

## Supplementary Material

### **Figure S1. Expression and purification of *S. exigua* OBP2 in a bacterial system.**

The bacterial extracts before (lane 1) and after (lane 2) 0.2 mM IPTG induction, and the supernatant (lane 3) and the pellet (lane 4) after sonication were analyzed by SDS-PAGE. The recombinant protein with His-tag (lane 5) was first purified, and after digestion of recombinant enterokinase the solution containing the target protein (lane 6) was re-purified. M: Protein molecular weight marker of 97.2, 66.4, 44.3, 29.0, 20.1 and 14.3 kDa.

**Table S1. Primers for identification, expression pattern analysis and prokaryotic expression of *S. exigua* chemosensory genes.**

**Table S2. The accession numbers of SNMPs used in the phylogenetic tree.**

**Table S3. The identified candidate *S. exigua* chemosensory genes.**

**Table S4. Amino acid sequences of identified candidate *S. exigua* ORs, GRs, IRs and *C. suppressalis*, *S. inferens* and *P. xylostella* SNMP3.**

**Table S5. Binding affinities of *S. exigua* OBP2 to different ligands.**



**Table S1**

<b>Purpose</b>	<b>Gene</b>	<b>Sequence (5' to 3')</b>
<b>Expression pattern</b>	OBP1-F†	AGCTGTGAAGCCATATATACAGGA
	OBP1-R‡	GAAACATGAAGTCAACAGCGC
	OBP2-F	GAGCGAATGCATCAAGGAAA
	OBP2-R	AGTACCCTGCTGATAGCATTGGA
	OBP3-F	TCCAAGGAGCCATAAAACCGT
	OBP3-R	GGCAATCACAGCAGTTTTATGCT
	OBP4-F	AATGAAGTGTAAACAAGGACGGGA
	OBP4-R	ACTTGAATCCAACTTGGGTGC
	OBP5-F	TGAGAAAACTTGCCAACCGA
	OBP5-R	CGGGATTGTGATTGTAGATGCA
	OBP6-F	GACCTGAAGCAGAAATACGCG
	OBP6-R	CGAAGCTGAAATCAGGAGATTTTC
	OBP7-F	GTACCAAGGAAGCCATGACCAC
	OBP7-R	CAATTTCCATCGACATCAGGC
	OBP8-F	TGATAGCAATGACTCGGAGCC
	OBP8-R	GCCGAAGATCTCTGGGAAGTT
	OBP9-F	AGCCAAAAGCCCATATAGAAGC
	OBP9-R	AAACTCGAGGTCAAATCCGAGT
	OBP10-F	TCAATGTATGCCGAAGAACTCTG
	OBP10-R	GGAAAGATGAAACTGTTTGGGTC
	OBP11-F	TGACAGATGAACAAAAAGCCCTC
	OBP11-R	CAAAGCCAACTTGGAAAGCATT
	OBP12-F	AGACGTGCTCAGCAAAAACG
	OBP12-R	AAGGGAACATAAAATTGGCGG
	OBP13-F	GCGAGTCTCTGAGACCCGTTA
	OBP13-R	GCCTTATGGTCCAAGAAGCAA
	OBP14-F	GGACTGCAACAATGAACACCC
	OBP14-R	AATTTTATTCCAGCTGCGG
	OBP15-F	AAGCCGGTGTTTAGTGACGAA
	OBP15-R	TGTGTACTTCAAACGCTCTCTGG
	OBP16-F	CAGTTGAAGAATTCTGGAAAGATGC
	OBP16-R	TCTGGTTTGAACCTCGTACATGCAC
	OBP17-F	GTTCAAATGCTGCCCAATACC
	OBP17-R	CATGTGTTGTTGCAATGCCTG
	OBP18-F	CATGACCGAGTGCTTGAAGGA
	OBP18-R	TAGTTGTGATGCCAACGTGCA
	OBP20-F	GTAAGGAGGAGAAGGCGATGTT
	OBP20-R	GAGTTATTGTCGGAACGTTTCG
	OBP21-F	TTACGTGGAAGGTTTGAAGGAG
	OBP21-R	TGTTCCAGTTGGCTTGAGCATA
	OBP22-F	GATTCTGAGTCAAGATGCCCGC

OBP22-R	GTCGAAGGAGACATCGCAGTT
OBP23-F	TCACCGATGTTGTGGTACTGG
OBP23-R	TTAGCTCCGATCTCGATGATCAC
OBP24-F	AGAGAAGGAAGCATTCCGTGAG
OBP24-R	CTTTGTGCTCCAAGAAGCACCC
OBP25-F	TGAGTGCCATGAAACCAATAGTG
OBP25-R	GAATTATCCACATCGTATTCGCC
OBP26-F	TTGAGACCCCAACCAAAAGAGA
OBP26-R	CTAACACTTCCACGCAGCTTCA
OBP27-F	TGTGTTGAATCTAGAAGCGGCT
OBP27-R	GGCATTACAGGAACCGATAGG
OBP28-F	AGAAACTCAAGAAGCACCCGCA
OBP28-R	GCTTGGGGTCTTTTTTCATGGT
OBP29-F	AAGAACCAGGCGAAATGAACC
OBP29-R	GGATTCCCTTTACCGTCAACC
ABPx-F	CGCTCGTGGAGCAAGTCAA
ABPx-R	CGTTCTGCCAGCACTGCTG
ABP2-F	CAGGTGTAAGAGATGCTTTGCG
ABP2-R	GTCCATCTTCTTTTTAGTTTCGGC
CSP1-F	GGAGCACCTACACCGACAGATA
CSP1-R	TTTGGACTGAGGGTCGTATTTG
CSP2-F	ACACCGACCGCTACGACAAT
CSP2-R	AGGCCTTGATCTTCTTGAGTTCC
CSP3-F	CACGACTCCCCTACACCGA
CSP3-R	CCTTCAGGGTCGTATTTGGC
CSP4-F	AGGACAAGTACAGCACGGAGAAT
CSP4-R	TTAAGAAGAGGCTACGGCTGCT
CSP5-F	CGATTACTACGAAATTGATACGTTG
CSP5-R	TCGATATAGCCTTCTCGAAAGC
CSP6-F	CCTCCACCTACACCGACAAGT
CSP6-R	TACTGTGCTTGACGGCATC
CSP7-F	CACCAGCAAGTACGACAACATTG
CSP7-R	ATTCTGGGATTATGATGCCGTT
CSP8-F	CCTCAAATGACAGACGCACAAT
CSP8-R	TAACCGTATTGGCGGACAATT
CSP9-F	CAGACAGATACGACCACATCAACA
CSP9-R	GCAGCGAGGAAGGTTTCATAGT
CSP10-F	TCGCTACGAGAACTTCAATCCTG
CSP10-R	CAAGGAAAGCGTACAAGGCATC
CSP11-F	CGATAACTTTGACGTGGACACC
CSP11-R	GAATTTGTGCAAGTTACCGCG
CSP12-F	TCCTGACGACGGTTTCTATGAC
CSP12-R	GGTCGTCATGATGCTTATGCTC
CSP13-F	CAACTTCGATGTGCGAGGCATT

