others.

The reaction is usually conducted in a solvent in the
 presence of a condensing agent or a base.

Examples of the condensing agent that are used in the
 reaction include dicyclohexylcarbodiimide and 1-ethyl-3-(3-
 20 dimethylaminopropyl)carbodiimide hydrochloride.

Examples of the base that are used in the reaction

include organic bases such as triethylamine, pyridine, N,N-diethylaniline, 4-dimethylaminopyridine and diisopropylethylamine.

Examples of the solvent that are used in the reaction include hydrocarbons such as benzene, toluene and hexane; ethers such as diethylether and tetrahydrofuran; halogenated hydrocarbons such as chloroform, dichloromethane, 1,2-dichloroethane and chlorobenzene; and a mixture of these solvents; and the others.

The reaction time of the reaction is usually within a range from 5 minutes to 72 hours.

The reaction temperature of the reaction is usually within the range from -20°C to 100°C (from -20°C to a boiling point of a solvent in the case that the boiling point of a solvent to be used is lower than 100°C), and preferably from -5°C to 100°C (from -5°C to a boiling point of a solvent in the case that the boiling point of the solvent to be used is lower than 100°C).

In the reaction, a molar ratio of the alcohol compound represented by formula (3) to the carboxylic acid compound represented by formula (4) or a reactive derivative thereof to be used can be arbitrarily set, and is preferably an equimolar ratio or a ratio close thereto.

The condensing agent or the base can be usually used in an arbitrarily proportion within the range from 0.25 mol

to an excessive amount, and preferably from 0.5 mol to 2 mol, based on 1 mol of the alcohol compound represented by formula (3). These condensing agents or bases are appropriately selected depending on the kind of the carboxylic acid compound represented by formula (4) or a reactive derivative thereof.

After the completion of the reaction, the reaction mixture is usually subjected to work-up procedures, for example, the reaction mixture is filtered and then the filtrate is concentrated, or the reaction mixture is poured into water and the resulting solution is extracted with an organic solvent and then the organic layer is concentrated, and the compound of the present invention can be thus obtained. The obtained compound of the present invention can be purified by an operation such as chromatography and distillation.

[0030]

The alcohol compound represented by formula (3) is a commercially available product, or a compound described in JP-A-05-255271, JP-A-57-158765, and can be thus purchased as a commercially available product, or can be produced according to the process described in these publications.

[0031]

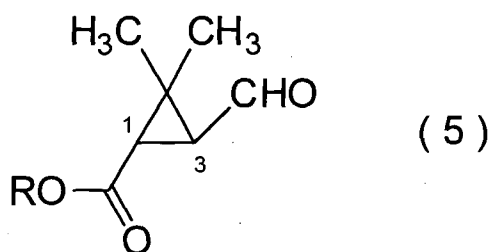
An intermediate of the present invention can be produced, for example, by the process shown below.

[0032]

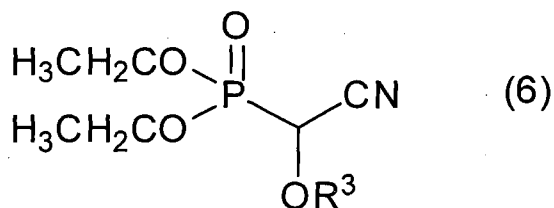
(Reference Production Process 1)

The carboxylic acid compound represented by formula (4) can be produced, for example, by the process shown below.

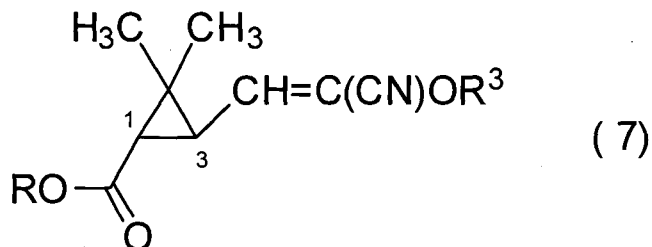
That is, a caronaldehyde ester derivative represented by formula (5):



wherein R represents C1-C5 alkyl group, and the relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent at the 3-position of the cyclopropane ring is a trans configuration, with a phosphonate compound represented by formula (6):

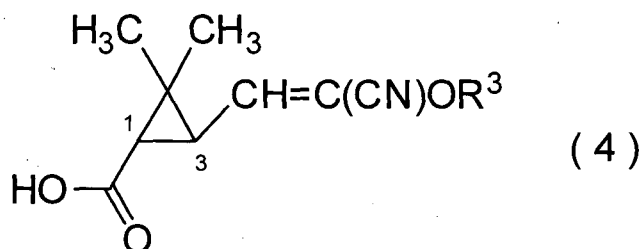


wherein R³ represents the same meanings as defined above, in the presence of a base to give a compound represented by formula (7):



wherein R and R³ represent the same meanings as defined above respectively, and the relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent at the 3-position of the cyclopropane ring is a trans configuration,

5 which is further subjected to a hydrolysis reaction in the presence of a base to produce a carboxylic acid compound represented by formula (4):



wherein R³ represents the same meanings as defined above,

10 and the relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent at the 3-position of the cyclopropane ring is a trans configuration.

[0033]

15 The reaction is usually conducted by using the phosphonate compound represented by formula (6) in the proportion within the range of the proportion of 1.0 to 1.5

mol and a base in the proportion of within the range of 1 to 10 mol, based on 1 mol of the caronaldehyde ester derivative represented by formula (5), and reacting them in a polar solvent or a non-polar solvent at the range from 0°C to 80°C, and preferably from 0°C to 30°C and thus a compound represented by formula (7) can be obtained. Examples of the base used in the reaction include an alkali metal compounds such as sodium methylate and potassium t-butoxide, metal hydride compounds such as sodium hydride and potassium hydride, and alkali amide compounds such as sodium bis(trimethylsilyl)amide, lithium bis(trimethylsilyl)amide and lithium diisopropylamide. Examples of the polar solvent used in the reaction include ethers such as diethyl ether and tetrahydrofuran, acid amides such as N,N-dimethylformaldehyde, and sulfoxides such as dimethyl sulfoxide. Examples of the non-polar solvent used in the reaction include hydrocarbons such as benzene, toluene and hexane.

After the completion of the reaction, the reaction mixture is subjected to work-up procedures, for example, the reaction mixture is added to water and the resulting solution is extracted with an organic solvent, and then the organic layer is dried and concentrated, and thus the compound represented by formula (7) can be obtained.

Also in a step of being subjected to a hydrolysis

reaction on the compound represented by formula (7), the reaction is usually conducted by using a base in the proportion within the range from 1 to 10 mol based on 1 mol of the compound represented by formula (7) and then
5 reacting them in a solvent at the range from 0°C to 80°C, and preferably from 0°C to 30°C and thus a carboxylic acid compound represented by formula (4) can be obtained. Examples of the base used in the reaction include an alkali metal compounds such as potassium hydroxide and sodium
10 hydroxide. Examples of the solvent used in the reaction include ethers such as 1,4-dioxane, tetrahydrofuran, ethyleneglycoldimethylether, alcohols such as methanol, ethanol, propanol, and water and a mixture of these solvents.

15 After the completion of the reaction, the reaction mixture is subjected to work-up procedures, for example, the reaction solution is acidified and then extracted with an organic solvent, and then the organic layer is dried and concentrated, and then the carboxylic acid compound
20 represented by formula (4) can be obtained.

[0034]

The caronaldehyde ester derivative represented by formula (5) can be produced according to the process described in Tetrahedron 45, 3039-3052 (1989).

25 [0035]

Examples of pests on which the compound of the present invention has a control effect include harmful arthropod pests such as harmful insects and harmful acarines, and more specifically, the following pests.

5 [0036]

Hemiptera: Planthoppers (such as *Laodelphax striatellus*, *Nilaparvata lugens*, and *Sogatella furcifera*), Leafhoppers (such as *Nephotettix cincticeps*, and *Nephotettix virescens*), Aphids (such as *Aphis gossypii*, and *Myzus persicae*), Plant bugs (such as *Nezara antennata*, *Riptortus clavetus*, *Eysarcoris lewisi*, *Eysarcoris parvus*, *Plautia stali*, and *Halyomorpha mista*), White flies (such as *Trialeurodes vaporariorum*, *Bemisia tabaci*, and *Bemisia argentifolii*), Scales (such as *Aonidiella aurantii*, *Comstockaspis perniciosa*, *Unaspis citri*, *Ceroplastes rubens*, and *Icerya purchasi*), Lace bugs, Bed bugs (such as *Cimex lectularius*), Jumping plantlice and so on;

15 [0037]

Lepidoptera: Pyralidae (such as *Chilo suppressalis*, *Cnaphalocrocis medinalis*, *Notarcha derogata*, and *Plodia interpunctella*), *Spodoptera litura*, *Pseudaletia separata*, Noctuidae such as (*Trichoplusia* spp., *Heliothis* spp., and *Earias* spp.), Pieridae (such as *Pieris rapae*), Tortricidae (such as *Adoxopheys* spp., *Grapholita molesta*, *Adoxophyes orana fasciata*, and *Cydia pomonella*), Carposinidae (such as

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Carposina niponensis), Lyonetiidae (such as *Lyonetia* spp.),
Lymantriidae (such as *Lymantria* spp.), Lymantriidae (such
as *Euproctis* spp.), Yponomeutidae (such as *Plutella*
xylostella), Gelechiidae (such as *Pectinophora gossypiella*),
5 Arctiidae (such as *Hyphantria cunea*), Tineidae (such as
Tinea translucens, and *Tineola bisselliella*), and so on;

Diptera: *Culex* spp. (such as *Culex pipiens pallens*,
Culex tritaeniorhynchus, and *Culex quinquefasciatus*), *Aedes*
spp. (such as *Aedes aegypti*, and *Aedes albopictus*),
10 *Anopheles* spp. (such as *Anopheles sinensis*, and *Anopheles*
gambiae), Chironomidae, Muscidae (such as *Musca domestica*,
and *Muscina stabulans*), Calliphoridae, Sarcophagidae,
little housefly, Anthomyiidae (such as *Delia platura*, and
Delia antiqua), Tephritidae, Drosophilidae, Phoridae (such
15 as *Megaselia spiracularis*), Phlebotominae (such as *Clogmia*
albipunctata), Psychodidae, Simuliidae, Tabanidae,
Stomoxyidae, Agromyzidae, and so on;

[0038]

Coleoptera: *Diabrotica* spp. (such as *Diabrotica*
20 *virgifera virgifera*, and *Diabrotica undecimpunctata*
howardi), Scarabaeidae (such as *Anomala cuprea*, and *Anomala*
rufocuprea), Curculionidae (such as *Sitophilus zeamais*,
Lissorhoptrus oryzophilus, and *Callosobruchus chienensis*),
Tenebrionidae (such as *Tenebrio molitor*, and *Tribolium*
25 *castaneum*), Chrysomelidae (such as *Oulema oryzae*,

Aulacophora femoralis, *Phyllotreta striolata*, and
Leptinotarsa decemlineata), Dermestidae (such as *Dermestes*
maculates), Anobiidae, *Epilachna* spp. (such as *Epilachna*
vigintioctopunctata), Lyctidae, Bostrychidae, Ptinidae,
5 Cerambycidae, *Paederus fuscipes*, and so on;

Blattodea: *Blattella germanica*, *Periplaneta fuliginosa*,
Periplaneta americana, *Periplaneta brunnea*, *Blatta*
orientalis, and so on;

