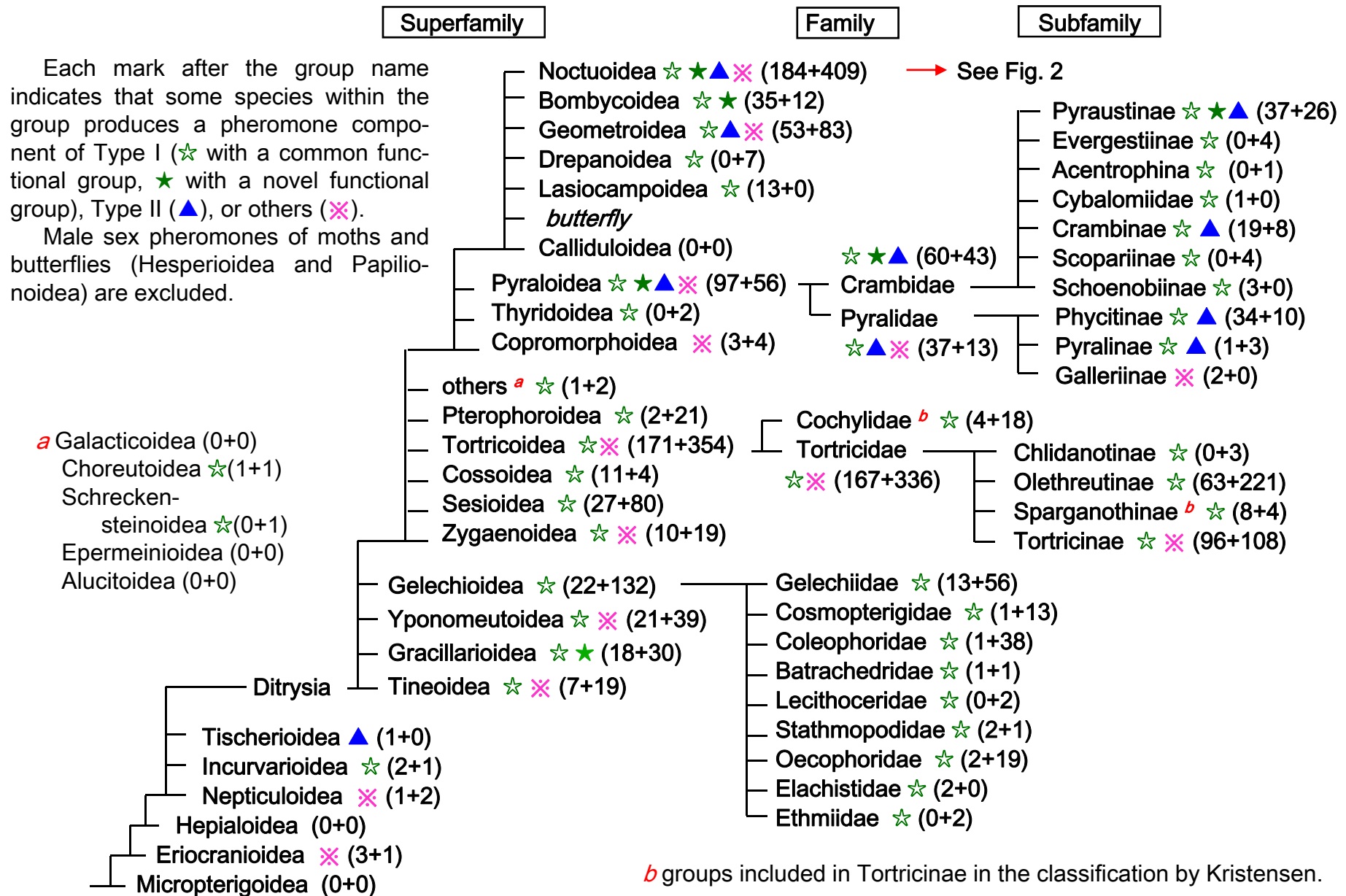


Fig. 1 (Update: 2017. 11. 29)

Taxonomy and pheromone studies of lepidopteran insects. The more highly evolved superfamily of moths is arranged at the upper position. The numbers before and after + in parenthesis of each group indicates the total number of species whose female sex pheromone and male attractant have been reported respectively.



^b groups included in Tortricinae in the classification by Kristensen.

Fig. 2 (Update: 2017. 11. 29)

Taxonomy and pheromone studies of insects in the superfamily of Noctuoidea. The numbers before and after + in parenthesis of each group indicates the total number of species whose female sex pheromone and male attractant have been reported respectively.