CSP13-R	CTTTGGCGTTCAAGAATCTGG
CSP14-F	GCAGTGAAGGTCATCAAACGGT
CSP14-R	TCATCATTGTGGGTCTGGGTG
CSP15-F	GTGCCCTAACAAAAGACGAAT
CSP15-R	TCCTTCTTAGTAGCCATTTTCTGC
CSP16-F	TAGATGTGGACAAGATTCTGGGTG
CSP16-R	GTCTGTACCGATGACGAAAGCAC
CSP17-F	GTACGACAGTTTTTGACGTTCAACC
CSP17-R	TCTGCTAAGAATTTGTCTGAAGGAG
CSP18-F	GACCATTACACCGACCGCTT
CSP18-R	GATGACATCCTCAACAATCCTCG
CSP19-F	GTATGATAATGTAAACGGGGAGGC
CSP19-R	CAGCAACAGACGCTTCGAACT
CSP20-F	AAAGGCCTCCAGTCTCCGAC
CSP20-R	CTATCCTGCGTATTGGCGAAC
OR3-F	ACCTTCGACATGTGGTTTCCA
OR3-R	GCGCTGACCAAGTGCCATAT
OR4-F	CAAGACGCTTCCAGCTTCAAG
OR4-R	GTTATCCATATGTGTGAACCCGG
OR5-F	AACAGAGTTCGATGGGGATGG
OR5-R	TCTTTCTTTCCCAACACAGCG
OR7-F	ATGGCACTGAGTTATGCAATGG
OR7-R	TAAGGTGGTGAGTAATGCGGC
OR8-F	TCAAACGTCAGTGCCCTCCTA
OR8-R	TCGCTCTCGAACCAGTAACCTT
OR9-F	CCACTCCTGGCGAGACCTATG
OR9-R	TCGTGACTGACTCTCTCCCTG
OR11-F	CCCTTTCGCGTTACTTACCAC
OR11-R	TAAAACGTGCGCAAGAAAGC
OR12-F	TCTTACAACAGCTATCCTGATCGC
OR12-R	TGTATGACCTTGGAACCTACTCCA
GR1-F	AGTTCTTTGTGTGGTGTACTGTGTTG
GR1-R	TTTGGGGATTTCCGGAGTCAGT
GR5-F	GTCCTTCTTACGCTACATTCTGTTG
GR5-R	AAGAACAGCATCACTATAACTGGCA
GR6-F	CGGCATCATCTTAGCCATCCT
GR6-R	GAGACACAATGAGCCGAGGTTT
IR25a-F	GGAAGGAAATGAGCCTAAACGA
IR25a-R	ATGGAGATTCCGTCAGATTGGT
IR68a-F	TGTGGATAGCAGTTCTCTTGGTG
IR68a-R	ACAGGTGACTTTGCTATCGACG
IR76b-F	AGGTGTGTGGGTTATGATGCTG
IR76b-R	TGGAGTCTCAATCGCGAGAGTA
IR87a-F	AACCCACTCCTAATGACAACCG

IR87a-R	TTGCCAGAGGATTCCAAGTTG
IR93a-F	ACATGGTGGTTGATGGTACTGGT
IR93a-R	GGCACTATCATTGCGACTTTTCTC
SNMP1-F	CTGGTCCAGGTCTCACAGGAG
SNMP1-R	GGTACAAGTGGCCTTCGGAG
SNMP2-F	CTTTGATGGCATCTACTTGAGCTG
SNMP2-R	ATCTGTTGTTCCGATTGGCACT
SNMP3-F	TATCATCCAAGTTGCCGAGACA
SNMP3-R	GTGGGTATATTCCAGCATCGGT
GAPDH-F	CATAGAAAAGGCGTCTGCTCACT
GAPDH-R	GCAGGAATGACTTTGCCGAC