Thysanoptera: *Thrips palmi*, *Thrips tabaci*,
10 *Frankliniella occidentalis*, *Frankliniella intonsa*, and so
on;

Hymenoptera: Formicidae (such as *Monomorium pharaonis*,
Formica fusca japonica, *Ochetellus glaber*, *Pristomyrmex*
pungens, *Pheidole noda*, and *Linepithema humile*), Long-
15 legged wasps (such as *Polistes chinensis antennalis*,
Polistes jadwigae, and *Polistes rothneyi*), Vespidae (such
as *Vespa mandarinia japonica*, *Vespa simillima*, *Vespa analis*
insularis, *Vespa crabro flavofasciata*, and *Vespa ducalis*),
Bethyridae, Xylocopa, Pompilidae, Sphecoidae, Mason wasp,
20 and so on;

Orthoptera: Mole crickets, Grasshoppers, etc.;

[0039]

Shiphonaptera: *Ctenocephalides felis*, *Ctenocephalides*
canis, *Pulex irritans*, *Xenopsylla cheopis*, and so on;

25 Anoplura: *Pediculus humanus corporis*, *Phthirus pubis*,

Haematopinus eurysternus, *Dalmalinia ovis*, and so on;

Isoptera: *Reticulitermes* spp. (such as *Reticulitermes speratus*, *Coptotermes formosanus*, *Reticulitermes flavipes*, *Reticulitermes hesperus*, *Reticulitermes virginicus*,
5 *Reticulitermes tibialis*, and *Heterotermes aureus*),
Incisitermes spp. (such as *Incisitermes minor*), and
Zootermopsis spp. (such as *Zootermopsis nevadensis*), and so
on;

Acarina: *Tetranychidae* (such as *Tetranychus urticae*,
10 *Tetranychus kanzawai*, *Panonychus citri*, *Panonychus ulmi*,
and *Oligonychus* spp.), *Eriophyidae* (such as *Aculops pelekassi*, and *Aculus schlechtendali*), *Tarsonemidae* (such
as *Polyphagotarsonemus latus*), *Tenuipalpidae*, *Tuckerellidae*,
Ixodidae (such as *Haemaphysalis longicornis*, *Haemaphysalis*
15 *flava*, *Dermacentor variabilis*, *Ixodes ovatus*, *Ixodes*
persulcatus, *Ixodes scapularis*, *Boophilus microplus*,
Amblyomma americanum, and *Rhipicephalus sanguineus*),
Acaridae (such as *Tyrophagus putrescentiae*), *Dermanyssidae*
(such as *Dermatophagoides farinae*, and *Dermatophagoides*
20 *ptrenyssus*), *Cheyletidae* (such as *Cheyletus eruditus*,
Cheyletus malaccensis, and *Cheyletus moorei*), chicken mite
(such as *Ornithonyssus bacoti*, *Ornithonyssus sylvaireum*, and
Dermanyssus gallinae), *Trombiculidae* (such as
Leptotrombidium akamushi), and so on;

25 Araneae: Japanese foliage spider (*Chiracanthium*

japonicum), redback spider (*Latrodectus hasseltii*), *Nephila*
clavata (*Tetragnathidae*), *Cyclosa octotuberculata*, St.
 Andrew's cross spider (*Argiope amoena*), Wasp spider
 (*Argiope bruennichii*), Orb-weaving spider (*Araneus*
 5 *ventricosus*), Grass spider (*Agelena silvatica*), Wolf spider
 (*Pardosa astrigera*), Dock spider (*Dolomedes sulfurous*),
Pardosa astrigera, *Dolomedes sulfureus*, *Carrhotus*
xanthogramma, Common house spider (*Achaeearanea*
tepidariorum), *Coelotes insidiosus*, Jumping spider
 10 (*Salticidae*), Huntsman spider (*Heteropoda venatoria*), etc.;

Chilopoda: Centipedes (such as House centipede
 (*Thereuonema hilgendorfi*), *Scolopendra subspinipes*,
Scolopendra subspinipes japonica, *Scolopocryptops*
rubiginosus, *Bothropolys asperatus*, etc.);

15 Diplopoda: Millipedes (such as Garden millipede
 (*Oxidus gracilis*), Garden millipede (*Nedyopus tambanus*),
Parafontaria laminata laminata, *Parafontaria laminata*
armigera, *Parafontaria acutidens*, *Epanerchodus orientalis*,
 etc.;

20 Isopoda: Sow bugs (such as *Porcellionides pruinosus*
 (Brandt), and *Porcellio scaber* Latreille), Pill bugs (such
 as Common pill bug (*Armadillidium vulgare*)), Sea louses
 (such as Wharf roach (*Ligia exotica*)), etc.;

Gastropoda: Tree slug (*Limax marginatus*), and Yellow
 25 slug (*Limax flavus*), etc.

[0040]

The pest control agent of the present invention comprises the compound of the present invention and an inert carrier. The pest control agent of the present invention is usually formulated into formulations described below. Examples of the formulation include an oil solution, an emulsifiable concentrate, a wettable powder, a flowable formulation (e.g., an aqueous suspension, or an aqueous emulsion), a microcapsule, a dust, a granule, an aerosol, a carbon dioxide formulation, a heat transpiration formulation (e.g., an insecticidal coil, an electric insecticidal mat, or a liquid absorbing core-type heat transpiration pesticide), a piezo insecticidal formulation, a heat fumigant (e.g., a self combustion-type fumigant, a chemical reaction-type fumigant, or a porous ceramic plate fumigant), an unheated transpiration formulation (e.g., a resin transpiration formulation, a paper transpiration formulation, an unwoven fabric transpiration formulation, a knit fabric transpiration formulation, or a sublimating tablet), an aerosol formulation (e.g., a fogging formulation), a direct contact formulation (e.g., a sheet-shaped contact formulation, a tape-shaped contact formulation, or a net-shaped contact formulation), an ULV formulation and a poison bait.

[0041]

Examples of a method of formulation include the following methods.

(1) A method comprising mixing the compound of the present invention with a solid carrier, a liquid carrier, a gaseous carrier, a bait or the like, followed by if necessary, addition of a surfactant and other auxiliary agents for formulation, and processing.

(2) A method comprising impregnation of a base material not containing an active ingredient with the compound of the present invention.

(3) A method comprising mixing the compound of the present invention and a base material, followed by subjecting the mixture to mold processing.

These formulations usually contain 0.001 to 98% by weight of the compound of the present invention, depending on formulation forms.

[0042]

Examples of the inert carrier used in the formulation include an inert solid carrier, an inert liquid carrier and an inert gaseous carrier.

Examples of the solid carrier used in the formulation include fine powders or granules of clays (e.g., kaolin clay, diatomaceous earth, bentonite, Fubasami clay, or acid white clay), synthetic hydrated silicon oxide, talc, ceramics, other inorganic minerals (e.g., sericite, quartz,

sulfur, active carbon, calcium carbonate, or hydrated silica), or chemical fertilizers (e.g., ammonium sulfate, ammonium phosphate, ammonium nitrate, ammonium chloride, or urea) and so on; substances that are in solid form at room temperature (e.g., 2,4,6-triisopropyl-1,3,5-trioxane, naphthalene, p-dichlorobenzene, camphor, or adamantane); as well as felt, fiber, fabric, knit, sheet, paper, thread, foam, porous material and multifilament comprising one or more substances selected from the group consisting of wool, silk, cotton, hemp, pulp, synthetic resins (e.g., polyethylene resins such as low density polyethylene, straight chain low density polyethylene and high density polyethylene; ethylene-vinyl ester copolymers such as an ethylene-vinyl acetate copolymer; ethylene-methacrylate copolymers such as an ethylene-methyl methacrylate copolymer and an ethylene-ethyl methacrylate copolymer; ethylene-acrylate copolymers such as an ethylene-methyl acrylate copolymer and an ethylene-ethyl acrylate copolymer; an ethylene-vinylcarboxylic acid copolymers such as an ethylene-acrylic acid copolymer; ethylene-tetracyclododecene copolymers; polypropylene resins such as a propylene homopolymer and a propylene-ethylene copolymer; poly-4-methylpentene-1, polybutene-1, polybutadiene, polystyrene; acrylonitrile-styrene resin;

acrylonitrile-butadiene-styrene resins; styrene elastomers such as a styrene-conjugated diene block copolymer and a hydrogenated styrene-conjugated diene block copolymer; fluorine resins; acrylic resins such as methyl
5 polymethacrylate; polyamide resins such as nylon 6 and nylon 66; polyester resins such as polyethylene terephthalate, polyethylene naphthalate, polybutylene terephthalate and polycyclohexylene dimethylene terephthalate; or porous resins such as polycarbonate,
10 polyacetal, polyacryl sulfone, polyarylate, hydroxybenzoic acid polyester, polyetherimide, polyester carbonate, polyphenylene ether resins, polyvinyl chloride, polyvinylidene chloride, polyurethane, foamed polyurethane, foamed polypropylene and foamed ethylene), glass, metal and
15 ceramics.

[0043]

Examples of the liquid carrier include aromatic or aliphatic hydrocarbons (e.g., xylene, toluene, alkylnaphthalene, phenylxylylethane, kerosene, light oil,
20 hexane, or cyclohexane), halogenated hydrocarbons (e.g., chlorobenzene, dichloromethane, dichloroethane, or trichloroethane), alcohols (e.g., methanol, ethanol, isopropyl alcohol, butanol, hexanol, benzyl alcohol, or ethylene glycol), ethers (e.g., diethyl ether, ethylene
25 glycol dimethyl ether, diethylene glycol monomethyl ether,

diethylene glycol monoethyl ether, propylene glycol monomethyl ether, tetrahydrofuran, or dioxane), esters (e.g., ethyl acetate, or butyl acetate), ketones (e.g., acetone, methyl ethyl ketone, methyl isobutyl ketone, or cyclohexanone), nitriles (e.g., acetonitrile, or isobutyronitrile), sulfoxides (e.g., dimethyl sulfoxide), acid amides (e.g., N,N-dimethylformamide, N,N-dimethylacetamide, or N-methyl-pyrrolidone), alkylidene carbonate (e.g., propylene carbonate), vegetable oils (e.g., soybean oil, or cottonseed oil), plant essential oils (e.g., orange oil, hyssop oil, or lemon oil), and water.

[0044]

Examples of the gaseous carrier include butane gas, chlorofluorocarbon, liquefied petroleum gas (LPG), dimethyl ether and carbon dioxide.

[0045]

Examples of the surfactant include alkyl sulfate, alkyl sulfonate, alkylaryl sulfonate, alkylaryl ethers, polyoxyethylenated alkylaryl ethers, polyethylene glycol ethers, polyhydric alcohol esters and sugar alcohol derivatives.

[0046]

Examples of the other auxiliary agents for formulation include a binder, a dispersant and a stabilizer. Specific examples include casein, gelatin, polysaccharides (e.g.,

starch, gum arabic, cellulose derivatives, or alginic acid),
lignin derivatives, bentonite, saccharides, synthetic
water-soluble polymers (e.g., polyvinyl alcohol, or
polyvinyl pyrrolidone), polyacrylic acid, BHT (2,6-di-tert-
5 butyl-4-methylphenol) and BHA (a mixture of 2-tert-butyl-4-
methoxyphenol and 3-tert-butyl-4-methoxyphenol).

[0047]

Examples of a base material for the insecticidal coil
include a mixture of vegetable powder such as wood flour
10 and lees powder, and a binder such as incense material
powder, starch and gluten.