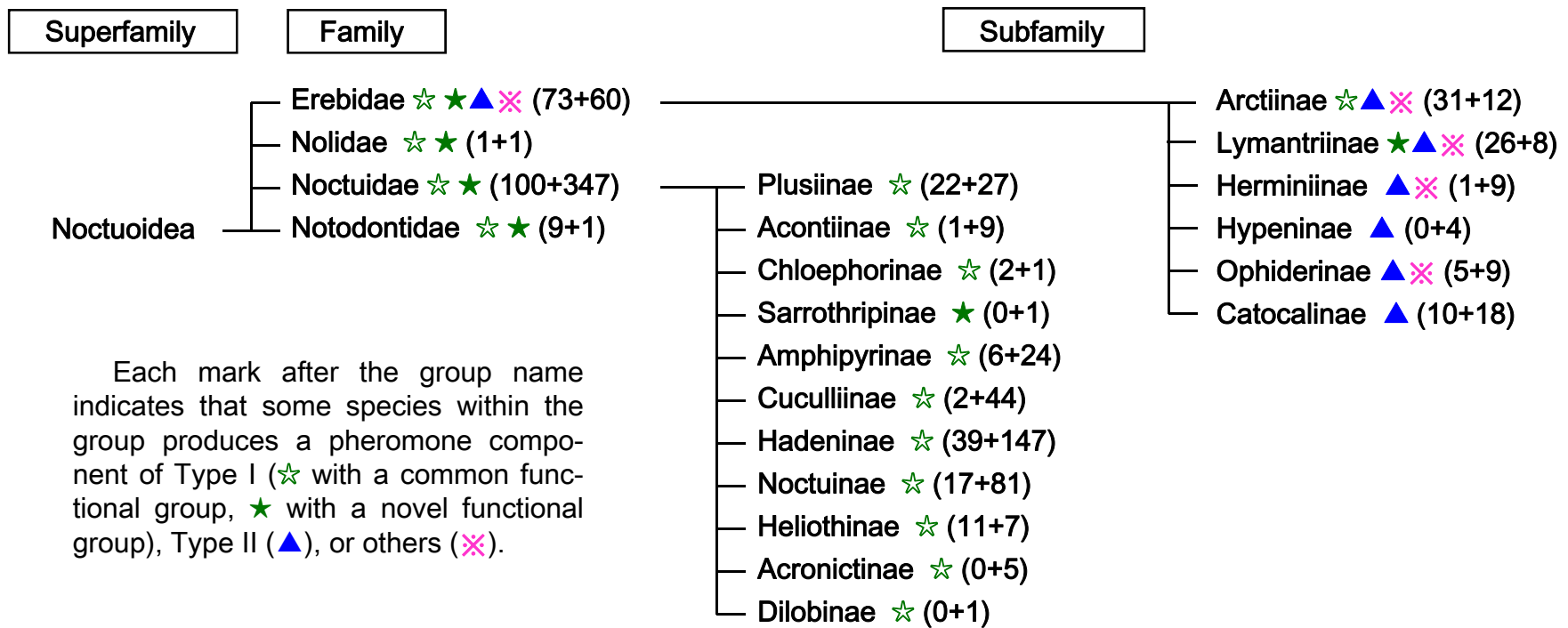


Fig. 3 (Update: 2017. 11. 29)

Double-bond positions of monoenyl components in Type I pheromones; (A) counting from the functional group, and (B) counting from the terminal methyl group. Components with an odd numbered chain (C₁₃, C₁₅, and C₁₇) are not included. Red colour indicates identification after 2004.

(A) Chain length	Double bond position, counting from the functional group															
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
C-10				↓		↓	↓		—	—	—	—	—	—	—	—
C-12		↓		↓		↓	↓	↓	↓	↓	—	—	—	—	—	—
C-14		↓		↓		↓	↓	↓	↓	↓	↓		—	—	—	—
C-16				↓		↓		↓	↓	↓		↓			—	—
C-18	↓				↓	↓				↓		↓				

(B) Chain length	Double bond position (w), counting from the terminal methyl group															
	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
C-10	—	—	—	—	—	—	—	—				↓		↓	↓	
C-12	—	—	—	—	—	—		↓		↓		↓	↓	↓	↓	↓
C-14	—	—	—	—		↓		↓		↓	↓	↓	↓	↓	↓	
C-16	—	—				↓		↓		↓	↓	↓		↓		
C-18	↓					↓				↓		↓				

Fig. 4 (Update: 2017. 11. 29)

Double-bond positions of dienyl and trienyl components in Type I pheromones. Components with an odd numbered chain (C_{13} and C_{15}) are not included. Red colour indicates identification after 2004.

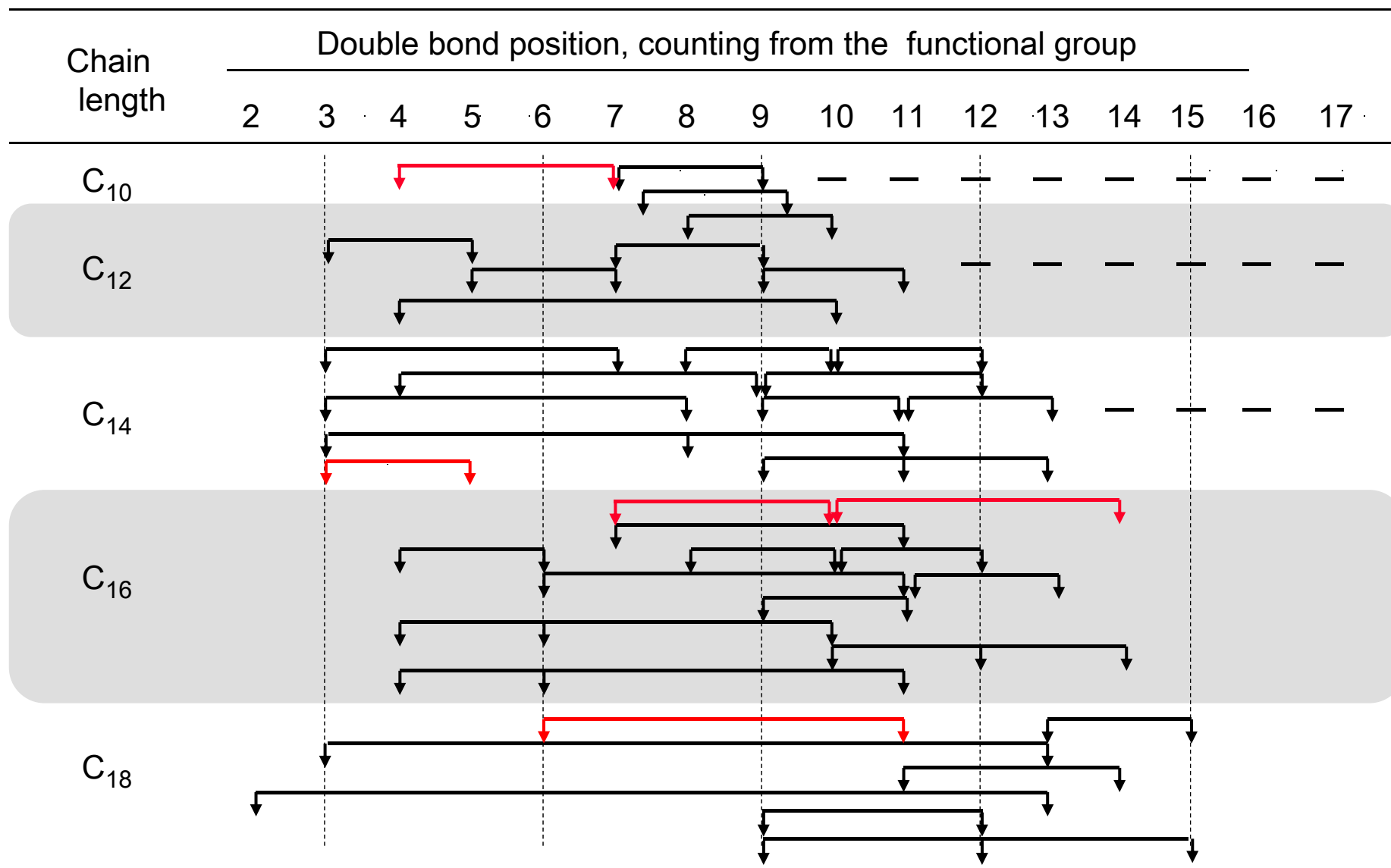
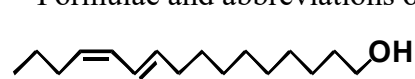