**RACE**

OBP1-3'GSP <sup>§</sup>	ACATGTTTGGTTTTGTGCGTTGTGGC
OBP1-5'GSP	CATGAACCCCACTCAGGCAACCAGC
OBP2-3'GSP	GTTTGCTTCATAAGCTGACGGGGGTCT
OBP2-5'GSP	TGTCCACTCCAGATAGCAGTTTCGCA
OBP3-3'GSP	GCAAACGAGAAATCTGTCCGAGACG
OBP3-5'GSP	GTCCAGCCAGACCCCTGTTTTTCAG
OBP4-3'GSP	GGTTAACGCAAAGAAAATGGCGGAT
OBP4-5'GSP	CCTTTGGCATTCATAACTTCGGCAG
OBP5-3'GSP	CCAATTGCCGAGGGTGTGTTTCATTG
OBP5-5'GSP	CAAATCACCCCTGTTTTATGG
OBP6-3'GSP	CAGCAGTACCCGTTGGATCGTGCTG
OBP6-5'GSP	TGCGTCAGCACGATCCAACGGGTAC
OBP8-3'GSP	AACGCCCATGCACTGAAGCCATGT
OBP8-5'GSP	TTCCATCGCTCACTGGTGCATCGT
OBP9-3'GSP	GCAAAGTTCTTGACAGTTGGCGCAG
OBP9-5'GSP	AGAGGGTGTTCCCTTAATACATTCTGCGC
OBP10-3'GSP	ACTTGATATGGCGCTCATCACAAAGCA
OBP10-5'GSP	TTGTCCCTGGCTGTGTAGGCACGCTG
OBP11-3'GSP	TCGCCGATTTACGAGCAAGGAAGA
OBP11-5'GSP	AGCATGGGGCATTGGACCACTCG
OBP12-3'GSP	CCCGAATGATATGAAGGCACCCGTT
OBP12-5'GSP	TTTGCTGTCCAATAGGATGCTTCGC
OBP14-3'GSP	GTATGGACTGCAACAATGAACACCCTT
OBP14-5'GSP	GCTTCGTCGTTCACTTTCTTACAGGCTT
OBP15-3'GSP	GCTTGTATCTACGAATTGACGAATGTGA
OBP15-5'GSP	AAGATCGATTTGTTTGATCGATGCTTCA
OBP16-3'GSP	AGTGTGTCGCTAAAACAGGGGTCCG
OBP16-5'GSP	CTCGTCCGGTATCAGACTGACCAGCA

**qPCR**

OBP1-F	TGGCATCAACGCTTGCTTCTTAC
OBP1-R	GGCTTTATCGGCATCGTATTCTCC
OBP2-F	AAGAAAGGGATCATTAGCGAAGACC

OBP2-R	TGCCTCAGATTTGTCCACTCCAG
OBP3-F	CTGTCCGAGACGGAGATGCTG
OBP3-R	ATATGAGTCATTACGCTGCTTAGGC
OBP4-F	AAGAATGGAGATGAGAAACGACTGG
OBP4-R	GAATATCATAGCGGCTCGGTCAC
OBP5-F	CTAAGGAAGCCATTACTGC
OBP5-R	CGGGATTGTGATTGTAGATG
OBP6-F	CAGTAGAAGGTGTCAATGC
OBP6-R	CTCTTGCTCCATCGCTAA
OBP8-F	AAGCAGATGATAGCAATGAC
OBP8-R	GGAATTTGTGGAAATGGGA
OBP9-F	GACGAAGAAGTGTCTGATG
OBP9-R	GTCAAATCCGAGTTGTTCA
OBP10-F	CAGGAAGCAGTTATGGAATG
OBP10-R	TAACAGAGTTCTTCGGCATA
OBP11-F	GTTATGGATGACAAGGGTATG
OBP11-R	GTGAGCACGAATGAAGATAA
OBP12-F	TGGGACAGAGCGTTAAG
OBP12-R	GGTGCCTTCATATCATTCTG
OBP14-F	GCAGACAGTTCAATAGCAAT
OBP14-R	TTCGTCGTTCACTTTCTTAC
OBP15-F	GCTGCTGTGGAGAAATG
OBP15-R	TCTTCTGGTTTGA <sup>‡</sup> ACTCGTA
OBP16-F	CGGCATATTTAAGGAGGATG
OBP16-R	GACTGACCAGCATATCGTA
GAPDH-F	GACAACCACTCATCTATCTTCG
GAPDH-R	AACATTTATCTCTACAACGCAATC
EF-F	TGATGCCACAGACAAGAG
EF-R	CCATTTCCACAAGTTCTACC
<b>Prokaryotic expression</b>	
OBP2-F	<u>CGGGATCCAAT</u> GAAAAGGGTAACAAACTCGC
OBP2-R	CCGCTCGAGTTATGAAGCAAACATGATGTGTGAT

<sup>†</sup>Forward primer.

<sup>‡</sup>Reverse primer.

<sup>§</sup>Gene specific primer.

Restriction enzyme sites are underlined.

**Table S2**

<b>Protein name</b>	<b>Accession number</b>	<b>Protein name</b>	<b>Accession number</b>
AipsSNMP1	AGF87119	Onub-ESNMP1	ADQ73893
AipsSNMP2	AGF87120	Onub-ESNMP2	ADQ73890
ApolSNMP1	AAC47540	PxyISNMP1	You et al. 2013
ApolSNMP2	CAP19029	PxyISNMP2	You et al. 2013
AtraSNMP1	ACX47899	PxyISNMP3	In this study
BmorSNMP1	NP_001037186	SexiSNMP1	AGN52676
BmorSNMP2-like-1	XP_004933211	SexiSNMP2	AGN52677
BmorSNMP2-like-2	XP_004928125	SinfSNMP1	AGY49250
CsupSNMP1	AFS50073	SinfSNMP2	AGY49251
CsupSNMP2	AFS50074	SinfSNMP3	In this study
CsupSNMP3	In this study	SlitSNMP1	Legeai et al. 2011
CmedSNMP1	AFG73002	SlitSNMP2	Legeai et al. 2011
CmedSNMP2	AFG73003	SlituSNMP1	AGN48098
HarmSNMP1	Liu et al. 2014	SlituSNMP2	AGN48099
HarmSNMP2	Liu et al. 2014	SlituSNMP3	KP729048
HassSNMP1	Xu et al. 2014	SnonSNMP1	Glaser et al. 2013
HassSNMP2	Xu et al. 2014	SnonSNMP2	Glaser et al. 2013
HvirSNMP1	CAB65739	DmelSNMP1	Q9VDD3
HvirSNMP2	CAP19028	DmelSNMP2	E1JI63
MbraSNMP1	AAO15603	DmelEMP-B	AAM70803
MsexSNMP1	AAG49366	DmelCrq-A	AAM70803
MsexSNMP2	AAG49365	DmelCG2736	AAF47308
OfurSNMP1	ADQ73894	DmelPes	ACL83014
OfurSNMP2	ADQ73891	TcasSNMP1	XP_001816436
Onub-ZSNMP1	ADQ73892	TcasSNMP2	XP_970008
Onub-ZSNMP2	ADQ73889		