Examples of a base material for the electric
insecticidal mat include a plate obtained by hardening
cotton linter and a plate obtained by hardening fibrils of
15 a mixture of cotton linter and pulp.

[0048]

Examples of a base material for the self combustion-
type fumigant include combustible exothermic agents such as
nitrate, nitrite, guanidine salt, potassium chlorate,
20 nitrocellulose, ethylcellulose and wood flour; thermal
decomposition stimulants such as alkali metal salt,
alkaline earth metal salt, dichromate and chromate; oxygen
carriers such as potassium nitrate; combustion-supporting
agents such as melamine and flour starch; extenders such as
25 diatomaceous earth, and binders such as synthetic glue.

[0049]

Examples of a base material for the chemical reaction-type fumigant include exothermic agents such as alkali metal sulfide, polysulfide, hydrosulfide and calcium oxide; catalytic agents such as a carbonaceous material, iron carbide and active white clay; organic foaming agents such as azodicarbonamide, benzenesulfonylhydrazide, dinitropentamethylenetetramine, polystyrene and polyurethane; and fillers such as strips of natural fiber and synthetic fiber.

[0050]

Examples of a resin used as a base material of the resin transpiration formulation include polyethylene resins such as a low density polyethylene, a straight chain low density polyethylene and a high density polyethylene; ethylene-vinyl ester copolymers such as an ethylene-vinyl acetate copolymer; ethylene-methacrylate copolymers such as an ethylene-methyl methacrylate copolymer and an ethylene-ethyl methacrylate copolymer; ethylene-acrylate copolymers such as an ethylene-methyl acrylate copolymer and an ethylene-ethyl acrylate copolymer; ethylene-vinylcarboxylic acid copolymers such as an ethylene-acrylic acid copolymer; ethylene-tetracyclododecene copolymers; polypropylene resins such as a propylene copolymer and a propylene-ethylene copolymer; poly-4-methylpentene-1, polybutene-1,

polybutadiene, polystyrene, acrylonitrile-styrene resins; acrylonitrile-butadiene-styrene resins; styrene elastomers such as a styrene-conjugated diene block copolymer and a hydrogenated styrene-conjugated diene block copolymer; 5 fluorine resins; acrylic resins such as methyl polymethacrylate; polyamide resins such as nylon 6 and nylon 66; polyester resins such as polyethylene terephthalate, polyethylene naphthalate, polybutylene butalate and polycyclohexylene dimethylene terephthalate; 10 polycarbonate, polyacetal, polyacryl sulfone, polyarylate, hydroxybenzoic acid polyester, polyetherimide, polyester carbonate, polyphenylene ether resin, polyvinyl chloride, polyvinylidene chloride and polyurethane. These base materials may be used alone or as a combination of two or 15 more kinds. If necessary, a plasticizer such as phthalate esters (e.g., dimethyl phthalate, dioctyl phthalate, etc.), adipic acid esters and stearic acid may be added to these base materials. The resin transpiration formulation can be prepared by mixing the compound of the present invention 20 with the above-mentioned base material, kneading the mixture, followed by molding it by injection molding, extrusion molding or pressure molding. The resultant resin formulation can be subjected to further molding or cutting procedure, if necessary, to be processed into shapes such 25 as a plate, film, tape, net or string shape. These resin

formulations can be processed into animal collars, animal ear tags, sheet products, trap strings, gardening supports and other products.

[0051]

5 Examples of a base material for the poison bait include bait ingredients such as grain powder, vegetable oil, saccharide and crystalline cellulose, antioxidants such as dibutylhydroxytoluene and nordihydroguaiaretic acid, preservatives such as dehydroacetic acid, accidental
10 ingestion inhibitors for children and pets such as a chili powder; insect attraction fragrances such as cheese flavor, onion flavor and peanut oil.

[0052]

15 The pest control method of the present invention is usually conducted by applying an effective amount of the compound of the present invention to a pest or a habitat thereof (e.g. plant bodies, soil, the interior of a house, animal bodies, the interior of a car, or outdoor open space) in the form of a pest control agent of the present
20 invention.

25 A method for applying the pest control agent of the present invention includes the following methods, and is appropriately selected depending on the form of the pest control agent of the present invention, the application area and so on.

(1) A method comprising applying a pest control agent of the present invention as it is to a pest or a habitat of the pest.

(2) A method comprising diluting a pest control agent of the present invention with a solvent such as water, and then spraying the dilution to a pest or a habitat of the pest.

In this case, the pest control agent of the present invention is usually formulated into an emulsifiable concentrate, a wettable powder, a flowable formulation, a microcapsule or the like. The formulation is usually diluted so that the concentration of the compound of the present invention can be within the range from 0.1 to 10,000 ppm.

(3) A method comprising heating a pest control agent of the present invention at a habitat of a pest, thereby allowing an active ingredient to volatilize and diffuse from the pest control agent.

In this case, any of the amount and concentration of application of the compound of the present invention can be appropriately determined depending on the form, application period, application area or application method of the pest control agent of the present invention, or kind of a pest, damage to be incurred and so on.

[0053]

When the pest control agent of the present invention is used for prevention of epidemics, the amount to be applied is usually from within the range from 0.0001 to 1,000 mg/m³ of the compound of the present invention in the case of applying to a space, and within the range from 0.0001 to 1,000 mg/m² of the compound of the present invention in the case of applying to a plane. An insecticidal coil or an electric insecticidal mat and so on is applied by heating to volatilize and diffuse an active ingredient, depending on the form of the formulation. A resin transpiration formulation, a paper transpiration formulation, an unwoven fabric transpiration formulation, a knit fabric transpiration formulation or a sublimating tablet and so on are allowed to stand as it is in a space to be applied, and place under air blowing.

When the pest control agent of the present invention is applied to a space for the purpose of prevention of epidemics, examples of the space include a closet, a Japanese cabinet, a Japanese chest, a cupboard, a toilet, a bathroom, a shed, a living room, a dining room, a garage, the interior of a car and so on. The pest control agent can be also applied to outdoor open space.

[0054]

When the pest control agent of the present invention is used for controlling external parasites of livestock

such as cows, horses, pigs, sheep, goats and chickens and small animals such as dogs, cats, rats and mice, the pest control agent of the present invention can be applied to the animals by a known method in the veterinary field.

5 Specifically, when systemic control is intended, the pest control agent of the present invention is administered to the animals as a tablet, a mixture with feed or a suppository, or by injection (including intramuscular, subcutaneous, intravenous and intraperitoneal injections).

10 On the other hand, when non-systemic control is intended, the pest control agent of the present invention is applied to the animals by means of spraying of the oil solution or aqueous solution, pour-on or spot-on treatment, or washing of the animal with a shampoo formulation, or by putting a
15 collar or ear tag made of the resin transpiration formulation to the animal. In the case of administering to an animal body, the dosage of the compound of the present invention is usually within the range from 0.01 to 1,000 mg per 1 kg of an animal body weight.

20 [0055]

When the pest control agent of the present invention is used for controlling a pest in the agricultural field, examples of the application method include a spray treatment, a soil treatment, a seed treatment and a
25 submerged treatment.

[0056]

When the pest control agent of the present invention is used for controlling a pest in the agricultural field, the amount can widely vary depending on the application period, application area, application method and other factors, and is usually within the range from 1 to 10,000 g in terms of the compound of the present invention per 10,000 m². When the pest control agent of the present invention is formulated into an emulsifiable concentrate, a wettable powder, a flowable formulation and so on, the pest control agent is usually applied after diluting with water so that the concentration of the active ingredient becomes a range from 0.01 to 10,000 ppm, and a granule or a dust is usually applied as it is.

[0057]

These formulations or water dilutions of the formulations may be directly sprayed over pests or plants such as crop plants to be protected from pests, or may be used in the soil treatment for the control of pests which inhabit the soil of the cultivated land.

[0058]

Application can also be conducted by a method of directly winding the resin formulation formed into sheet-shaped, or string- or cord-shaped formulation around plants, disposing the formulation in the neighborhood of plants, or

spreading the formulation on the soil surface at the root.

[0059]

The compound of the present invention can be used as pest control agent in cultivating field such as farm, paddy field, lawn or orchard, or non-cultivating field. The compound of the present invention can control pests which inhabit the cultivating field in the cultivating field and so on where the following "plant crops" are cultivated.

Agricultural crops: corn, rice, wheat, barley, rye, oat, sorghum, cotton, soybean, peanut, sarrazin, sugar beet, rapeseed, sunflower, sugar cane, tobacco, etc.;

Vegetables: Solanaceae vegetables (eggplant, tomato, green pepper, hot pepper, potato etc.), Cucurbitaceae vegetables (cucumber, pumpkin, zucchini, watermelon, melon etc.), Cruciferae vegetables (Japanese radish, turnip, horseradish, kohlrabi, Chinese cabbage, cabbage, brown mustard, broccoli, cauliflower etc.), Compositae vegetables (burdock, garland chrysanthemum, artichoke, lettuce etc.), Liliaceae vegetables (Welsh onion, onion, garlic, asparagus etc.), Umbelliferae vegetables (carrot, parsley, celery, parsnip etc.), Chenopodiaceae vegetables (spinach, Swiss chard etc.), Labiatae vegetables (Japanese basil, mint, basil etc.), strawberry, sweet potato, yam, aroid, etc.;

Fruit trees: pomaceous fruits (apple, common pear, Japanese pear, Chinese quince, quince etc.), stone fleshy

fruits (peach, plum, nectarine, Japanese plum, cherry, apricot, prune etc.), citrus plants (Satsuma mandarin, orange, lemon, lime, grapefruit etc.), nuts (chestnut, walnut, hazel nut, almond, pistachio, cashew nut, macadamia nut etc.), berry fruits (blueberry, cranberry, blackberry, raspberry etc.), grape, persimmon, olive, loquat, banana, coffee, date, coconut palm, oil palm, etc.;

Trees other than fruit trees: tea, mulberry, woody plants (azalea, camellia, hydrangea, sasanqua, Illicium religiosum, cherry tree, tulip tree, crape myrtle, fragrant olive etc.), street trees (ash tree, birch, dogwood, eucalyptus, ginkgo, lilac, maple tree, oak, poplar, cercis, Chinese sweet gum, plane tree, zelkova, Japanese arborvitae, fir tree, Japanese hemlock, needle juniper, pine, spruce, yew, elm, horse-chestnut etc.), sweet viburnum, Podocarpus macrophyllus, Japanese cedar, Japanese cypress, croton, spindle tree, Chinese hawthorn, etc.

Lawn: zoysia (Japanese lawn grass, mascarene grass, etc.), Bermuda grass (Cynodon dactylon, etc.), bent grass (creeping bent grass, Agrostis stolonifera, Agrostis tenuis, etc.), bluegrass (Kentucky bluegrass, rough bluegrass, etc.), fescue (tall fescue, chewing fescue, creeping fescue, etc.), ryegrass (darnel, perennial ryegrass, etc.), cocksfoot, timothy grass, etc.;

Others: flowers (rose, carnation, chrysanthemum,

Eustoma grandiflorum Shinnars (prairie gentian), gypsophila, gerbera, pot marigold, salvia, petunia, verbena, tulip, aster, gentian, lily, pansy, cyclamen, orchid, lily of the valley, lavender, stock, ornamental kale, primula, poinsettia gladiolus, cattleya, daisy, verbena, cymbidium, begonia, etc.), bio-fuel plants (Jatropha, safflower, gold-of-pleasure, switchgrass, Miscanthus, ribbon grass, giant reed, kenaf, cassava, willow, etc.), foliage plant; etc.