Table 1. Type I lepidopteran female pheromones

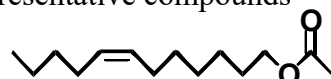
(Update 2017. 11. 29)

(A) Compounds with a common functional group (☆)

Formulae and abbreviations of representative compounds



E10,Z12-16:OH (bombykol)



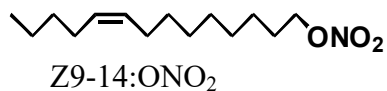
Z7-12:OAc



Z11-16:Ald

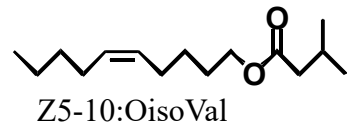
(B) Compounds with a novel functional group (★)

Compound class Formula and abbreviation	Super-family Family (Suffamily)	Identified component	Insect species	Year [Ref.] ^a			
<u>Acetylenic derivative</u> ≡ 11,Z13-16:OAc	Gelechioidea	Z9, ≡ 11,13-14:Ald	<i>Stenoma catenifer</i>	08 [10], 09 [11]			
	Elachistidae						
	Pyraloidea	≡ 11-16:Ald	<i>Desmia funeralis</i>	02 [3]			
	Pyralidae						
	Noctuoidea						
<u>Nitrate ester</u>	Noctuidae	≡ 11,Z13-16:OAc	<i>Thaumetopoea pityocampa</i>	81 [1] 93 [2] 93 [2] 93 [2] 93 [2]			
	Notodontidae						
	Gracillarioidea						
	Bucculatrigidae				Z9-14:ONO ₂	<i>Bucculatrix thurberiella</i>	92 [4]



Z8-13:ONO₂

Ester with miscellaneous acid



Bombycoidea
Saturniidae

Z5-10:OisoVal

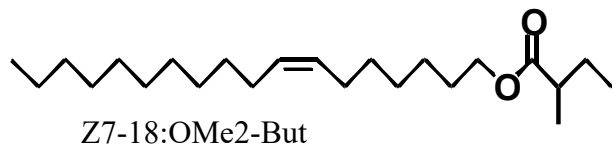
Nudaurelia cytherea 73 [5]

Noctuoidea
(Lymantriinae)

Z7-18:OisoVal

Euproctis similis 94 [6]

E. similes xanthocampa 84 [9]



Z7-18:OMe2-But

E. similis 94 [6]

Z7-18:OBut

E. similis 94 [6]

Z7-18:OisoBut

E. similis 94 [6]

Z7,Z13,Z16,Z19-22:OisoBut^b

E. chrysorrhoea 91 [7]

Z11,Z14,Z17-20:OisoBut^b

E. pulverea 01 [8]

Z11,Z14,Z17-20:OMe4-Val^b

E. pulverea 01 [8]

^a Publication year and [reference].

^b Related to Type II compounds based on an aspect of their predicted biosynthetic pathway. Abbreviations; OisoBut = isobutyryl ester, and OMe4-Val = 4-methylvaleryl ester.

References

- 1 Guerrero A, Camps F, Coll J, Riba M, Einhorn J, Descoins C, Lallemand JY (1981) *Tetrahedron Lett*, **22**: 2013
- 2 Frerot B, Demolin G (1993) *Boll Zool Agric Bachic Ser II*, **25**: 33
- 3 Millar J, McElfresh JS, Marques FA (2002) *J Econ Entomol*, **95**: 692
- 4 Hall DR, Beevor PS, Campion DG, Chamberlain DJ, Cork A, White RD, Almestar A, Henneberry TJ (1992) *Tetrahedron Lett*, **33**: 4811
- 5 Henderson HE, Warren FL, Augustyn OPH, Burger BV, Schneider DF, Boshoff PR, Spies HSC, Geertsema H (1973) *J Insect Physiol*, **19**: 1257
- 6 Yasuda T, Yoshii S, Wakamura S (1994) *Appl Entomol Zool*, **29**: 21
- 7 Leonhardt BA, Mastro VC, Schwarz M, Tang JD, Charlton RE, Pellegrini-Toole A, Warthen JD, Schwalbe CP, Cardé RT (1991) *J Chem Ecol*, **17**: 897
- 8 Wakamura S, Arakaki N, Ono H, Yasui H (2001) *Entomol Exp Appl*, **100**: 109
- 9 Tan Z-X, Wu Y-W, Lin G-Q, Wu B-C, Liu H-Q, Xu X-Y, Zhou W-S, Pu G-Q, Zhang M-S (1984) *Huaxue Xuebao (Acta Chimica Sinica)*, **42**: 1178
- 10 Millar JG, Hoddle M, McElfresh JS, Zou Y, Hoddle C (2008) *Tetrahedron Lett*, **49**: 4820
- 11 Hoddle MS, Millar JG, Hoddle CD, Zou Y, McElfresh JS (2009) *J Econ Entomol*, **102**: 1460

Table 2. Type II lepidopteran female pheromones (▲)

(Update: 2017.11.29)

(A) Trienes, dienes, and their monoepoxy derivatives

Formulae and abbreviations of representative compounds



Z3,Z6-21:H



Z6,epo9-18:H



Z3,Z6,Z9-17:H





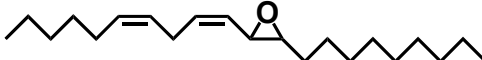

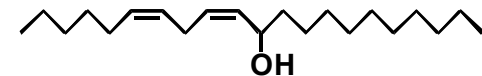
epo3,Z6,Z9-19:H

Chain length	Number of lepidopteran species whose sex pheromones were found to be the indicated component						
	Diene Z6,Z9	Epoxymonoene epo6,Z9 Z6,epo9		Triene Z3,Z6,Z9	Epoxydiene epo3,Z6,Z9 Z3,epo6,Z9 Z3,Z6,epo9		
17	no	no	no	G(7)	G(7)	no	no
18	no	no	G(1)	G(3)	no	G(2)	G(1)
19	G(3)	G(2)	G(1)	G(13)	G(5)	G(4)	G(2), L(1)
20	G(1), A(1)	no	no	G(1), E(6)	no	no	E(1), A(2)
21	G(1), E(2), L(2), A(4)	no	E(1), L(1), A(1)	C(1), G(3), E(10), L(1), A(15)	no	E(1), L(1)	G(1), E(5), A(11)
22	A(1)	no	no	A(1)	no	no	no
23	no	no	no	C(4), G(1), A(2)	no	no	no
Total	G(5), E(2), L(2), A(6)	G(2)	G(2), E(1), L(1), A(1)	C(5), G(28), E(16), L(1), A(18)	G(12)	G(6), E(1), L(1)	G(4), E(6), L(1), A(13)