**Table S3**

Gene	Accession No.	ORF (AA)	Full length	NCBI Blast Hit (References/Name/Species)	E value	Identity (%)
<b>Odorant binding proteins</b>						
PBP1		164	Y	AAU95536 pheromone binding protein 1 [ <i>Spodoptera exigua</i> ]	1e-115	99
PBP2		168	N	AAS55551 pheromone binding protein 2 [ <i>Spodoptera exigua</i> ]	2e-120	99
PBP3		164	Y	ACY78413 pheromone binding protein 3 [ <i>Spodoptera exigua</i> ]	9e-116	100
GOBP1		164	Y	ACY78412 general binding protein 1 [ <i>Spodoptera exigua</i> ]	2e-117	99
GOBP2		162	Y	AGH70098 odorant binding protein 2 [ <i>Spodoptera exigua</i> ]	3e-113	99
OBP1	ADY17883	147	Y	AAR28762 odorant-binding protein [ <i>Spodoptera frugiperda</i> ]	1e-85	88
OBP2	ADY17884	129	Y	AFI57167 odorant-binding protein 18 [ <i>Helicoverpa armigera</i> ]	2e-43	65
OBP3	ADY17885	147	Y	AEX07271 odorant-binding protein [ <i>Helicoverpa assulta</i> ]	1e-37	44
OBP4	ADY17886	145	Y	AEX07279 odorant-binding protein [ <i>Helicoverpa armigera</i> ]	8e-80	81
OBP5	AFM77983	121	Y	AEB54589 OBP8 [ <i>Helicoverpa armigera</i> ]	3e-73	88
OBP6	AFM77984	147	Y	All00976 odorant binding protein [ <i>Dendrolimus houi</i> ]	2e-47	50
OBP7	ADY17882	157	Y	AGH70106 odorant binding protein 10 [ <i>Spodoptera exigua</i> ]	1e-109	99
OBP8	AGP03454	151	Y	AGR39565 odorant binding protein 2 [ <i>Agrotis ipsilon</i> ]	6e-26	42
OBP9	AGP03455	153	Y	XP_004928233 PREDICTED: general odorant-binding protein 99a-like [ <i>Bombyx mori</i> ]	2e-56	58
OBP10	AGP03456	140	Y	AGS36755 OBP15, partial [ <i>Sesamia inferens</i> ]	3e-53	74
OBP11	AGP03457	154	Y	ADK47525 odorant binding protein [ <i>Manduca sexta</i> ]	9e-66	66
OBP12	AGP03458	145	Y	AGM38613 odorant binding protein [ <i>Chilo suppressalis</i> ]	4e-55	55
OBP13	AGP03459	145	Y	AAR28763 odorant-binding protein-2 precursor [ <i>Spodoptera frugiperda</i> ]	4e-64	75
OBP14	AGP03460	139	Y	All00969 odorant binding protein [ <i>Dendrolimus houi</i> ]	2e-43	49
OBP15		142	Y	AGH70103 odorant binding protein 7 [ <i>Spodoptera exigua</i> ]	6e-97	100
OBP16		149	Y	AGH70104 odorant binding protein 8 [ <i>Spodoptera exigua</i> ]	1e-103	99
OBP17	KP729037	148	Y	AGR39569 odorant binding protein 6, partial [ <i>Agrotis ipsilon</i> ]	1e-64	78
OBP18	KP729038	186	Y	AGR39564 odorant binding protein 1, partial [ <i>Agrotis ipsilon</i> ]	2e-72	58

OBP19	KP729039	216	Y	AGC92793 odorant-binding protein 19 [ <i>Helicoverpa assulta</i> ]	8e-63	54
OBP20	KP729040	146	N	AIL54057 odorant-binding protein 21, partial [ <i>Chilo suppressalis</i> ]	6e-61	69
OBP21		65	N	XP_004922682 PREDICTED: uncharacterized protein LOC101744305 [ <i>Bombyx mori</i> ]	1e-29	73
OBP22	KP729041	156	Y	AGK24578 odorant-binding protein 2 [ <i>Chilo suppressalis</i> ]	7e-17	33
OBP24	KP729043	184	Y	AI100978 odorant binding protein [ <i>Dendrolimus houi</i> ]	7e-124	93
OBP26	KP729045	149	Y	AEB54581 OBP5 [ <i>Helicoverpa armigera</i> ]	2e-57	60
OBP27	KP729046	97	N	AAR28762 odorant-binding protein [ <i>Spodoptera frugiperda</i> ]	1e-27	56
OBP28		133	Y	AGH70105 odorant binding protein 9 [ <i>Spodoptera exigua</i> ]	2e-91	100
OBP29		123	N	AGH70107 odorant binding protein 11 [ <i>Spodoptera exigua</i> ]	2e-81	98
ABP2		147	Y	ADY17881 antennal binding protein [ <i>Spodoptera exigua</i> ]	1e-98	99
ABPx	AGP03461	142	Y	CAA05508 antennal binding protein X [ <i>Heliothis virescens</i> ]	7e-64	80