[0060]

10 The above "plant crops" include gene transgenic plant crops.

[0061]

The compound of the present invention can be mixed with or can be used in combination with other insecticide, acaricide, nematocide, soil pest control agent, fungicide, herbicide, plant growth regulating agent, repellent, synergist, fertilizer, or soil modifier.

[0062]

20 Examples of active ingredient of such the insecticide and acaricide include:

(1) Synthetic pyrethroid compounds:

acrinathrin, allethrin, beta-cyfluthrin, bifenthrin, cycloprothrin, cyfluthrin, cyhalothrin, cypermethrin, empenethrin, deltamethrin, esfenvalerate, ethofenprox, fenpropathrin, fenvalerate, flucythrinate, flufenoprox,

flumethrin, fluvalinate, halfenprox, imiprothrin,
permethrin, prallethrin, pyrethrins, resmethrin, sigma-
cypermethrin, silafluofen, tefluthrin, tralomethrin,
transfluthrin, tetramethrin, phenothrin, cyphenothrin,
5 alpha-cypermethrin, zeta-cypermethrin, lambda-cyhalothrin,
gamma-cyhalothrin, furamethrin, tau-fluvalinate,
metofluthrin, 2,3,5,6-tetrafluoro-4-methylbenzyl 2,2-
dimethyl-3-(1-propenyl)cyclopropane carboxylate, 2,3,5,6-
tetrafluoro-4-(methoxymethyl)benzyl 2,2-dimethyl-3-(2-
10 methyl-1-propenyl)cyclopropane carboxylate, 2,3,5,6-
tetrafluoro-4-(methoxymethyl)benzyl 2,2,3,3-
tetramethylcyclopropane carboxylate, and so on;

(2) Organic phosphorous compounds:

acephate, Aluminium phosphide, butathiofos, cadusafos,
15 chlorethoxyfos, chlorfenvinphos, chlorpyrifos,
chlorpyrifos-methyl, cyanophos (abbrev. CYAP), diazinon,
DCIP (dichlorodiisopropyl ether), dichlofenthion (abbrev.
ECP), dichlorvos (abbrev. DDVP), dimethoate,
dimethylvinphos, disulfoton, EPN, ethion, ethoprophos,
20 etrimfos, fenthion (abbrev. MPP), fenitrothion (abbrev.
MEP), fosthiazate, formothion, Hydrogen phosphide,
isofenphos, isoxathion, malathion, mesulfenfos,
methidathion (abbrev. DMTP), monocrotophos, naled (abbrev.
BRP), oxydeprofos (abbrev. ESP), parathion, phosalone,
25 phosmet (abbrev. PMP), pirimiphos-methyl, pyridafenthion,

quinalphos, phenthoate (abbrev. PAP), profenofos, propaphos, prothiofos, pyraclorfos, salithion, sulprofos, tebupirimfos, temephos, tetrachlorvinphos, terbufos, thiometon, trichlorphon (abbrev. DEP), vamidothion, phorate, cadusafos, and so on;

(3) Carbamate compounds:

alanycarb, bendiocarb, benfuracarb, BPMC, carbaryl, carbofuran, carbosulfan, cloethocarb, ethiofencarb, fenobucarb, fenothiocarb, fenoxycarb, furathiocarb, isoprocarb (abbrev. MIPC), metolcarb, methomyl, methiocarb, NAC, oxamyl, pirimicarb, propoxur (abbrev. PHC), XMC, thiodicarb, xylylcarb, aldicarb, and so on;

(4) Nereistoxin compounds:

cartap, bensultap, thiocyclam, monosultap, bisultap, and so on;

(5) Neonicotinoid compounds:

imidacloprid, nitenpyram, acetamiprid, thiamethoxam, thiacloprid, dinotefuran, clothianidin, and so on;

(6) Benzoylurea compounds:

chlorfluazuron, bistrifluron, diafenthiuron, diflubenzuron, fluazuron, flucycloxuron, flufenoxuron, hexaflumuron, lufenuron, novaluron, noviflumuron, teflubenzuron, triflumuron, triazuron, and so on;

(7) Phenylpyrazole compounds:

acetoprole, ethiprole, fipronil, vaniliprole, pyriprole,

pyrafluprole, and so on;

(8) Bt toxin insecticides:

Live spores derived from and crystal toxins produced from Bacillus thuringiensis and a mixture thereof;

5 (9) Hydrazine compounds:

chromafenozide, halofenozide, methoxyfenozide, tebufenozide, and so on;

(10) Organic chlorine compound:

10 aldrin, dieldrin, dienochlor, endosulfan, methoxychlor, and so on;

(11) Natural insecticides:

machine oil, nicotine-sulfate;

(12) Other insecticides:

15 avermectin-B, bromopropylate, buprofezin, chlorphenapyr, cyromazine, D-D (1,3-Dichloropropene), emamectin-benzoate, fenazaquin, flupyrazofos, hydroprene, methoprene, indoxacarb, metoxadiazone, milbemycin-A, pymetrozine, pyridalyl, pyriproxyfen, spinosad, sulfluramid, tolfenpyrad, triazamate, flubendiamide, lepimectin, Arsenic
20 acid, benclothiaz, Calcium cyanamide, Calcium polysulfide, chlordane, DDT, DSP, flufenerim, flonicamid, flurimfen, formetanate, metam-ammonium, metam-sodium, Methyl bromide, Potassium oleate, protrifenbute, spiromesifen, Sulfur, metaflumizone, spirotetramat, pyrifluquinazone, spinetoram,
25 chlorantraniliprole, tralopyril, and so on.

[0063]

Examples of the active ingredient of the repellent include N,N-diethyl-m-toluamide, limonene, linalool, citronellal, menthol, menthone, hinokitiol, geraniol, eucalyptol, indoxacarb, carane-3,4-diol, MGK-R-326, MGK-R-874 and BAY-KBR-3023.

[0064]

Examples of the active ingredient of the synergist include 5-[2-(2-butoxyethoxy)ethoxymethyl]-6-propyl-1,3-benzodioxol, N-(2-ethylhexyl)bicyclo[2.2.1]hept-5-ene-2,3-dicarboxyimide, octachlorodipropylether, thiocynoacetic acid isobornyl, and N-(2-ethylhexyl)-1-isopropyl-4-methylbicyclo[2.2.2]oct-5-ene-2,3-dicarboxyimide.

EXAMPLES

[0065]

The present invention is further described in more detail below by way of Production Examples, Reference Production Examples, Formulation Examples and Test Examples, but the present invention is not limited to these Examples.

[0066]

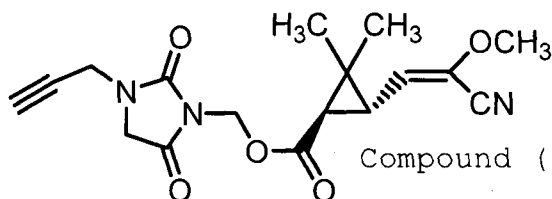
Firstly, Production Examples of the compound of the present invention are shown below. In ^1H -NMR, the description "'1.17+1.18 (s+s, 3H)'" means that peaks of singlet(s) exist at 1.17 ppm and 1.18 ppm, and the total of

integral values of these two peaks is 3H, for example.

[0067]

Production Example 1

To a chloroform solution (5mL) of 3-hydroxymethyl-1-(2-propynyl)imidazolidine-2,4-dione (252 mg, 1.50 mmol) and (1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid (293 mg, 1.50 mmol) were added 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride (302 mg, 1.58 mmol) and 4-dimethylaminopyridine (30mg). After stirring the reaction mixture at room temperature for 12 hours, water was poured into the reaction mixture and the resulting solution was extracted with ethyl acetate. The organic layer was dried over magnesium sulfate and then concentrated under reduced pressure, and the residue was subjected to silica gel column chromatography to obtain 210 mg of 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl 1-(1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropane carboxylate (hereinafter, referred to as the compound (1) of the present invention) represented by the following formula:



Compound (1) of the present invention

[0068]

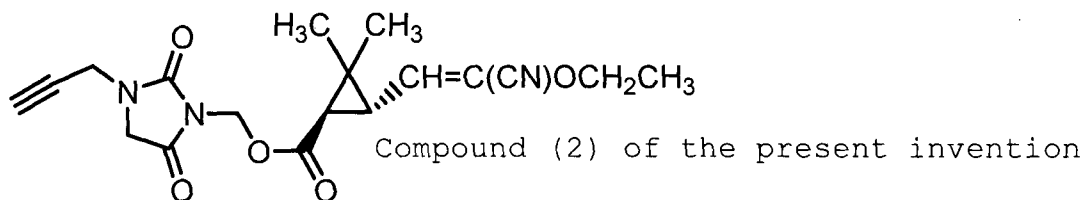
Pale yellow liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.17 (s, 3H),

1.32 (s, 3H), 1.58 (d, 1H), 2.27 (dd, 1H), 2.36 (d, 1H), 3.62 (s, 3H), 4.05 (s, 2H), 4.27 (d, 2H), 5.25 (d, 1H), 5.49-5.62 (dd, 2H)

[0069]

5 Production Example 2

3-Hydroxymethyl-1-(2-propynyl)imidazolidine-2,4-dione (193 mg, 1.15 mmol) was dissolved in tetrahydrofuran (3 mL) and thereto was added 0.15 mL of pyridine. To this solution was added a tetrahydrofuran solution (1 mL) of
10 (1R)-trans-3-[(1EZ)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid chloride (250 mg, 1.10 mmol, E:Z = 2:1) under ice-cooling. After stirring the reaction mixture at room temperature for 12 hours, water was poured into the reaction solution and the solution was
15 extracted with ethyl acetate. The organic layer was washed with 5% hydrochloric acid, saturated sodium bicarbonate aqueous solution and saturated brine successively, and then dried over magnesium sulfate. After concentration of the organic layer under reduced pressure, the residue was
20 subjected to silica gel column chromatography to obtain 261mg of 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1EZ)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropan carboxylate (E:Z = 2:1) (hereinafter referred to as the compound (2) of the
25 present invention) represented by the following formula:



[0070]

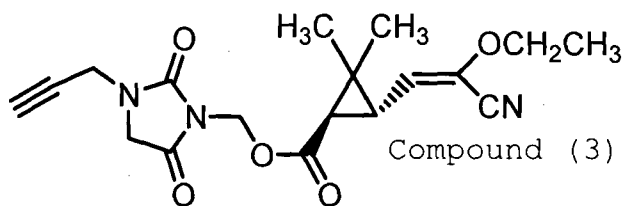
Pale yellow liquid: ^1H -NMR (CDCl_3 , TMS) δ (ppm): 1.17+1.18 (s+s, 3H), 1.26-1.31 (m, 3H), 1.32+1.33 (s+s, 3H), 1.58 (d, 0.67H), 1.63 (d, 0.33H), 2.27 (m, 0.67H), 2.37 (m, 1H), 2.43-2.47 (m, 0.33H), 3.84 (q, 1.34H), 4.04 (q, 0.66H), 4.06 (m, 2H), 4.27 (m, 2H), 5.18 (d, 0.33H), 5.29 (d, 0.67H), 5.47-5.62 (m, 2H)

[0071]

Production Example 3

10 The 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1E)-2-cyano-2-(ethoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 2:1) obtained in Production Example 2 was subjected to a silica gel column chromatography (eluent: hexane/ethyl acetate = 2:1) to