C: Crambidae, G: Geometridae, E: Erebidae (Catocalinae, Ophiderinae, Hermininae), L: Lymantriinae, A: Arctiinae

(B) Further modified compounds ^a

Compound class Formula and abbreviation	Family Sub-family	Identified component	Insect species	Year [Ref.] ^b		
<u>Polyene also unsaturated at the positions other than 3, 6, and 9</u>  1,Z3,Z6,Z9-19:H	Geometridae	1,Z3,Z6,Z9-19:H	<i>Operophtera brumata</i>	82 [2, 3]		
			<i>O. bruceata</i>	87 [4]		
			<i>O. fagata</i>	04 [15]		
			1,Z3,Z6,Z9-21:H	<i>Epirrita autumnata</i>	95 [5]	
			Z3,Z6,Z9,Z11-19:H	<i>Alsophila pometaria</i>	84 [9]	
			Z3,Z6,Z9,E11-19:H	<i>A. pometaria</i>	84 [9]	
			E4,Z6,Z9-19:H	<i>Bupalus piniaria</i>	98 [13]	
			Z6,Z9,Z12-18:H	<i>Hemithea tritonaria</i>	09 [18]	
				<i>Pamphlebia rubrolimbraria</i>	09 [18]	
			Z6,Z9,Z12-20:H	<i>Maxates versicauda</i>	09 [18]	
			Z3,Z6,Z9,Z12-20:H	<i>Thalassodes immissaria</i>	09 [18]	
			Erebidae Arctiinae	1,Z3,Z6,Z9-21:H	<i>Arctia villica</i>	84 [6]
					<i>A. plantaginis</i>	17 [24]
					<i>Pareuchaetes pseudoinsulata</i>	93 [7]
		<i>Syntomoides imaon</i>		08 [20]		
		<i>Utetheisa ornatix</i>		83 [8]		
		E4,Z6,Z9-21:H	<i>Arctia plantaginis</i>	17 [24]		
		Z2,E4,Z6,Z9-21:H	<i>A. plantaginis</i>	17 [24]		
	Pyralidae	Z3,Z6,Z9,Z12,Z15-23:H	<i>Pyralis farinalis</i>	10 [21]		
			<i>Amyelois transitella</i>	05 [16]		
		Z3,Z6,Z9,Z12,Z15-25:H	<i>A. transitella</i>	05 [16]		
			<i>Dioryctria abietivorella</i>	05 [17]		

			<i>D. mendacella</i>	17 [23]
	Tischeriidae	Z3,Z6,Z9,Z19-23:H	<i>Tischeria ekebladella</i>	12 [22]
<u>Epoxytriene</u>	Erebidae			
	Arctiinae	1,Z3,Z6,9-epoxy-20:H 1,Z3,Z6,9-epoxy-21:H	<i>Hyphantria cunea</i> <i>H. cunea</i> <i>Diacrisia oblique</i>	89 [1] 89 [1] 01 [19]
1,Z3,Z6,9-epoxy-21:H				
<u>trans-Epoxyde</u>	Geometridae	<i>t</i> -epoxy4,Z6,Z9-19:H	<i>B. piniaria</i>	98 [13]
	Erebidae			
Z6,Z9, <i>t</i> -epoxy11-21:H (posticlure)	Lymantriinae	Z6,Z9, <i>t</i> -epoxy11-21:H (11 <i>S</i> ,12 <i>S</i>)	<i>Orgyia postica</i>	01 [10]
<u>Diepoxy derivative</u>	Erebidae			
	Lymantriinae	Z3,epoxy6,epoxy9-21:H epoxy3,epoxy6,Z9-21:H (3 <i>R</i> ,4 <i>S</i> ,6 <i>S</i> ,7 <i>R</i>) (3 <i>S</i> ,4 <i>R</i> ,6 <i>S</i> ,7 <i>R</i>)	<i>Leucoma salicis</i> <i>Perina nuda</i>	97 [11] 02 [12]
Z3,epoxy6,epoxy9-21:H (leucomalure)				
<u>Hydroxy derivative</u>	Erebidae			
	Lymantriinae	Z6,Z9-21:11-OH	<i>Orgyia detrita</i>	03 [14]
Z6,Z9-21:11-OH				

a Keto derivatives such as Z6,Z9-19:3-one, and Z6-21:9-one, and Z6,Z9-21:11-one are listed in Table 4.

b Publication year and [reference].

References

1. Tóth M, Buser HR, Peña A, Arn H, Mori K, Takeuchi T, Nikolaeva LN, Kovalev BG (1989) *Tetrahedron Lett*, **30**: 3405
2. Roelofs WL, Hill AS, Linn CE, Meinwald J, Jain SC, Herbert HJ, Smith RF (1982) *Science*, **217**: 657
3. Bestmann HJ, Brosche T, Koschätzky KH, Michaelis K, Platz H, Roth K, Süß J, Vostrowsky O, Knauf W (1982) *Tetrahedron Lett*, **23**: 4007
4. Underhill EW, Millar JG, Ring RA, Wong JW, Barton D, Giblin M (1987) *J Chem Ecol*, **13**: 1319
5. Zhu J, Löfstedt C, Philipp P, Francke W, Tammaru T, Haukioja E (1995) *Entomol Exp Appl*, **75**: 159
6. Einhorn J, Boniface B, Renou M, Milat M (1984) *C R Acad Sci Ser 3*, **298**: 573
7. Frérot B, Malosse C, Chenon RD, Ducrot PH, Cain A (1993) *C R Acad Sci Ser 2*, **317**: 1045
8. Jain SC, Dussourd DE, Conner WE, Eisner T, Guerrero A, Meinwald J (1983) *J Org Chem*, **48**: 2266
9. Wong JW, Palaniswamy P, Underhill EW, Steck WF, Chisholm MD (1984) *J Chem Ecol*, **10**: 463
10. Wakamura S, Arakaki N, Yamamoto M, Hiradate S, Yasui H, Yasuda T, Ando T (2001) *Tetrahedron Lett*, **42**: 687
11. Gries R, Holden D, Gries G, Wimalaratne PDC, Slessor KN, Saunders C (1997) *Naturwissenschaften*, **84**: 219
12. Wakamura S, Arakaki N, Yamazawa H, Nakajima N, Yamamoto M, Ando T (2002) *J Chem Ecol*, **28**: 449
13. Millar JG (2000) *Annu Rev Entomol*, **45**: 575
14. Gries R, Khaskin G, Khaskin E, Foltz JL, Schaefer PW, Gries G (2003) *J Chem Ecol*, **29**: 2201
15. Szöcs G, Tóth M, Kárpáti Z, Zhu J, Löfstedt C, Plass E, Francke W (2004) *Chemoecology*, **14**: 53
16. Leal WS, Parra-Pedrazzoli AL, Kaissling K-E, Morgan TI, Zalom FG, Pesak DJ, Dundulis EA, Burks CS, Higbee BS (2005) *Naturwissenschaften*, **92**: 139
17. Millar JG, Grant GG, McElfresh JS, Strong W, Rudolph C, Stein JD, Moreira JA (2005) *J Chem Ecol*, **31**: 1229
18. Yamakawa R, Do ND, Adachi Y, Kinjo M, Ando T (2009) *Tetrahedron Lett*, **50**: 4738
19. Yadav JS, Valli MY, Prasad AR (2001) *Pure Appl Chem*, **73**: 1157
20. Matsuoka K, Yamamoto M, Yamakawa R, Muramatsu M, Naka H, Kondo Y, Ando T (2008) *J Chem Ecol*, **34**: 1437