#### Chemosensory proteins

CSP1		128	Y	ABM67688 chemosensory protein CSP1 [ <i>Spodoptera exigua</i> ]	4e-89	100
CSP2		128	Y	ABM67689 chemosensory protein CSP2 [ <i>Spodoptera exigua</i> ]	1e-86	99
CSP3		126	Y	ABM67690 chemosensory protein CSP3 [ <i>Spodoptera exigua</i> ]	2e-85	98
CSP4	KP729023	123	Y	AFR92092 chemosensory protein 8 [ <i>Helicoverpa armigera</i> ]	8e-55	70
CSP5	KP729024	131	Y	NP_001091781 chemosensory protein 15 [ <i>Bombyx mori</i> ]	6e-44	73
CSP6	KP729025	122	Y	AGR39576 chemosensory protein 6 [ <i>Agrotis ipsilon</i> ]	1e-72	83
CSP7	KP729026	128	Y	AIU68827 chemosensory protein [ <i>Chilo auricilius</i> ]	4e-78	89
CSP8	KP729027	107	Y	AI101044 chemosensory protein [ <i>Dendrolimus kikuchii</i> ]	7e-51	75
CSP9		123	Y	AGR39578 chemosensory protein 8 [ <i>Agrotis ipsilon</i> ]	9e-79	90
CSP10	KP729028	122	Y	BAG71921 chemosensory protein 13 [ <i>Papilio xuthus</i> ]	3e-65	77
CSP11	KP729029	122	Y	AFR92094 chemosensory protein 10 [ <i>Helicoverpa armigera</i> ]	2e-75	90
CSP12	KP729030	125	Y	NP_001037066 chemosensory protein precursor [ <i>Bombyx mori</i> ]	6e-46	60
CSP13	KP729031	123	Y	AIW65100 chemosensory protein [ <i>Helicoverpa armigera</i> ]	6e-72	83
CSP14	KP729032	287	Y	AIW65104 chemosensory protein [ <i>Helicoverpa armigera</i> ]	4e-157	84
CSP15		111	Y	AEX07268 CSP7 [ <i>Helicoverpa armigera</i> ]	1e-35	51

CSP16	KP729033	122	Y	EHJ73331 chemosensory protein 12 [ <i>Danaus plexippus</i> ]	3e-40	63
CSP17		122	Y	AEX07267 CSP6 [ <i>Helicoverpa armigera</i> ]	2e-73	88
CSP18	KP729034	117	Y	ABM67689 chemosensory protein CSP2 [ <i>Spodoptera exigua</i> ]	2e-39	58
CSP19	KP729035	122	Y	AGR20054 chemosensory protein 16, partial [ <i>Helicoverpa armigera</i> ]	1e-38	49
CSP20	KP729036	107	Y	AGR39575 chemosensory protein 5 [ <i>Agrotis ipsilon</i> ]	5e-66	93

#### Sensory neuron membrane proteins

SNMP1		87	N	AGN52676 sensory neuron membrane protein 1 [ <i>Spodoptera exigua</i> ]	1e-52	99
SNMP2		520	Y	AGN52677 sensory neuron membrane protein 2 [ <i>Spodoptera exigua</i> ]	0.0	99
SNMP3	KP729047	529	Y	XP_004933211 PREDICTED: sensory neuron membrane protein 2-like [ <i>Bombyx mori</i> ]	0.0	55

#### Odorant receptors

OR1		65	N	AGY14588 putative odorant receptor, partial [ <i>Sesamia inferens</i> ]	6e-26	72
OR3		136	N	EHJ75442 odorant receptor 3 [ <i>Danaus plexippus</i> ]	6e-40	45
OR4		101	N	AIT69896 olfactory receptor 47, partial [ <i>Ctenopseustis herana</i> ]	8e-43	72
OR5		75	N	AIG51876 odorant receptor, partial [ <i>Helicoverpa armigera</i> ]	2e-35	77
OR7		87	N	NP_001166893 olfactory receptor 27 [ <i>Bombyx mori</i> ]	5e-29	64
OR8		145	N	AIG51882 odorant receptor, partial [ <i>Helicoverpa armigera</i> ]	8e-61	68
OR9		95	N	AIG51900 odorant receptor, partial [ <i>Helicoverpa armigera</i> ]	8e-35	71
OR10		57	N	AIG51858 olfactory receptor, partial [ <i>Helicoverpa armigera</i> ]	6e-29	96
OR11		99	N	AGH58120 odorant receptor 11 [ <i>Spodoptera exigua</i> ]	2e-60	100
OR12		69	N	CAG38121 putative chemosensory receptor 20 [ <i>Heliothis virescens</i> ]	1e-17	67

#### Gustatory receptors

GR1		121	N	EHJ69979 putative gustatory receptor candidate 59 [ <i>Danaus plexippus</i> ]	4e-21	80
GR2		37	N	AIG51908 gustatory receptor [ <i>Helicoverpa armigera</i> ]	3e-14	97
GR3		214	N	DAA06392 TPA_inf: gustatory receptor 58 [ <i>Bombyx mori</i> ]	1e-07	28
GR4		109	N	DAA06393 TPA_inf: gustatory receptor 61 [ <i>Bombyx mori</i> ]	0.002	32
GR5		133	N	DAA06391 TPA_inf: gustatory receptor 57 [ <i>Bombyx mori</i> ]	5e-12	29

GR6	413	N	AGA04648 gustatory receptor [ <i>Helicoverpa armigera</i> ]	0.0	89
<b>Ionotropic receptors</b>					
IR25a	657	N	AFC91757 putative ionotropic receptor IR25a [ <i>Cydia pomonella</i> ]	1e-130	83
IR68a	246	N	ADR64682 putative chemosensory ionotropic receptor IR68a [ <i>Spodoptera littoralis</i> ]	9e-78	93
IR75p	66	N	AIIO1118 ionotropic receptors, partial [ <i>Dendrolimus houi</i> ]	4e-21	62
IR76b	542	Y	ADR64687 putative chemosensory ionotropic receptor IR76b [ <i>Spodoptera littoralis</i> ]	0.0	93
IR87a	141	N	NP_650290 ionotropic receptor 87a [ <i>Drosophila melanogaster</i> ]	0.84	29
IR93a	413	N	AIG51923 ionotropic receptor, partial [ <i>Helicoverpa armigera</i> ]	0.0	83

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Note: Newly identified candidate OBPs and CSPs, except for OBP21 due to a short sequence, were submitted to GenBank and the accession numbers of these genes are present in this table.