15 obtain, as a fraction having higher polarity, 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate (hereinafter referred to as the compound (3) of the present invention represented by the following formula:



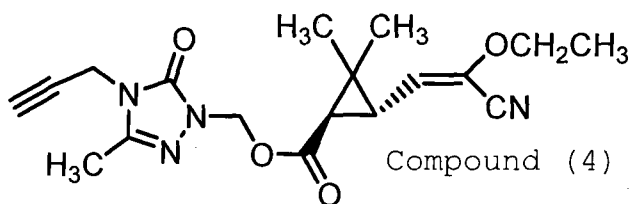
Compound (3) of the present invention

Pale yellow liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.17 (s, 3H), 1.24-1.31 (m, 3H), 1.33 (s, 3H), 1.58 (d, 1H), 2.27 (m, 1H), 2.37 (m, 1H), 3.84 (q, 2H), 4.05 (s, 2H), 4.27 (d, 2H), 5.29 (d, 1H), 5.49-5.62 (dd, 2H)

5 [0072]

Production Example 4

The operation was conducted in the same manner as Production Example 1, except that 2-hydroxymethyl-5-methyl-4-(2-propynyl)-2,4-dihydro-[1,2,4]-triazole-3-one was used in place of 3-hydroxymethyl-1-(2-propynyl)imidazolidine-2,4-dione, to obtain 3-methyl-5-oxo-4-(2-propynyl)-4,5-dihydro-[1,2,4]-triazolylmethyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate (hereinafter referred to as the compound (4) of the present invention) represented by the following formula:



Compound (4) of the present invention

[0073]

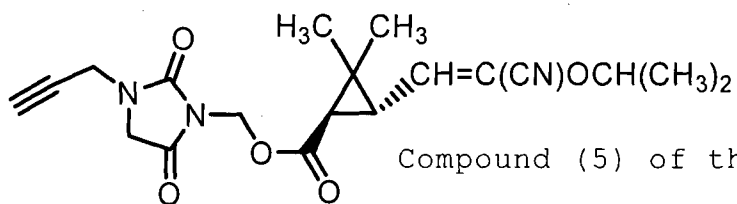
Pale yellow liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.17 (s, 3H), 1.24-1.31 (m, 3H), 1.32 (s, 3H), 1.61 (d, 1H), 2.29 (m, 1H),

2.34 (m,1H), 2.35 (s,3H), 3.84 (q,2H), 4.43 (d,2H), 5.23 (d,1H), 5.68-5.81 (dd,2H)

[0074]

Production Example 5

5 The operation was conducted in the same manner as Production Example 1, except that (1R)-trans-3-[(1EZ)-2-cyano-2-(isopropoxy)ethenyl]-2,2-dimethylcyclopropanecarboxylic acid (E:Z = 4:1) was used in place of (1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid, to obtain 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1EZ)-2-cyano-2-(isopropoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 78:22) (hereinafter referred to as the compound (5) of the present invention) represented by the
10
15 following formula:



Compound (5) of the present invention

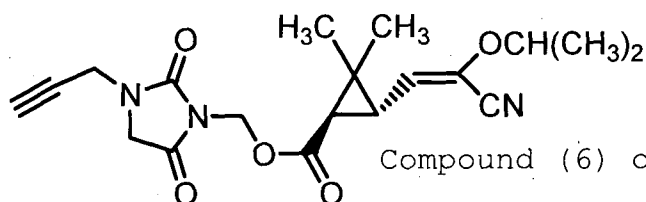
[0075]

Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.16-1.32 (m,12H), 1.59-1.64 (m,1H), 2.28 (m,0.78H), 2.36 (m,1H),
20 2.43-2.46 (m,0.22H), 4.06 (s,2H), 4.28 (d,2H), 4.27-4.36 (m,1H), 5.24 (d,0.22H), 5.42 (d,0.78H), 5.49-5.62 (m,2H)

[0076]

Production Example 6

The 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1E)-2-cyano-2-(isopropoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 78:22) obtained in Production Example 5 was subjected to a silica gel column chromatography (eluent: hexane/ethyl acetate = 2:1) to obtain, as a fraction having higher polarity, 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1E)-2-cyano-(isopropoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (hereinafter referred to as the compound (6) of the present invention) represented by the following formula:



Compound (6) of the present invention

[0077]

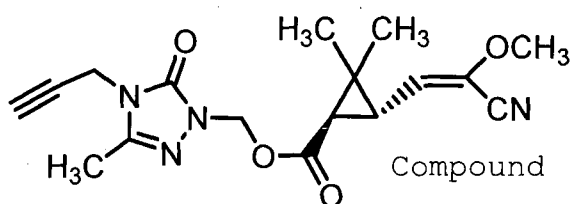
Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.16 (s, 3H), 1.24-1.28 (m, 6H), 1.32 (s, 3H), 1.59 (d, 1H), 2.28 (m, 1H), 2.36 (m, 1H), 4.06 (s, 2H), 4.27-4.31 (m, 3H), 5.42 (d, 1H), 5.49-5.62 (m, 2H)

[0078]

Production Example 7

The operation was conducted in the same manner as Production Example 1, except that 2-hydroxymethyl-5-methyl-4-(2-propynyl)-2,4-dihydro-[1,2,4]-triazole-3-one was used

in place of 3-hydrozymethyl-1-(2-propynyl)imidazolidine-2,4-dione, to obtain 3-methyl-5-oxo-4-(2-propynyl)-4,5-dihydro-[1,2,4]-triazolylmethyl (1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropane carboxylate (hereinafter referred to as the compound (7) of the present invention) represented by the following formula:



Compound (7) of the present invention

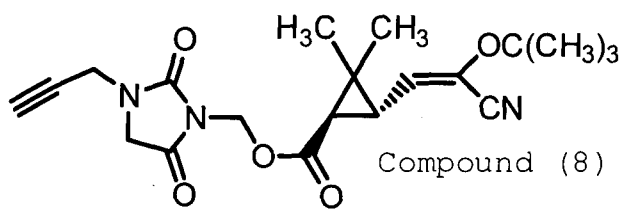
Pale yellow liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.17 (s, 3H), 1.32 (s, 3H), 1.60 (d, 1H), 2.29 (m, 1H), 2.34 (m, 1H), 2.36 (s, 3H), 3.62 (s, 3H), 4.43 (d, 2H), 5.23 (d, 1H), 5.68-5.81 (dd, 2H)

Production Example 8

The operation was conducted in the same manner as Production Example 1, except that (1R)-trans-3-[(1EZ)-2-cyano-2-(tert-butoxy)ethenyl]-2,2-dimethylcyclopropanecarboxylic acid (E:Z = 4:1) was used in place of (1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid, to obtain 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1EZ)-2-cyano-2-(tert-butoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 78:22).

The 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl_ (1R)-

trans-3-[(1E)-2-cyano-2-(tert-butoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 78:22) was subjected to a silica gel column chromatography (eluent: hexane/ethyl acetate = 2:1) to obtain, as a fraction having higher polarity, 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1E)-2-cyano-(tert-butoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate (hereinafter referred to as the compound (8) of the present invention) represented by the following formula:



Compound (8) of the present invention

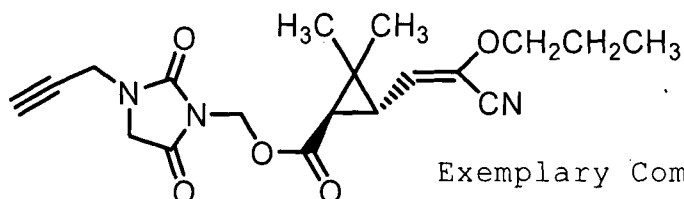
Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.16 (s, 3H), 1.28 (s, 9H), 1.32 (s, 3H), 1.59 (d, 1H), 2.28 (m, 1H), 2.36 (m, 1H), 4.06 (s, 2H), 4.27-4.31 (m, 2H), 5.42 (d, 1H), 5.49-5.62 (m, 2H)

[0079]

Specific compounds other than the above-mentioned compounds are shown below.

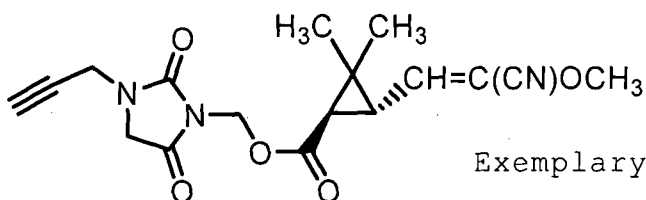
(Exemplary Compound 1)

2,5-Dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-[(1E)-2-cyano-2-(propoxy)ethenyl]-2,2-dimethylcyclopropane carboxylate represented by the following formula:



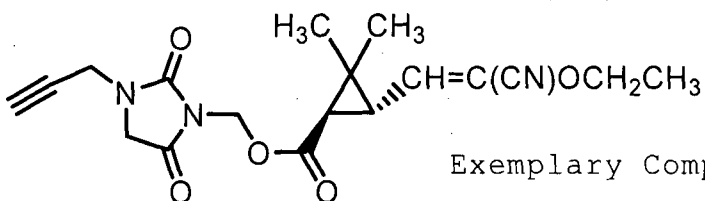
(Exemplary Compound 2)

2,5-Dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-
trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-
5 dimethylcyclopropane carboxylate (E:Z = 1:1) represented by
the following formula:



(Exemplary Compound 3)

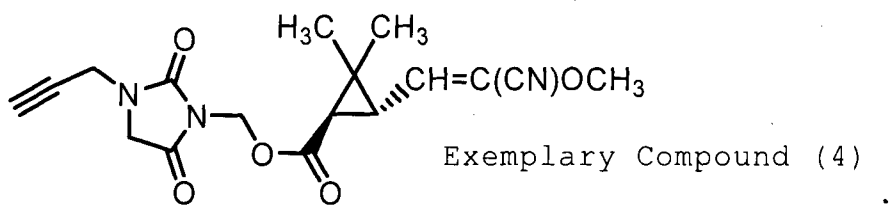
2,5-Dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-
10 trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-
dimethylcyclopropane carboxylate (E:Z = 1:1) represented by
the following formula:



(Exemplary Compound 4)

15 2,5-Dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-
trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-

dimethylcyclopropane carboxylate (E:Z = 2:1) represented by the following formula:



[0080]

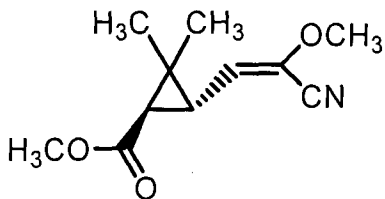
5 Next, with reference to the production of the intermediate for preparing the above-mentioned compounds of the present invention, Reference Production Examples are shown below.