21. Kuenen LPS, McElfresh JS, Millar JG (2010) *J Econ Entomol*, **103**: 314
22. Hall DR, Farman D, Domínguez JC, Pajares JA (2017) *J Chem Ecol*, **43**: 433
23. MurakiY, Yamakawa R, Yamamoto M, Naka H, Honma A, Mappes J, Suisto K, Ando T (2017) *Am J Chem Anal*, **8**: 645

Table 3. Stereochemistry of natural pheromones containing an epoxy ring (main components) and field attractancy of the synthetic racemate.
(Update 2005. 5. 15)

Species	Main pheromonal component	Stereochemistry of the epoxy ring (main component)				[Ref.]
		Natural configuration	Method for chiral analysis	Field attraction		
				Optimum isomer ^a	Racemate ^b	
<i>Semiothisa clathrata</i> ^c	epo3,Z6,Z9-17:H	3 <i>R</i> ,4 <i>S</i>	GC ⁱ	3 <i>R</i> ,4 <i>S</i>	none	[2]
<i>Ascotis selenaria cretacea</i> ^c	epo3,Z6,Z9-19:H	racemate	GC ^f , HPLC ^g	3 <i>R</i> ,4 <i>S</i>	weak	[3]
<i>Milionia basalis pryeri</i> ^c	epo3,Z6,Z9-19:H	3 <i>S</i> ,4 <i>R</i>	HPLC ^g	3 <i>S</i> ,4 <i>R</i>	weak	[8]
<i>Biston robustum</i> ^c	epo6,Z9-19:H	6 <i>S</i> ,7 <i>R</i>	HPLC ^h	6 <i>S</i> ,7 <i>R</i> + 6 <i>R</i> ,7 <i>S</i> (9:1)	none	[7]
<i>Colotois pennaria</i> ^c	Z3,epo6,Z9-19:H	6 <i>R</i> ,7 <i>S</i>	GC ⁱ	6 <i>R</i> ,7 <i>S</i>	weak	[1]
<i>Erannis defoliaria</i> ^c	Z3,epo6,Z9-19:H	6 <i>S</i> ,7 <i>R</i>	GC ⁱ	6 <i>S</i> ,7 <i>R</i>	same	[1]
<i>Oraesia excavata</i> ^d	Z6,epo9-21:H	9 <i>S</i> ,10 <i>R</i>	HPLC ^h	racemate	best	[5]
<i>Teia anartoides</i> ^e	Z6,epo9-21:H	9 <i>R</i> ,10 <i>S</i>	GC ⁱ	? (minor comp.)	-	[10]
<i>Menophra atrilineata</i> ^c	Z3,Z6,epo9-18:H	9 <i>S</i> ,10 <i>R</i>	HPLC ^{h,j}	9 <i>S</i> ,10 <i>R</i>	same	[4]
<i>Lymantria mathura</i> ^e	Z3,Z6,epo9-19:H	9 <i>R</i> ,10 <i>S</i> + 9 <i>S</i> ,10 <i>R</i> (4:1)	GC ⁱ	9 <i>R</i> ,10 <i>S</i> + 9 <i>S</i> ,10 <i>R</i> (4:1)	weak	[6]
<i>Orgyia postica</i> ^e	Z6,Z9, <i>t</i> -epo11-21:H	11 <i>S</i> ,12 <i>S</i>	HPLC ^h	11 <i>S</i> ,12 <i>S</i>	same	[9]

^a Optimum configuration of the main component to attract male moths in the field.


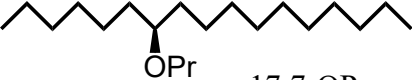

^b Activity of racemate in a field test, comparison to lure baited with the optimum isomer.

c Geometridae, *d* Erebidae: Ophiderinae, *e* Erebidae: Lymantriinae,
f Chiraldex A-PH column, *g* Chiralpak AS column, *h* Chiralpak AD column,
i custom-made column with a 1:1 mixture of heptakis-(2,6-di-*O*-methyl-3-*O*-pentyl)- β -cyclodextrin and OV-1701, *j* Chiralcel OJ-R

1. Szöcs G, Tóth M, Francke W, Schmidt F, Philipp P, König WA, Mori K, Hansson BS Löfstedt C (1993) *J Chem Ecol*, **19**: 2721
2. Tóth M, Szöcs G, Francke W, Schmidt F, Philipp P, Löfstedt C, Hansson BS, Farag AI (1994) *Z Naturforsch*, **49c**: 516
3. Ando T, Ohtani K, Yamamoto M, Miyamoto T, Qin X, Witjaksono (1997) *J Chem Ecol*, **23**: 2413
4. Pu G, Yamamoto M, Takeuchi Y, Yamazawa H, Ando T (1999) *J Chem Ecol*, **25**: 1151
5. Yamamoto M, Takeuchi Y, Ohmasa Y, Yamazawa H, Ando T (1999) *Biomed Chromatogr*, **13**: 410
6. Gries G, R Gries, PW Schacher, T Gotoh, Y Higashiura (1999) *Naturwissen*, **86**: 235
7. Yamamoto M, Kiso M, Yamazawa H, Takeuchi J, Ando T (2000) *J Chem Ecol*, **26**: 2579
8. Yasui H, Wakamura S, Arakaki N, Irei H, Kiyuna C, Ono H, Yamazawa H, Ando T (2005) *J Chem Ecol*, **31**: 647
9. Wakamura S, Arakaki N, Yamamoto M, Hiradate S, Yasui H, Kinjo K, Yasuda T, Ando T (2005) *Biosci Biotechnol Biochem*, **69**: 957
10. Gries R, Khaskin G, Cleawater J, Hasman D, Schaefer PW, Khaskin E, Miroshnychenko O, Hosking G, Gries G (2005) *J Chem Ecol*, **31**:

Table 4. Lepidopteran female pheromones of other groups (✖)

(Update 2017. 11. 29)

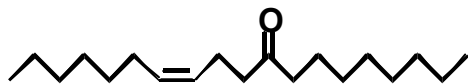
<u>Compound class</u> Formula and abbreviation	Super-family Family (Subfamily)	Identified comp.	Insect species	Year [Ref.] ^a
<u>Secondary alcohol and ester</u>				
 Z4-7:2-OH	Ereiochraniioidea			
	Eriocraniidae	Z4-7:2-OH (<i>R</i>)	<i>Eriocrania cicatricella</i>	95 [2]
		7:2-OH (<i>R</i>)	<i>E. cicatricella</i>	95 [2]
		Z6-9:2-OH (<i>S</i>)	<i>E. sangii</i>	96 [3]
			<i>E. semipurpurella</i>	96 [3]
	Nepticuloidea			
	Nepticulidae	Z6,8-9:2-OH (<i>S</i>)	<i>Stigmella malella</i>	95 [4]
		E6,8-9:2-OH (<i>S</i>)	<i>S. malella</i>	95 [4]
	Tineoidea			
	Tineidae	Z12-17:2-OAc (<i>S</i>)	<i>Kermania pistaciella</i>	06 [38]
 17:7-OPr	Noctuoidea			
	(Arctiinae)	17:7-OPr (<i>S</i>)	<i>Barsine expressa</i>	13 [39]
		17:8-OPr (<i>S</i>)		
<u>Ester of a long chain acid</u>				
 1-Methylbutyl 10:Ate	Tineoidea			
	Psychidae	(<i>R</i>)-1-Methylbutyl 10:Ate	<i>Thyridopteryx</i> <i>ephemeraeformis</i>	83 [5]
			<i>Oiketicus kirbyi</i>	94 [6]
		Isopropyl 8:Ate	<i>Megalophanes viciella</i>	00 [7]
	Zygaenoidea			



Isobutyl E7,9-10:Ate

Limaconidae	Isobutyl E7,9-10:Ate	<i>Darna bradleyi</i>	00 [8]
	Methyl E7,9-10:Ate	<i>D. bradleyi</i>	00 [8]
Zygaenidae	Butyl E7,9-10:Ate	<i>D. pallivitta</i>	07 [40]
	(E)-2-Hexenyl E7,9-10:Ate	<i>D. trima</i>	00 [8]
	(S)-2-Methylbutyl E7,9-10:Ate	<i>D. trima</i>	00 [8]
	(S)-sec-Butyl Z7-14:Ate	<i>Harrisina brillians</i>	82 [9]
	(R)-sec-Butyl Z7-12:Ate	<i>Theresimima</i>	98 [10]
	(R)-sec-Butyl Z9-14:Ate	<i>ampellophaga</i>	09 [41]
		<i>Illiberis rotundata</i>	

Unsaturated ketone



Z7-19:11-one

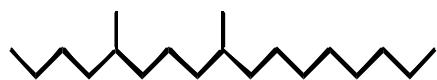
Copromorphaeidea			
Carposinidae	Z7-18:11-one	<i>Coscinoptycha improbana</i>	06 [42]
	Z7-19:11-one	<i>Carposina niponensis</i>	77 [11]
	(= Z12-19:9-one)	<i>Heterocrossa rubophaga</i>	00 [12]
	Z7-20:11-one	<i>C. niponensis</i>	77 [11]
Geometroidea			
Geometridae	Z6,Z9-19:3-one ^b	<i>Peribatodes rhomboidaria</i>	85 [13]
Noctuoidea			
(Lymantriinae)	Z6-21:11-one	<i>Orgyia pseudotsugata</i>	75 [14]
		<i>O. thyellina</i>	99 [15]
		<i>O. postica</i>	01 [16]
		<i>O. ericae</i>	10 [43]
		<i>O. pseudotsugata</i>	78 [17]
		<i>O. pseudotsugata</i>	97 [18]
		<i>O. thyellina</i>	99 [15]
		<i>O. leucostigma</i>	03 [19]
		<i>Teia anartoides</i>	05 [44,45]

Methyl-branched epoxide



Me2, epo7-18:H
(disparlure)

Methyl-branched hydrocarbon



Me5, Me9-17:H



1, Me14-18:H

Noctuoidea (Lymantriinae)	Me2, epo7-18:H (7R,8S)	<i>Lymantria dispar</i>	70 [1]
		<i>L. fumida</i>	99 [20]
		<i>L. monacha</i>	75 [21]
	epo7-18:H (7R,8S)	<i>L. monacha</i>	01 [22]
	Me2, epo7-20:H	<i>L. xyliana</i>	99 [23]
	Me2, epo7,17-18:H	<i>L. dispar</i>	05 [46]
Yponomeutoidea Lyonetiidae	Me5, Me9-17:H (5S,9S)	<i>Leucoptera malifoliella</i>	87 [24]
	Me5, Me9-16:H	<i>L. malifoliella</i>	87 [24]
		<i>Perileucoptera coffeella</i>	88 [25]
	Me5, Me9-15:H	<i>P. coffeella</i>	88 [25]
	Me5, Me9-18:H	<i>L. malifoliella</i>	90 [26]
	1, Me14-18:H (S)	<i>L. clerkella</i>	84 [27]
	1, Me10, Me14-18:H	<i>L. prunifoliella</i>	97 [28]
Geometroidea Geometridae	Me2, Me5-17:H (R), (S)	<i>Lambdina fiscellaria</i>	91 [29]
	Me5, Me11-17:H (5R,11S)	<i>L. fiscellaria</i>	91 [29]
	Me7-17:H (S)	<i>L. athasaria</i>	94 [30], 01[47]
		<i>L. fiscellaria</i>	93 [31]
		<i>L. pellucidaria</i>	98 [32]
	Me7, Me11-17:H (meso)	<i>L. athasaria</i>	94 [30], 01[47]
		<i>L. pellucidaria</i>	98 [32]
	Me3, Me13-17:H (3S,13R)	<i>Nepytia freemani</i>	93 [33], 95[48]
Noctuoidea			