## Table S4

>SexiOR1

PLLGQLAASGVLICFIGYQATATIGQSVVECMTSFLFLAYNLDFYMICRWCQEITNQSAN  
VGEA

>SexiOR3

LILRTFDMWFPWSLEDYTVYIISFIFHAYAGYLCCIAYPGLQSIILLGQIIRQIRILTFILLHM  
XKVS�DTMKYIHEFCFILVLMFCLVGGQVDNECEALERAVTEKWIYIFNHNHKS NIRIFN  
MALGQRMSIY

>SexiOR4

KLQQDASSFKSVRLITSVAFFVAMILQLGMQCLTGNELTIQAERISDAIMQCKWERIPPSQ  
RRLLLIMMMRAQRPLRLTAAGFTHMDNACFLAVSIKKFLV-

>SexiOR5

NYIFKQSSMGMGQGPFAAASWCLSPRIRRDVLVILGSGMMKPRHLRAGPFNFDLPSFIQ  
VVRAAYSYYAVLGKKE-

>SexiOR7

SKVLAMALSYAMEDHLKELFDTCLTSRKFPQPWKEGRLVLLQKGRPPDSPSAYRPIVL  
LDEAGKMLERILASRITHHLSTVGPDL

>SexiOR8

IVILTSNVSALLRLLQVDLENAIKIHDEDKNLKKINIVTDPESEYENVRTLIVVHQKTFKNIGS  
TEQCFWVVIHVAFAALEICFFGFLTLVYGGGLADTIANLPTVFNAVFTIFLLSLSGQFLCDT  
SSQVADAAYQGYWFESDVK

>SexiOR9

RYLPTTPGETYGLSPKYETPFYEITFVLTYVATAFSAINQTGYIVLFTLICHELGHFYANH  
GSTGRDSYNLDKERTFSKQRRQGTGRESVDDL

>SexiOR10

MPVTPLKSPDYELGYLYQMVSIIYISAF LFISVDSVAVCMIMFGCAELEIIMDKIQKV

>SexiOR11

TAAALSRYLPLTIIMFGELVLLSIIFETIGTMSEKLDKAVYKMPWEYMDTKNRRTVLIFLIKV  
QEPIHVKAGGLVDVGVTTMASILKTSFSYFAFLRTF-

>SexiOR12

TIFLNDQFLTTAILIASISPLATMIFIDMYKCMASDIVNIIRHSTVVGPFLLGGFFKVREWS  
RFQGHT-

>SexiGR1

MYKSLIVLCVVYCVVIEARPKWQVLPPMPGYVPVYIRPGDTPLEEINLDLAEAFHELPSG  
RSVGKQVEASPEAPEQADQPQDEVPAAPADEIVDHRPYEKKILEKKKKTDSEIPKPIER  
R

>SexiGR2

HVNRELLTSAISMIAIYLIVLLQFKISLPKDPQIVAT-

>SexiGR3

GIRILVLFNKYFDVWIESVYKMDNQQNNEEDCNKLVKLYRDILEAYKLFTAIFTVLIFFRTID  
LFMRGLIYLYLYFIDFKYSHVEEEIHNYTIIATLIVGLDWMIKNIIIIISAICMQCEKFQMHIEEA  
ESACIQLVMKRDCPKSNKYLYKRVLQYNHLFTKMSAYGFFTFDAKLPMPLLGLLTNYII  
VFIAVRFSFEFCTVCRNGMGEGFFYFY-

>SexiGR4

ENEYKIVSWNIIILTIIWLLKDIVLVFLQNFFSEK FYMTVEEAETTCILLMKNTNCTQNEKRL  
CKKVLWEKRTFNKMAILGVS VGALLPISVIAHVTNYVIVLIQFAFL-

>SexiGR5

MSILMSFLRYILLTYQFFYKYTFNKTRATDYNRFIVIFTYVSVMMMPLAAGQMTRNQGK  
YHRVLARLYNKMIGTDANAEE TKMIKDFIRLIKKNPLQINLISNFPAGMNLLPVIVMLFFNY  
LIVILQFNHVI-

>SexiGR6

PSRPTHCVVGGAHAFILRISSFFGLAPLRFEARNGFTVSISSAMCVYSYILVTVLVICTIF  
GLVAEXTAGAGVYGAPQRMNRMLKFMENIASVDTSIGGQYSLLTERKLCGIIILAILIFFSV  
LIADDFTFYALQAKKLDREWDVVTNYLGFYLLWFVLMLELQFAFTALSVRARFSAVNDA  
LALTARQVSVPEKPKIPSSLNIAIRVAPADSARSANVSLLVETMTGREHVVIKRTASG  
EPRLIVSPCDAVRRLAALHGTLCDDVNSIDDSYGLPLIVVLISTLLHLIVTPYFLIMEIIVSTN  
RVHFLVLQFLWCVTHMLRMIVVVEPGHYTIAEGKRTEALVCRLMTSAPSTGVLP SRLEIF  
SRQLMLQSVSYAPMG MCTLHRPLVASVIGAVTTYLVILIQFQRYDS-