[0081]

10 Reference Production Example 1

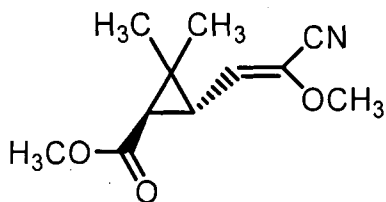
Sodium hydride (55.2%, oil dispersion) (0.42 g, 9.7 mmol) was added to a round bottom flask and thereto was added 15 mL of absolute tetrahydrofuran. Thereto was added dropwise a solution of diethyl methoxy(cyano)methylphosphonate (2.0 g, 9.7 mmol) dissolved in absolute tetrahydrofuran (5 mL) under ice-cooling under nitrogen atmosphere. The reaction mixture was stirred under ice-cooling for 30 minutes and at 25°C for another 1 hour. Thereto was added dropwise a solution of methyl (1R)-trans-3-formyl-2,2-dimethylcyclopropane carboxylate (1.40 g, 9.0 mmol) dissolved in absolute tetrahydrofuran (5 mL). After stirring the mixture at 25°C for 2 hours, the

reaction solution was added to a mixed solution consisting of 10 mL of 5% hydrochloric acid and 30 mL of iced water and the reaction mixture was extracted twice with each 50 mL of ethyl acetate. The obtained ethyl acetate layers were combined and washed with saturated sodium bicarbonate aqueous solution and 30 mL of saturated brine successively and dried over magnesium sulfate. The resulting solution was concentrated under reduced pressure and the residue was subjected to silica gel column chromatography to obtain, as a fraction having higher polarity, 480 mg of methyl (1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropane carboxylate represented by the following formula:



Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.19 (s, 3H), 1.31 (s, 3H), 1.61 (m, 1H), 2.27 (m, 1H), 3.63 (s, 3H), 3.70 (s, 3H), 5.29 (d, 1H)

Also as the fraction having lower polarity, 591 mg of methyl (1R)-trans-3-[(1Z)-2-cyano-2-methoxyethenyl]-2,2-dimethylcyclopropane carboxylate represented by the following formula:



was obtained.

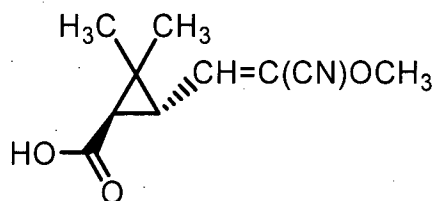
Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.31 (s, 3H),
1.35 (s, 3H), 1.66 (m, 1H), 2.46 (m, 1H), 3.69 (s, 3H), 3.77
5 (s, 3H), 5.21 (d, 1H)

[0082]

(Reference Production Example 2)

Methyl (1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-
2,2-dimethylcyclopropane carboxylate (463 mg, 2.2 mmol) was
10 dissolved in a mixed solution consisting of 1.5 mL of
methanol and 0.5 mL of water, and then thereto was added
potassium hydroxide (200 mg, 3.6 mmol) and the reaction
mixture was stirred at room temperature for 12 hours. The
reaction solution was added to 20 mL of iced water and the
15 reaction mixture was extracted with 20 mL of ethyl acetate.
To the resulting aqueous layer was added hydrochloric acid
until the aqueous layer was made pH 2 and then the
resulting mixture was extracted twice with 20 mL of ethyl
acetate. The obtained ethyl acetate layers were combined
20 and washed twice with 20 mL of saturated brine and then
dried over magnesium sulfate. The solution was
concentrated under reduced pressure to obtain 336 mg of
(1R)-trans-3-[(1E)-2-cyano-2-methoxyethenyl]-2,2-

dimethylcyclopropanecarboxylic acid represented by the following formula:



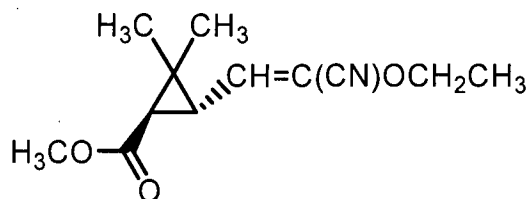
Pale yellow crystals: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.22 (s, 3H), 1.36 (s, 3H), 1.62 (d, 1H), 2.32 (m, 1H), 3.64 (s, 3H), 5.29 (d, 1H)

[0083]

(Reference Production Example 3)

Sodium hydride (50.0%, oil dispersion) (1.56 g, 32.5 mmol) was added to a 200 mL round bottom flask and thereto was added 43 mL of absolute tetrahydrofuran. Thereto was added dropwise a solution of diethyl ethoxy(cyano)methylphosphonate dissolved in absolute tetrahydrofuran (11 mL) under ice-cooling under nitrogen atmosphere. The reaction mixture was stirred under ice-cooling for 40 minutes and at 25°C for another hour. Thereto was added dropwise a solution of methyl (1R)-trans-3-formyl-2,2-dimethylcyclopropane carboxylate (3.17 g, 20.3 mmol) dissolved in absolute tetrahydrofuran (11 mL). After stirring the reaction mixture at 25°C for 12 hours, the reaction solution was added to a mixed solution consisting of 10 mL of 5% hydrochloric acid and 100 mL of iced water

and the resulting mixture was extracted twice with each 100 mL of ethyl acetate. The obtained ethyl acetate layers were combined and washed with saturated sodium bicarbonate aqueous solution and 50 mL of saturated brine successively and then dried over magnesium sulfate. The resulting mixture was concentrated under reduced pressure and the residue was subjected to silica gel column chromatography to obtain 6.00 g of methyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 2:1) represented by the following formula:



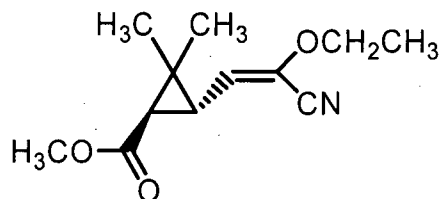
Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm); 1.18+1.19 (s+s, 3H), 1.29+1.31 (s+s, 3H), 1.29-1.34 (m, 3H), 1.61 (d, 0.67H), 1.65 (d, 0.33H), 2.25-2.29 (m, 0.67H), 2.42-2.46 (m, 0.33H), 3.69+3.70 (s+s, 3H), 3.83 (q, 1.34H), 4.03 (q, 0.66H), 5.24 (d, 0.33H), 5.34 (d, 0.67H)

[0084]

(Reference Production Example 4)

4.0 g of the methyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate (E:Z = 2:1) obtained in Reference Production Example 3 was subjected to a silica gel column chromatography (eluate:

hexane/ethyl acetate = 10:1) to obtain, as a fraction having higher polarity, 2.91 g of methyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate represented by the following formula:



Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.18 (s, 3H), 1.31 (s, 3H), 1.29-1.33 (m, 3H), 1.61 (d, 1H), 2.25-2.29 (m, 1H), 3.70 (s, 3H), 3.83 (q, 2H), 5.34 (d, 1H)

[0085]

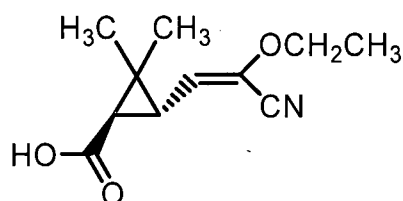
10 (Reference Production Example 5)

Methyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate (2.91 g, 13.0 mmol) was dissolved in a mixed solution consisting of 17 mL of methanol and 6 mL of water and then thereto was added potassium hydroxide (1.56 g, 27.9 mmol) and the reaction mixture was stirred at room temperature for 12 hours. The resulting reaction solution was added to 45 mL of iced water and the resulting mixture was extracted with 45 mL of ethyl acetate. To the resulting aqueous layer was added hydrochloric acid until the aqueous layer was made pH 2, and then the resulting mixture was extracted twice with 45 mL of ethyl acetate. The obtained ethyl acetate layers

15

20

were combined and washed twice with 50 mL of saturated brine and then dried over magnesium sulfate. The resulting solution was concentrated under reduced pressure to obtain 2.64 g of (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid represented by the following formula:



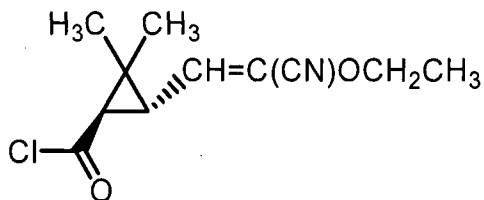
White crystals: ^1H -NMR (CDCl_3 , TMS) δ (ppm): 1.21 (s, 3H), 1.33 (s, 3H), 1.31-1.35 (t, 3H), 1.66 (d, 1H), 2.46 (m, 1H), 4.05 (q, 2H), 5.24 (d, 1H)

[0086]

Reference Production Example 6

To (1R)-trans-3-[(1EZ)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid (E:Z = 2:1) (500 mg, 2.39 mmol) was added 3 mL of toluene, followed by addition of thionyl chloride (370 mg, 3.11 mmol) and further 10 mg of N,N-dimethylformamide, and the reaction mixture was stirred at 60 to 70°C as internal temperature for 4 hours. The reaction solution was stood to cool to room temperature, and concentrated under reduced pressure to obtain 550 mg of (1R)-trans-3-[(1EZ)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid chloride (E:Z = 2:1)

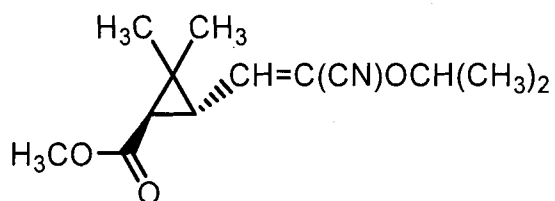
represented by the following formula:



[0087]

Reference Production Example 7

5 The reaction was conducted in the same manner as
Reference Production Example 3, except that diethyl
isopropoxy(cyano)methylphosphonate was used in place of
diethyl ethoxy(cyano)methylphosphonate to obtain methyl
(1R)-trans-3-[(1EZ)-2-cyano-2-(isopropoxy)ethenyl]-2,2-
10 dimethylcyclopropane carboxylate (E:Z = 4:1) represented by
the following formula:



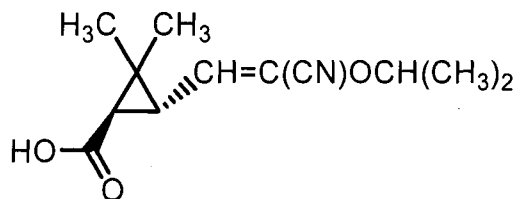
Colorless liquid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.19-1.31
(m, 12H), 1.62 (d, 0.8H), 1.65 (d, 0.2H), 2.28 (m, 0.8H), 2.43
15 (m, 0.2H), 3.69+3.70 (s+s, 3H), 4.29 (q, 0.8H), 4.37 (q, 0.2H),
5.29 (d, 0.2H), 5.46 (d, 0.8H)

[0088]

Reference Production Example 8

The reaction was conducted in the same manner as

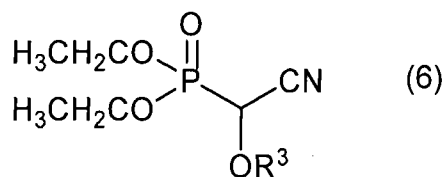
Reference Production Example 5, except that methyl (1R)-trans-3-[(1E)-2-cyano-2-isopropoxyethenyl]-2,2-dimethylcyclopropane carboxylate was used in place of methyl (1R)-trans-3-[(1E)-2-cyano-2-ethoxyethenyl]-2,2-dimethylcyclopropane carboxylate to obtain (1R)-trans-3-[(1E)-2-cyano-2-isopropoxyethenyl]-2,2-dimethylcyclopropanecarboxylic acid (E:Z = 4:1) represented by the following formula:



10 Pale yellow solid: $^1\text{H-NMR}$ (CDCl_3 , TMS) δ (ppm): 1.20-1.36 (m, 12H), 1.62 (d, 0.8H), 1.66 (d, 0.2H), 2.31 (m, 0.8H), 2.48 (m, 0.2H), 4.30 (q, 0.8H), 4.39 (q, 0.2H), 5.29 (d, 0.2H), 5.46 (d, 0.8H)

[0089]

15 Next, the process for preparing phosphonate compound represented by formula (6):



wherein R^3 represents the same meanings as defined above, is described below.