Erebidae	Me9-19:H (S) Me7-17:H (S) Z6,Me13-21:H	<i>Alabama argillacea</i> <i>Anomis texana</i> <i>Scoliopteryx libatrix</i>	93[49] 93[49] 00 [34], 03[50]
(Lymantriinae)	Me2,Z7-18:H	<i>Lymantria fumida</i> <i>L. lucescens</i> <i>L. monacha</i> <i>L. serva</i> <i>L. bantaizana</i>	99 [20] 02 [35] 01 [22] 02 [35] 05 [51]
	Me2,Z7,E9-18:H		
(Arctiinae)	Me2-17:H	<i>Holomelina aurantiaca</i> <i>H. ferruginosa</i> etc. <i>Pyrrharctia isabella</i>	71 [36] 71 [36] 71 [36]

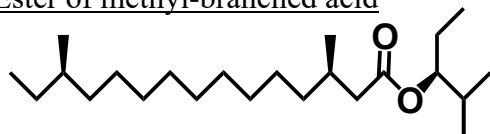
Ester of methyl-branched primary alcohol



Me10,Me14-15:OisoBu

Tortricoidae			79 [37]
Tortricidae	Me10-12:OAc	<i>Adoxophyes honmai</i>	
Noctuoidea			
(Lymantriinae)	Me10,Me14-15:OisoBu (R)	<i>Arna pseudoconspersa</i> <i>Artaxa subflava</i>	94 [52], 95 [53] 07 [54]
	Me14-15:OisoBu Z9,Me16-17:OisoBu	<i>A. pseudoconspersa</i> <i>Orvasca taiwana</i>	94 [52], 95 [53] 95 [55]

Ester of methyl-branched acid



(S)-1-ethyl-2-methylpropyl
Me3,Me13-15:Ate

Tineoidea			
Psychidae	(S)-1-ethyl-2-methylpropyl Me3,Me13-15:Ate (3R,13R)	<i>Clania (= Eumeta)</i> <i>variegata</i>	06 [56], 10 [57]

Methyl-branched secondary alcohol and ketone



Me6-18:2-one



Me5-17:7-OH

Pyraloidea

Pyralidae

Me6,Me10,Me14-15:2-OH

Aphomia sociella

12 [58]

Me6,Me10,Me14-15:2-one

Corcyra cephalonica

87 [59]

Aphomia sociella

12 [58]

Noctuoidea

(Arctiinae)

Me6-18:2-one (*S*)

Lyclene dharmadharmia

08 [60], 10 [61]

Me14-18:2-one (*S*)

08 [60], 10 [61]

Me6,Me14-18:2-one

08 [60]

Me5-17:7-OH (*5R,7R*)

Miltochrista calamina

11 [62], 14 [63]

a Publication year and [reference].

b Related to Type II compounds based on an aspect of their predicted biosynthetic pathway.

1. Bierl BA, Beroza M, Collier CW (1970) *Science*, **170**: 87
2. Zhu JW, Kozlov MV, Philipp P, Francke W, Löfstedt C (1995) *J Chem Ecol*, **21**: 29
3. Kozlov MV, Zhu J, Philipp P, Francke W, Zvereva EL, Hansson BS, Löfstedt C (1996) *J Chem Ecol*, **22**: 431
4. Tóth M, Szöcs G, Nieukerken EJ, Philipp P, Schmidt F, Francke W (1995) *J Chem Ecol*, **21**: 13
5. Leonhardt BA, Neal JW, Klun JA, Schwarz M, Plimmer JR (1983) *Science*, **219**: 314
6. Rhainds M, Gries G, Li J, Gries R, Slessor KN, Chinchilla CM, Oehlschlager AC (1994) *J Chem Ecol*, **20**: 3083
7. Subchev M, Toshova T, Stanimirova L, Stan G, Embacher G, Francke W, Reckziegel A, Ferreira JT, Priesner E (2000) *J Chem Ecol*, **26**: 487
8. Sasaerila Y, Gries R, Gries G, Khaskin G, King S, Boo TC (2000) *J Chem Ecol*, **26**: 1969
9. Myerson J, Haddon WF, Soderstrom EL (1982) *Tetrahedron Lett*, **23**: 2757
10. Subchev M, Harizanov A, Francke W, Franke S, Plass E, Reckziegel A, Schröder F, Pickett JA, Wadhams LJ, Woodcock CM (1998) *J Chem Ecol*, **24**: 1141
11. Tamaki Y, Honma K, Kawasaki K (1977) *Appl Entomol Zool*, **12**: 60
12. Foster SP, Thomas WP (2000) *J Chem Ecol*, **26**: 2549
13. Buser HR, Guerin PM, Tóth M, Szöcs G, Schmid A, Francke W, Arn H (1985) *Tetrahedron Lett*, **26**: 403
14. Smith RG, Daterman GE, Daves GD (1975) *Science*, **188**: 63
15. Gries G, Clearwater J, Gries R, Khaskin G, King S, Schaefer P (1999) *J Chem Ecol*, **25**: 1091
16. Chow YS, Tsai RS, Gries G, Gries R, Khaskin G (2001) *Entomol Sinica*, **8**: 13
17. Smith LM, Smith RG, Loehr TM, Daves GD (1978) *J Org Chem*, **43**: 2361
18. Gries G, Slessor KN, Gries R, Khaskin G, Wimalaratne PDC, Gray TG, Grant GG, Tracey AS, Hulme M (1997) *J Chem Ecol*, **23**: 19
19. Grant GG, Slessor KN, Liu W, Abou-Zaid MM (2003) *J Chem Ecol*, **29**: 589
20. Schaefer PW, Gries G, Gries R, Holden D (1999) *J Chem Ecol*, **25**: 2305
21. Bierl BA, Beroza M, Adler VE, Kasang G, Schröter H, Schneider D (1975) *Z Naturforsch*, **30c**: 672