>SexilR25a

MSARTVFLLIYFIRITFGQTTQINIVLLINEESNALAEKAFEVAKEYVRRNPSLGLAVDPVI  
VVGNRTEXSFTEALSLPTISGSFGQVGD LRQWRSLNANQTRFLLQVMPPADILPEAIRAIV  
TKQDITNAIIFDEFXCGCKNATIVHIRPTDANSRDR LGKIKTTYSMNGEPEITSAFYFDL  
SLRTFLTIKSLLDSGKWPNDMKYITCDDYDGKNTPNRTL DLKTAFQEIKETPTYAPFYIPP  
DDPMNGRSYMEFSTDLLAITVKDGASISSHSLGSKAGLSSNLTLXTMDENGNWNGIIK  
ELVDKKADIGLSSLSVMAERENVVDFTVPPYDLVGITIMMKLPRTPTSLFKFLTVLENDV  
WLSILAAAYFFTSFLMWVFDKWSPYSYQNNREKYKEDEEKREFTLKECLWFCMTSLTPQ  
GGGEAPKNLSGRLLXIWKEMSLNDSLKEVERAKLAVWDYPVSDKYSKMWQAMEEAVL  
PNTIEEAIQVRDSSKSSSEGFALWGDATDVKYHVMTSCDLQSVGDEF SRKPYAIAVQQ  
GSPLKDQFNAILQLLNKRKLEKLKEIWWNNNPESMKCEKQDDQSDGISIQNIGGVFIVIF  
MGIGLACVTLGVEYWWYKWRKRPVAVGDVTQVEPAKLTRNNVDKQGDGFNFRGRNLGI  
NFKPKF-

>SexilR68a

LTISFRLYMWIAVLLVLLITGTIFYGLAKNHMNLQEYKCLRVTQTKHDEDNDAKPGLYLFG  
EIINSILYTYGMLLVVSLPRLPTGWSIRLLTGWYWLYCILLVVSYRASMTAILANPAPRVTI  
DTLRELVDSKVTCCGXPISIGFHKNSPLKPLADVMMWRVVEVGLVEKWLNDVMYPIHSL  
ETNEDEVKALMNLKPLYGAFIALAIGYTLSALCLTDELIHWHFIVKRDPNFDKYALHLYR  
KKNY-

>SexilR75p

HSRYQTYNNQVRRSIYKRIDPEIGQKHFYNLDEGVERIRQGLFAFHSIVEPVYRQIEDTFL  
ENEKC

>SexilR76b

MAGIELIISSICNATFCEIPYNETYQAPDSLVEKDINFMSLMKEVNGKHIKVTTYNNTPLSS  
TEFENGTVVGYGVAFTIMNLRKKNFTYEIILPTKNYELGSKISDDSIIGLLNTSKVDMAVA  
FLPTLLPYREKV/SFSIDLDEGVVMMMLKRPKESAAGSGLLAPFNDLVWYLVLA AVLTFG  
PCITFFTRVRSKLITDDEGVLPLKPSFWFVYSAFLKQGTNLSPEANTTRVLFVTWWLFMI  
LLSAFYTANLTAFLTLSKFTLAIETPRDLYQKNTRWVASAGSSVEHVVKTEGEDLYFLNA  
MISSGKARFLSVSGDKEFLEYVKKEAVLVKEQTVVDHLMYNDYISKKDVDDESDKCTYVV  
APSAFMKKQRAFAYPVGSKLKSFLDPVLTQIFQAGILDFLKRSDLPSTKICPLDLQSKDRK  
LRNSDLIMTYLVMVAGSATAVAVFGAEIFVKRYLSGKLNKTKKSKRKKSKAGKSSKIHND  
SRPPPYDSLFGKNPKFNLETTRMKMINGREYYVFETSNGDKKLIPARAPSSFLYRSDK-

>SexilR87a

MFAFLRTVLFFIHTSSMSENPLLMTTANSGQIAKTAECVLKLSAKYFVEKKALSGSIVIINI  
NSYTSTTQXFYPHANASHFPEKAKNYMLILEEKSELKRNILQLNKLPTWNPLAKAIVFYQL  
KYNETAETAVDFINELR

>SexilR93a

LLNVGIWRPIDGVRFEFVLFPHIHHGFRGKELPIITYHNPPWTILQRNESGAIVKYGGGLIFD  
IIHQLAINKNFTVKVILASVLKKELSNDTTTTDMMHSMEAKLTISAIKGGALAAASFTVLA  
DPVPGVXPSGAQQSIIILLPFTTDTWLCLGLAVILMGPTLYIIHRMSPYYEAMEITRQGGLA  
TIHNCLWYIYGALLQQGGMYLPRADSGRLVVGTTWWLMVLVVVTTYSGNLVAFLTFPKQ  
EVPVTTISDLLANRALYTW SINKGSYLEMELKNSDEPKYLALLKGAELVSP TDGKSGTMS  
SGSSLLQVRFRHRHVIIDWKLRLSYMMRADRLEDDNCFALSTEEFLDEKVAMIVPAGS  
PYLPVINKELDRMHKAGLIMRWLEAYLPKKDRCWKSSSMMQEVEQPHCQPQ-

>CsupSNMP3

MCSGFVCGLVTIVIGAALVISSSIVGFVVVPNIVKEGIVNQVALMDDTIQLERFTEVPFPLQ  
CRVRVFNISNAAEVLEGAVPIVTEMGPYVYKLYSSRLIEERTDDRLRYRKLDRFEFDDAVA  
SFPYTENXVLQVAERRFPGVMTVLNEALPEIFEEYNKPIVPVRVRDLIFDGMPLCRNPSY  
VGTLACIIIRQISNDIQNMMPQPDGSIHFSVLNYRNGIPGGLMDVYRGLDDPADLGRINW  
QSSPNLSYWTGANSNLCNMLNGTDSGIFQPFINREPRNLLRRFGFTSDICRSVELRYQHD  
IVHNDIPGVRFAAREWLLNNNEGCFCLNITSGINAEDGCLLNGAMELFCVGMVLSN