20 The compound represented by formula (6) wherein R^3

represents methyl group, that is, diethyl methoxy(cyano)methylphosphonate is synthesized according to the process described in J. Org. Chem. (1976), vol.41, pp.2846-2849. Also the phosphonate compounds represented
5 by formula (6) wherein R³ represents ethyl group, propyl group or isopropyl group, that is, diethyl ethoxy(cyano)methylphosphonate, diethyl propoxy(cyano)methylphosphonate, or diethyl isopropoxy(cyano)methylphosphonate is similarly synthesized
10 according to the process described in J. Org. Chem. (1976) vol.41, pp.2846-2849, except that ethoxyacetonitrile, propoxyacetonitrile or isopropoxyacetonitrile is used in place of methoxyacetonitrile.

[0090]

15 Next, Formulation Examples are shown below. Parts are by mass.

[0091]

Formulation Example 1

Twenty (20) parts of each of the compounds (1) to (8)
20 of the present invention is dissolved in 65 parts of xylene and 15 parts of SOLPOL 3005X (a registered trademark of TOHO Chemical industry Co., Ltd.) is added thereto and thoroughly mixed with stirring to obtain emulsifiable concentrates.

25 [0092]

Formulation Example 2

Five (5) parts of SORPOL 3005X is added to 40 parts of each of the compounds (1) to (8) of the present invention and the mixture is thoroughly mixed, and 32 parts of
5 CARPLEX #80 (synthetic hydrated silicon oxide, a registered trademark of SHIONOGI & CO., LTD.) and 23 parts of 300-mesh diatomaceous earth are added thereto, followed by mixing with stirring by a mixer to obtain wettable powders.

[0093]

10 Formulation Example 3

A mixture of 1.5 parts of each of the compounds (1) to (8) of the present invention, 1 part of TOKUSIL GUN (synthetic hydrated silicon oxide, manufactured by Tokuyama Corporation), 2 parts of REAX 85A (sodium lignin sulfonate,
15 manufactured by West Vaco Chemicals), 30 parts of BENTONITE FUJI (bentonite, manufactured by Houjin) and 65.5 parts of SHOUKOUZAN A clay (kaoline clay, manufactured by Shoukouzan Kougyousho) is thoroughly pulverized and mixed, and water is added thereto. The mixture is thoroughly kneaded,
20 granulated by an extruding granulator, and then dried to obtain 1.5 % granules.

[0094]

Formulation Example 4

To a mixture of 10 parts of each of the compounds (1)
25 to (8) of the present invention, 10 parts of

phenylxylylethane and 0.5 part of SUMIDUR L-75 (tolylene diisocyanate, manufactured by Sumitomo Bayer Urethane Co., Ltd.) is added 20 parts of 10 % aqueous solution of gum arabic, and the mixture is stirred with a homomixer to obtain an emulsion having an average particle diameter of 20 μm . To the emulsion, 2 parts of ethylene glycol is added and the mixture is further stirred in a warm bath at a temperature of 60°C for 24 hours to obtain microcapsule slurry. On the other hand, 0.2 part of xanthan gum and 1.0 part of VEEGUM R (aluminum magnesium silicate, manufactured by Sanyo Chemical industries, Ltd.) are dispersed in 56.3 parts of ion-exchanged water to obtain a thickener solution. Then, 42.5 parts of the above-mentioned microcapsule slurry and 57.5 parts of the above-mentioned thickener solution are mixed to obtain microcapsules..

[0095]

Formulation Example 5

A mixture of 10 parts of each of the compounds (1) to (8) of the present invention and 10 parts of phenylxylylethane is added to 20 parts of a 10% aqueous solution of polyethylene glycol, and the mixture is stirred by a homomixer to obtain an emulsion having an average particle diameter of 3 μm . On the other hand, 0.2 part of xanthan gum and 1.0 part of VEEGUM R (aluminum magnesium silicate, manufactured by Sanyo Chemical Industries, Ltd.)

are dispersed in 58.8 parts of ion-exchanged water to obtain a thickener solution. Then, 40 parts of the above-mentioned emulsion solution and 60 parts of the above-mentioned thickener solution are mixed to obtain flowable formulations.

[0096]

Formulation Example 6

To 5 parts of each of the compounds (1) to (8) of the present invention, 3 parts of CARPLEX #80 (synthetic hydrated silicon oxide, a registered trademark of SHIONOGI & CO., LTD.), 0.3 parts of PAP (a mixture of monoisopropyl phosphate and diisopropyl phosphate) and 91.7 parts of talc (300 mesh) are added and the mixture is stirred by a mixer to obtain dusts.

[0097]

Formulation Example 7

Zero point one (0.1) part of each of the compounds (1) to (8) of the present invention is dissolved in 10 parts of dichloromethane and the solution is mixed with 89.9 parts of deodorized kerosine to obtain oil solutions.

[0098]

Formulation Example 8

Zero point one (0.1) part of each of the compounds (1) to (8) of the present invention and 39.9 parts of deodorized kerosine are mixed and dissolved, and the

solution is filled into an aerosol container and a valve portion is installed. Then, 60 parts of power propellant (liquefied petroleum gas) is filled therein under pressure through the valve portion to obtain oil-based aerosol formulations.

[0099]

Formulation Example 9

Zero point six (0.6) part of each of the compounds (1) of (8) of the present invention, 5 parts of xylene, 3.4 parts of deodorized kerosine and 1 part of Reodol MO-60 (emulsifier, a registered trademark of Kao Corporation) are mixed and dissolved, and then the resulting solution and 50 parts of water are filled into an aerosol container, and then 40 parts of power propellant (liquefied petroleum gas) is filled therein under pressure through a valve portion to obtain aqueous aerosol formulations.

[0100]

Formulation Example 10

Zero point three (0.3) g of each of the compounds (1) to (8) of the present invention is dissolved in 20 mL of acetone, and the resulting solution is uniformly mixed with stirring with 99.7 g of a base material for a coil (obtained by mixing Tabu powder, Pyrethrum mark and wooden powder at a ratio of 4:3:3). Then, 100 mL of water is added thereto, and the mixture is thoroughly kneaded, dried

and molded to obtain insecticidal coils.

[0101]

Formulation Example 11

A mixture of 0.8 g of each of the compounds (1) to (8)
5 of the present invention and 0.4 g of piperonyl butoxide is
dissolved in acetone and the total volume is adjusted to 10
mL. Then, 0.5 mL of this solution is uniformly impregnated
into a base material for an insecticidal mat for electric
heating (a plate obtained by hardening fibrils of a mixture
10 of cotton linters and pulp) having a size of 2.5 cm × 1.5
cm and a thickness of 0.3 cm to obtain insecticidal mats
for electric heating.

[0102]

Formulation Example 12

15 A solution obtained by dissolving 3 parts of each of
the compounds (1) to (8) of the present invention in 97
parts of deodorized kerosine is poured into a vessel made
of vinyl chloride. A liquid absorptive core whose upper
part can be heated by a heater (an inorganic pulverized
20 powder is hardened with a binder and sintered) is inserted
thereinto to obtain parts to be used for a liquid
absorptive core type thermal transpiring apparatus.

[0103]

Formulation Example 13

25 One hundred (100) mg of each of the compounds (1) to

(8) of the present invention is dissolved in an appropriate amount of acetone, and the resulting solution is impregnated into a porous ceramic plate having a size of 4.0 cm × 4.0 cm and a thickness of 1.2 cm to obtain thermal fumigants.

[0104]

Formulation Example 14

One hundred (100) µg of each of the compounds (1) to (8) of the present invention is dissolved in an appropriate amount of acetone, and the resulting solution is uniformly applied to filter paper having a size of 2 cm × 2 cm and a thickness of 0.3 mm, and air-dried to remove acetone, and thus volatile agents for using at room temperature are obtained.

[0105]

Formulation Example 15

Ten (10) parts of each of the compounds (1) to (8) of the present invention, 35 parts of white carbon containing 50 parts of a polyoxyethylene alkyl ether sulfate ammonium salt, and 55 parts of water are mixed and then finely ground by a wet grinding method to obtain 10% flowable formulations.

[0106]

Next, the following Test Examples illustrate that the compounds of the present invention are effective as an

active ingredient of a pest control agent.

[0107]

Test Example 1

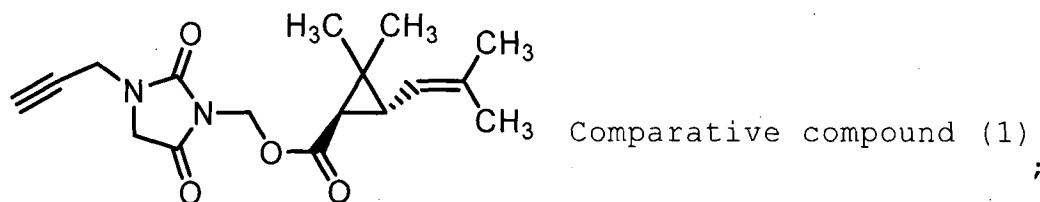
Each 0.00156 part of each of the compounds (1) to (5) of the present invention was dissolved in 10 parts of isopropyl alcohol, and the resulting solution was mixed with 89.998 parts of deodorized kerosene to prepare a 0.00156% (w/v) oil solution.

Ten (10) adult German cockroaches (*Blattella germanica*, 5 males and 5 females) were released in a test container (diameter 8.75 cm, height 7.5 cm, the bottom face is made of 16 mesh metallic wire), the inner face on which butter was applied, and the container was set at the bottom of a test chamber (bottom face: 46 cm × 46 cm, height: 70 cm). Each 1.5 mL of the oil solution of each of the compounds (1) to (5) of the present invention was sprayed using a spray gun at a pressure of 0.42 kg/cm² from 60 cm higher than the upper face of the container. Thirty seconds after the spraying, the container was pulled out from the test chamber, and the cockroaches were transferred into a clean poly cup. After a prescribed time, the number of knocked-down cockroaches was counted and a knock-down ratio was determined (repeated twice). The knocked-down ratio was calculated by the following equation.

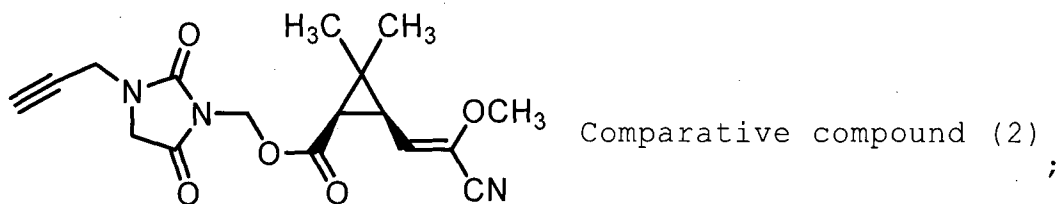
Knocked-down ratio (%) = (Number of knocked-down

cockroaches / Number of test cockroaches) × 100

As controls for comparison, the test was conducted in the same manner as the above, except for using 2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-trans-3-(2-methyl-1-propenyl)-2,2-dimethylcyclopropane carboxylate (compound described in Pesticide Science, 10, p.291(1979), hereinafter referred to as the comparative compound (1)) represented by the following formula:

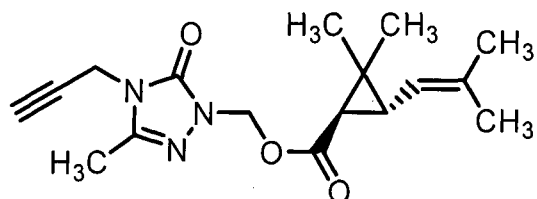


2,5-dioxo-3-(2-propynyl)imidazolidinylmethyl (1R)-cis-3-((Z)-2-cyano-2-methoxyethenyl)-2,2-dimethylcyclopropane carboxylate (compound described in JP-A-60-16962, hereinafter referred to as the comparative compound (2)) represented by the following formula:



and

3-methyl-5-oxo-4-(2-propynyl)-4,5-dihydro-[1,2,4]-triazolylmethyl (1R)-trans-3-(2-methyl-1-propenyl)-2,2-dimethylcyclopropane carboxylate (compound described in JP-A-57-158765, hereinafter referred to as the comparative compound (3)) represented by the following formula:



Comparative compound (3)

The results (0.7 minutes after spraying) are shown in Table 1.