22. Gries G, Schaefer PW, Gries R, Liska J, Gotoh T (2001) *J Chem Ecol*, **27**: 1163
23. Gries G, Schaefer PW, Khaskin G, Hahn R, Gries R, Chao J (1999) *J Chem Ecol*, **25**: 2535
24. Franke W, Franke S, Toth M, Szöcs G, Guerin P, Arn H (1987) *Naturwissenschaften*, **74**: 143
25. Franke W, Toth M, Szöcs G, Krieg W, Ernst H, Buschmann E (1988) *Z Naturforsch*, **43c**: 787
26. Riba M, Rosell JA, Eizaguirre M, Canela R, Guerrero A (1990) *J Chem Ecol*, **16**: 1471
27. Sugie H., Tamaki Y, Sato R, Kumakura M (1984) *Appl Entomol Zool*, **19**: 323
28. Gries R, Gries G, King GGS, Maier CT (1997) *J Chem Ecol*, **23**: 1119
29. Gries G, Gries R, Borden JH, Li J, Slessor KN, King GGS, Bowers WW, West RJ, Underhill EW (1991) *Naturwissenschaften*, **78**: 315
30. Gries R, Gries G, Li J, Maier CT, Lemmon CR, Slessor KN (1994) *J Chem Ecol*, **20**: 2501
31. Gries G, Gries R, Krannitz SH, Li J, King GGS, Slessor KN, Borden JH, Bowers WW, West RJ, Underhill EW (1993) *J Chem Ecol*, **19**: 1009
32. Maier CT, Gries R, Gries G (1998) *J Chem Ecol*, **24**: 491
33. Gries G, King GGS, Gries R, Wimalaratne PDC, Gray TG, Shepherd RF, Li J, Slessor KN, Khaskin G (1993) *J Chem Ecol*, **19**: 1501
34. Francke W, Plass E, Zimmermann N, Tietgen H, Tolasch T, Franke S, Subchev M, Toshova T, Pickett JA, Wadhams LJ, Woodcock CM (2000) *J Chem Ecol*, **26**: 1135
35. Gries G, Schaefer PW, Gries R, Fan Y, Higashiura Y, Tanaka B (2002) *J Chem Ecol*, **28**: 469
36. Roelofs WL, Cardé RT (1971) *Science*, **171**: 684
37. Tamaki Y, Noguchi H, Sugie H, Sato R, Kariya A (1979) *Appl Entomol Zool*, **14**: 101
38. Gries R, Khaskin G, Daroogheh H., Mart C, Karadag S, Kubilay EM, Britton R, Gries G (2006) *J Chem Ecol*, **32**: 2667
39. Fujii T, Yamakawa R, Terashima Y, Imura S, Ishigaki K, Kinjo M, Ando T (2013) *J Chem Ecol*, **39**: 28
40. Siderhurst MS, Jang EB, Hara AH, Conant P (2007) *Entomol Exp Appl*, **125**: 63
41. Subchev M, Toshova T, Koshio C, Franke S, Tröger A, Twele R, Francke W, Pickett JA, Wadhams LJ, Woodcock CM (2009) *Chemoecol*, **19**: 47

42. Gibb AR, Suckling DM, Morris BD, Dawson TE, Bunn B, Comeskey D, Dymock JJ (2006) *J Chem Ecol*, **32**: 221
43. Chen GF, Sheng ML, Li T, Millar JG, Zhang QH (2010) *Entomol Exp Appl*, **136**: 227
44. Gries R, Khaskin G, Cleawater J, Hasman D, Schaefer PW, Khaskin E, Miroshnychenko O, Hosking G, Gries G. (2005) *J Chem Ecol*, **31**: 603
45. El-Sayed AM, Gibb AR, Suckling DM, Bunn B, Fielder S, Comeskey D, Manning LA, Foster SP, Morris BD, Ando T, Mori K (2005) *J Chem Ecol*, **31**: 621
46. Gries R, Khaskin G, Schaefer PW, Hahn R, Gotoh T, Gries G (2005) *J Chem Ecol*, **31**: 49
47. Duff, CM, Gries G, Mori K, Shirai Y, Seki M, Takikawa H, Sheng T, Slessor KN, Gries R, Maier CT, Ferguson DC (2001) *J Chem Ecol*, **27**: 431
48. King GGS, Gries R, Gries G, Slessor KN (1995) *J Chem Ecol*, **21**: 2027
49. Hall DR, Beever PS, Campon DG, Chamberlain DJ, Cork A, White R, Almestree A, Henneberry TJ, Nandagopal V, Wightman JA, Rao GVR (1993) *Bulletin OILB SROP*, **16**: 1
50. Toshova T, Subchev M, Plass E, Francke W (2003) *J Appl Entomol*, **127**: 195
51. Gries R, Khaskin G, Gotoh T, Schaefer PW, Gries G (2005) *J Chem Ecol*, **31**: 879
52. Wakamura S, Yasuda T, Ichikawa A, Fukumoto T, Mochizuki F (1994) *Appl Entomol Zool*, **29**: 403
53. Ichikawa A, Yasuda T, Wakamura S (1995) *J Chem Ecol*, **21**: 627
54. Wakamura S, Yasuda T, Hirai Y, Tanaka H, Doki T, Nasu Y, Shibao M, Yunotani A, Kadono K (2007) *Appl Entomol Zool*, **42**: 375
55. Yasuda T, Wakamura S, Arakaki N (1995) *J Chem Ecol*, **21**: 1813
56. Gries R, Khaskin G, Tan ZX, Zhao BG, King GGS, Miroshnychenko A, Lin GQ, Rhainds M, Gries G (2006) *J Chem Ecol*, **32**: 1673
57. Mori K, Tashiro T, Zhao B, Suckling DM, El-Sayed AM (2010) *Tetrahedron*, **66**: 2642
58. Kindl J, Jiroš P, Kalinová B, Žáček P, Valterová I (2012) *J Chem Ecol*, **38**: 400
59. Hall DR, Cork A, Lester R, Nesbitt BF, Zagatti P (1987) *J Chem Ecol*, **13**: 1575
60. Yamamoto M, Kamata T, Do ND, Adachi Y, Kinjo M, Ando T (2007) *Biosci Biotechnol Biochem*, **71**: 2860

61. Adachi Y, Do ND, Kinjo M, Makisako S, Yamakawa R, Mori K, Ando T (2010) *J Chem Ecol*, **36**: 814
62. Yamakawa R, Kiyota R, Taguri T, Ando T (2011) *Tetrahedron Lett*, **52**: 5808
63. Muraki Y, Taguri T, Yamakawa R, Ando T (2014) *J Chem Ecol*, **40**: 250