PHFLFGDIRYRNGVFGMNPVIDKHGIFLDIEPNTGTILRGSKRAQFNVMRPVTRVHATQ  
KLRTTLTPIFWIEEAMTLPEEYTDEIS

>PxyISNMP3

MKFGVRSSAAVLAVGAVVAVAVAIVGYAVVPGIIDETILQEVALENTIALERFENVFPPL  
NFTIHLFSVENGPVLAGGIPRVREERGPYIYKLYQTRVIEGFNEDTISYRFLQTYEFDKEA  
SFPNTEDDRVTIANVAYHSV LQVAEQLAPTLLGALSLALDSVFGRELSPLATVRVGDV  
FDGIPLCRGGGLLASVACAVIRDAAKDIPNMEVQPDGSLVFSLFAHKRDKLGELYKVDR  
GLQDPLALGSILQWNQRDFLPNWAGGPLSQCARLNGTDTGIFPPFIKRDTVLYGFNTDI  
CRSVELRYQYDTQYSGVPAYRFAANDWFLSNREGCFCLNVTAGVTAPDGCLLHGAQE  
MYSCIEPTLGYLVCARKKDYIISGHSILTDDSYSISRVEALGGGWHTTSSPVAVKSNRGT  
ALSPTIAGSYLVLTYPHFLFAHPTYANMVVGMTPDLERHRIFLDLEPVSTPYFLRKV

>SinfSNMP3

QRTGLNREDGCLLKGAMELYTCVGAFLVMSYP



**Table S5**

Ligand	OBP2		
	Relative fluorescence (%)	IC <sub>50</sub> (μM)	K <sub>i</sub> (μM)
<b><i>Alcohols</i></b>			
Hexanol	65.70	—	
Z-2-Hexenol	72.64	—	
Z-3-Hexenol	81.17	—	
<i>E</i> -3-Hexenol	74.86	—	
Heptanol	61.77	—	
2-Heptanol	69.09	—	
Nonanol	53.56	—	
2-Hexyl-1-decanol	70.98 (66.09)	—	
undecanol	34.23	<b>4.99</b>	<b>3.60</b>
Hexadecanol	67.50	—	
Linalool	63.05	—	
(+)-Cedrol	66.97	—	
Nerolidol	66.46	—	
Farnesol	50.56	—	
Geraniol	67.19	—	
α-Ionol	74.04	—	
β-Citronellol	70.42	—	
S-Z-Verbenol	79.22	—	
(+)-Borneol	77.75	—	
Menthol	78.08	—	
(1 <i>R</i> )-(-)-Myrtenol	71.23	—	
Phenethyl alcohol	71.23	—	
<b><i>Aldehydes</i></b>			
Hexanal	80.10	—	
<i>E</i> -2-Hexenal	67.76	—	
Z-3-Hexenal	66.90	—	
Heptanal	74.07	—	
Octanal	67.62	—	
Decanal	58.89	—	
Dodecyl aldehyde	40.69	<b>6.96</b>	<b>5.03</b>

Benzaldehyde	66.42	—	
<b>Ketones</b>			
2-Hexanone	78.87	—	
2-Tridecanone	60.29	—	
2-Pentadecanone	44.61	<b>11.06</b>	<b>7.99</b>
Geranylacetone	61.02	—	
$\beta$ -Ionone	64.26	—	
Damascenone	71.55	—	
(+)-Carvone	72.83	—	
Acetophenone	69.65	—	
<b>Esters</b>			
Butyl acetate	63.34	—	
Amyl acetate	66.94	—	
Isoamyl acetate	76.52	—	
Hexyl acetate	70.54	—	
Heptyl acetate	59.14	—	
Octyl acetate	43.11	<b>7.99</b>	<b>5.77</b>
Nonyl acetate	42.75	<b>11.68</b>	<b>8.44</b>
Decyl acetate	40.06	<b>6.74</b>	<b>4.87</b>
Z-3-Hexenyl acetate	71.16	—	
E-2-Hexenyl butyrate	63.87	—	
Z-2-Hexenyl butyrate	62.89	—	
Geranyl acetate	62.64	—	
Methyl salicylate	71.56	—	
Methyl benzoate	73.25	—	
<b>Alkanes</b>			
Undecane	60.86	—	
Dodecane	68.28	—	
Tridecane	75.78	—	
Tetradecane	74.02	—	
Heptadecane	82.76	—	
Octadecane	83.33	—	
Icosane	77.90	—	
<b>Olefines</b>			
Myrcene	64.73	—	

<i>E</i> - $\beta$ -Farnesene	70.04	—	
Ocimene	83.09	—	
(+)- $\alpha$ -Pinene	68.76	—	
(+)- $\beta$ -Pinene	73.19	—	
( <i>R</i> )-(+)-Limonene	67.37	—	
$\alpha$ -Phellandrene	67.09	—	
(+)-Camphene	76.45	—	
$\beta$ -Caryophyllene	75.74	—	
<b>Others</b>			
Eucalyptol	70.04	—	
Camphor	72.81	—	
Cumene	69.15	—	
Lauric acid	37.30 (36.40)	<b>2.99</b>	<b>2.16</b>

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Note: Relative fluorescence means the fluorescent percent as fluorescence intensity at the maximal concentration of 20  $\mu$ M relative to the initial fluorescence. The values in the bracket indicates that at 20  $\mu$ M relative fluorescence values of these ligands are not the lowest values and are shown at other concentrations. In binding assays, IC<sub>50</sub> values (the concentrations of the ligands halving the fluorescence of 1-NPN) of the ligands at 20  $\mu$ M could be not obtained and represented as “—”.