[0108]

5 Table 1

Test compound	Knock-down ratio (%) 0.7 minutes after spraying
compound (1) of the present invention	95
compound (2) of the present invention	85
compound (3) of the present invention	90
compound (4) of the present invention	75
compound (5) of the present invention	80
comparative compound (1)	50
comparative compound (2)	45
comparative compound (3)	10

[0109]

Test Example 2

Each 0.00625 part of each of the compounds (1) to (8) of the present invention was dissolved in 10 parts of isopropyl alcohol, and the resulting solution was mixed with 89.99375 parts of deodorized kerosene to prepare a 0.00625% (w/v) oil solution.

Ten (10) adult German cockroaches (*Blattella germanica*, 5 males and 5 females) were released in a test container

(diameter 8.75 cm, height 7.5 cm, the bottom face is made of 16 mesh metallic wire), the inner face on which butter was applied, and the container was set at the bottom of a test chamber (bottom face: 46 cm × 46 cm, height: 70 cm).

Each 1.5 mL of the oil solution of each of the compounds (1) to (8) of the present invention was sprayed using a spray gun at a pressure of 0.42 kg/cm² from 60 cm higher than the upper face of the container. Thirty seconds after the spraying, the container was pulled out from the test chamber, and the cockroaches were transferred into a clean poly cup. After a prescribed time, the number of knocked-down cockroaches was counted and a knock-down ratio was determined (repeated twice). The knocked-down ratio was calculated by the following equation.

$$\text{Knocked-down ratio (\%)} = (\text{Number of knocked-down cockroaches} / \text{Number of test cockroaches}) \times 100$$

The results (0.7 minutes after spraying) are shown in Table 2.

[0110]

Table 2

Test compound	Knock-down ratio (%) 0.7 minutes after spraying
compound (1) of the present invention	100
compound (2) of the present invention	100
compound (3) of the present invention	100
compound (4) of the present invention	100

invention	
compound (5) of the present invention	100
compound (6) of the present invention	100
compound (7) of the present invention	100
compound (8) of the present invention	100

[0111]

Test Example 3

Each 0.1 part of each of the compounds (1) to (8) of the present invention was dissolved in 10 parts of isopropyl alcohol, and the resulting solution was mixed with 89.9 parts of deodorized kerosene to prepare a 0.1% (w/v) oil solution.

Six (6) adult American cockroaches (*Periplaneta americana*, 3 males and 3 females) were released in a test container (diameter 12.5 cm, height 10 cm, the bottom face is made of 32 mesh metallic wire), the inner face on which butter was applied, and the container was set at the bottom of a test chamber (bottom face: 46 cm × 46 cm, height: 70 cm). Each 1.5 mL of the oil solution of each of the compounds (1) to (8) of the present invention was sprayed using a spray gun at a pressure of 0.42 kg/cm² from 60 cm higher than the upper face of the container. Thirty seconds after the spraying, the container was pulled out from the test chamber, and the cockroaches were transferred into a clean poly cup. After a prescribed time, the number

of knocked-down cockroaches was counted and a knock-down ratio was determined (repeated twice). The knocked-down ratio was calculated by the following equation.

$$\text{Knocked-down ratio (\%)} = (\text{Number of knocked-down cockroaches} / \text{Number of test cockroaches}) \times 100$$

The results (5 minutes after spraying) are shown in Table 3.

[0112]

Table 3

Test compound	Knock-down ratio (%) 5 minutes after spraying
compound (1) of the present invention	100
compound (2) of the present invention	100
compound (3) of the present invention	100
compound (4) of the present invention	100
compound (5) of the present invention	100
compound (6) of the present invention	100
compound (7) of the present invention	92
compound (8) of the present invention	100

10 [0113]

Test Example 4

Each 0.1 part of each of the compounds (1) to (7) of the present invention was dissolved in 10 parts of isopropyl alcohol, and the resulting solution was mixed
15 with 89.9 parts of deodorized kerosene to prepare a 0.1%

(w/v) oil solution.

Ten (10) adult houseflies (*Musca domestica*, 5 males and 5 females) were released in a polyethylene cup (lower diameter 10.6 cm, upper diameter 12 cm, height 7 cm), and the polyethylene cup was covered with 16-mesh nylon gauze. The cup was set at the bottom of a test chamber (bottom face: 46 cm × 46 cm, height: 70 cm). Each 1.5 mL of the oil solution of each of the compounds (1) to (7) of the present invention was sprayed using a spray gun at a pressure of 0.9 kg/cm² from 30 cm higher than the upper face of the cup. Immediately after the spraying, the cup was pulled out from the test chamber. After a prescribed time, the number of knocked-down houseflies was counted and a knock-down ratio was determined (repeated twice).

The results are shown in Table 4.

[0114]

Table 4

Test compound	Knock-down ratio (%) 1 minutes after spraying
compound (1) of the present invention	100
compound (2) of the present invention	100
compound (3) of the present invention	100
compound (4) of the present invention	100
compound (5) of the present invention	100
compound (6) of the present invention	100
compound (7) of the present invention	100

invention	
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[0115]

Test Example 5

Each 0.00625 part of each of the compounds (1) to (7) of the present invention was dissolved in 10 parts of isopropyl alcohol, and the resulting solution was mixed with 89.99375 parts of deodorized kerosene to prepare a 0.00625 part (w/v) oil solution.

Ten (10) adult female common house mosquitoes (*Culex pipens pallens*) were released in a polyethylene cup (lower diameter 10.6cm, upper diameter 12cm, height 7 cm), and the polyethylene cup was covered with 16-mesh nylon gauze. The cup was set at the bottom of a test chamber (bottom face: 46 cm × 46 cm, height: 70 cm). Each 1.5 mL of the oil solution of each of the compounds (1) to (7) of the present invention was sprayed using a spray gun at a pressure of 0.4 kg/cm² from 30 cm higher than the upper face of the cup. Immediately after the spraying, the cup was pulled out from the test chamber. After a prescribed time, the number of knocked-down common house mosquitoes was counted and a knock-down ratio was determined (repeated twice).

The results are shown in Table 5.

[0116]

Table 5

Test compound	Knock-down ratio (%) 0.5 minutes after spraying
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compound (1) of the present invention	100
compound (2) of the present invention	100
compound (3) of the present invention	100
compound (4) of the present invention	100
compound (5) of the present invention	100
compound (6) of the present invention	100
compound (7) of the present invention	100

INDUSTRIAL APPLICABILITY

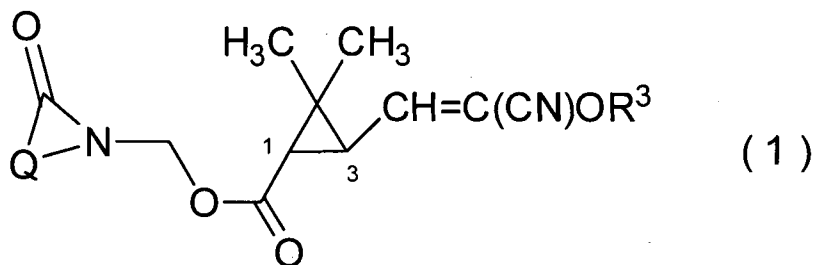
[0117]

The compound of the present invention has an excellent pest control effect and is therefore useful as active ingredient of a pest control agent.

5

CLAIMS

1. An ester compound represented by formula (1):



wherein

Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$ or $N(CH_2C\equiv CH)-$

5 $C(CH_3)=N^*$ (where, * represents a binding position with N atom being adjacent to a carbonyl group);

R^3 represents a C1-C4 alkyl group; and

a relative configuration between the substituent at the 1-position of the cyclopropane ring and the substituent
10 at the 3-position of the cyclopropane ring is a trans configuration.

2. The ester compound according to claim 1, wherein Q represents $N(CH_2C\equiv CH)-CH_2-C^*(=O)$.

3. The ester compound according to claim 1, wherein Q
15 represents $N(CH_2C\equiv CH)-C(CH_3)=N^*$.

4. The ester compound according to any one of claims 1 to 3, wherein an absolute configuration at the 1-position of the cyclopropane ring is an R configuration in formula (1).

5. The ester compound according to any one of claims 1 to
20 4, wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in the E

configuration or a mixture of E configuration and Z configuration, and the proportion of the E configuration is 50% or more in formula (1).

6. The ester compound according to any one of claims 1 to 5, wherein a double bond present on the substituent at the 3-position of the cyclopropane ring is in the E configuration in formula (1).

7. The ester compound according to any one of claims 1 to 6, wherein R³ represents methyl group in formula (1).

8. The ester compound according to any one of claims 1 to 6, wherein R³ represents ethyl group in formula (1).

9. The ester compound according to any one of claims 1 to 6, wherein R³ represents isopropyl group in formula (1).

10. The ester compound according to any one of claims 1 to 6, wherein R³ represents tert-butyl group in formula (1).

11. A pest control agent comprising the ester compound according to any one of claims 1 to 10 and an inert carrier.

12. A method of controlling pests, which comprises the step of applying an effective amount of the ester compound according to any one of claims 1 to 10 to pests or a place where pests inhabit.

13. A method of controlling pests, which comprises the step of applying an effective amount of the ester compound according to any one of claims 1 to 10 to cockroaches or a place where cockroaches inhabit.

14. The method according to claim 13, wherein the cockroach is American cockroach.

15. The method according to claim 13, wherein the cockroach is German cockroach.

5 16. A method of controlling pests, which comprises a step of spraying an effective amount of the ester compound according to any one of claims 1 to 10 to cockroaches or a place where cockroaches inhabit.

10 17. The method according to claim 16, wherein the cockroach is American cockroach.

18. The method according to claim 16, wherein the cockroach is German cockroach.

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2012/071937

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07D233/78 C07D249/12 A01N53/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07D A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2010/087419 A2 (SUMITOMO CHEMICAL CO [JP]; MAE MASAYUKI [JP]; MORI TATSUYA [JP]) 5 August 2010 (2010-08-05) the whole document -----	1-18
Y	US 4 602 038 A (TESSIER JEAN [FR] ET AL) 22 July 1986 (1986-07-22) the whole document -----	1-18
A	US 4 176 189 A (HIRANO MASACHIKA [JP] ET AL) 27 November 1979 (1979-11-27) the whole document -----	1-18
A	JP 57 158765 A (SUMITOMO CHEMICAL CO) 30 September 1982 (1982-09-30) cited in the application the whole document ----- -/--	1-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

21 January 2013

Date of mailing of the international search report

28/01/2013

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INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2012/071937

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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