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ORIGINAL ARTICLE

Identification and expression patterns of chemosensory proteins in the black-back prominent moth, *Clostera restitura* (Lepidoptera: Notodontidae)

Hui LI[1,2], Tianzi GU[1,2], Changyu CHEN[1,2], Kairu HUANG[1,2], Ruixu CHEN[1,2] and Dejun HAO[1,2,*]

[1] Co-Innovation Center for the Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing, 210037 Jiangsu, China; e-mails: 15720616317@163.com, tianzigu@gmail.com, 1134614728@qq.com, 286412533@qq.com, 1017385045@qq.com, djhao @ njfu.edu.cn

[2] College of Forestry, Nanjing Forestry University, Nanjing, 210037 Jiangsu, China

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Abstract. Insects have evolved highly specific and sensitive olfactory sensory systems to detect plant hosts and mates. Chemosensory proteins (CSPs) play an important role in this process, but in this respect there is limited information on *Clostera restitura*, one of the most destructive defoliators of poplars in China. In the present study, we first identified seven candidate CSPs in *C. restitura*. Sequence alignment and phylogenetic analysis showed that these candidate proteins possessed typical characteristics of the insect CSP family and were similar to those of other Lepidoptera. These genes were expressed in different developmental stages and tissues, and the levels of expression differed after mating. Some CresCSPs were more associated with development and others with mating. They may play an important role in host recognition, egg development and mating behaviour. Furthermore, the CSPs were ubiquitously detected in all tissues and most of them were highly expressed in antennae, especially female antennae. We suggest the CresCSPs may contribute to female oviposition site recognition. CresCSPs that are highly transcribed in wings and legs, may function in gustation. This study provides a better understanding of the molecular mechanisms of olfaction in *C. restitura* and environmentally friendly pest management strategy for controlling *C. restitura.*

INTRODUCTION

Clostera restitura Walker (Lepidoptera: Notodontidae) is one of the most destructive defoliators of poplar trees in China. This pest is widespread in southern China, especially in forest-rich provinces, such as Anhui, Jiangsu, Zhejiang, Shanghai, Fujian, Guangxi, Guang dong, Hunan and Hainan (Zhang, 1997; Liu et al., 2016; Fang et al., 2018; Xin et al., 2018). It also occurs widely in other Asian countries including India, Indonesia, Malaysia and Vietnam (Wu & Fang, 2003; Schintlmeister, 2008). An outbreak of *C. restitura* usually causes severe economic damage in a surprisingly short period. More and more scientists are exploring the biological characteristics, behaviour and control strategies for *C. restitura* (Jing et al., 2007; Tang et al., 2008).

Insects have evolved highly specific and sensitive olfactory sensory systems to perceive chemical information from the environment and transform this information into electrical signals. This process is essential for insect feeding, courtship, defence and migration (Zwiebel & Takken, 2004). Diverse kinds of proteins, odour binding proteins (OBPs), chemosensory proteins (CSPs), odour receptors (ORs), odour degrading enzymes (ODEs), ion receptors (IRs) and sensory neuron membrane proteins (SNMPs), participate in chemical perception (Leal, 2013; Cao et al., 2014; Elfekih et al., 2016, Fleischer et al., 2018). Volatile chemical signals and other stimuli of lipophilic compounds cannot be directly transported to chemosensory receptors across hydrophilic lymph and must be bound by OBPs and CSPs (Yi et al., 2014a). Therefore, OBPs and CSPs, which are known as carrier proteins, play key roles in insect olfaction (Dani et al., 2011).

CSPs and well-studied OBPs, are low-molecular-mass and soluble proteins used in insect chemoreception (Pelosi et al., 2006). CSPs are characterized by four cysteine residues (C_1-$X_{6\text{-}8}$-C_2-$X_{16\text{-}21}$-C_3-X_2-C_4) that form two disulfide bridges (Tomaselli et al., 2006). Similar to OBPs, the rigid hydrophobic pocket in CSPs can capture and transport external chemical cues to receptors. CSPs were first discovered in the antennae of *Drosophila melanogaster* (Mckenna et al., 1994). Further studies revealed that CSPs were expressed not only in antennae but also in other insect

* Corresponding author; e-mail: djhao@njfu.edu.cn

tissues, including legs (Picimbon et al., 2001), pheromone glands (Dani et al., 2011), wings (Zhu et al., 2015), proboscises (Liu et al., 2014), labial palps and maxillae (Angeli et al., 1999), which differs from OBPs.

The multi-tissue expression pattern of CSPs indicate they may also have other functions, apart from chemo sensation (Tegoni et al., 2004). In fact, with the development of genome and transcriptome sequencing, recent studies have demonstrated that CSPs do contribute to other physiological processes (Zhu et al., 2015; Kang, 2016; Zhang et al., 2017; Ting et al., 2018; Zeng et al., 2018). As carrier proteins, CSPs bind with small molecules, for instance nutrients, toxic compounds, hormones and semiochemicals, (Pelosi et al., 2017). Most CSPs identified in *Bombyx mori* (Dani et al., 2011; Qiao et al., 2013), *Plutella xylostella* (Liu et al., 2010) and *Sesamia inferens* (Zhang et al., 2013) are widely expressed not only in antenna but also the female sex pheromone gland, which indicates a role in insect mating. In addition, CSP6 of *Helicoverpa armigera* is highly transcribed in sensory organs and pheromone glands, and has high binding affinity for pheromone components, which reveals that HarmCSP6 is probably involved in transporting female sex pheromones in *H. armigera* (Li et al., 2015). A decrease in CSPs is associated with reduced survival and fecundity in females of *Spodoptera exigua*, which demonstrates that female survival and reproduction is closely associated with CSPs transcription (Gong et al., 2012). Xin et al. (2017) reports that the mid gut expressed CSPs in *Spodoptera litura* may be responsible for its ability to adapt to different ecosystems. Populations of insecticide-resistant *Diatraea saccharalis* have a higher CSPs transcription than susceptible populations, which indicates that CSPs participate in this insect's immune response. A similar phenomenon is reported in *Tribolium castaneum* (Guo et al., 2012; Gao et al., 2018). Moreover, CSPs are essential for the development of the embryonic integument of *Apis mellifera*, behavioural phase change in migratory locust and insect tissue regeneration (Pelosi et al., 2006; Maleszka et al., 2007; Guo et al., 2011). Notably, RNAi reduction in NlugCSP8 transcript abundance causes a decrease in the behavioural response to particular attractants, which is likely to result in more effective and eco-friendly control strategies for the brown plant hopper (Muhammad et al., 2018).

This laboratory previously constructed a cDNA library for *C. restitura* and characterized the expression profiles of OBPs. It is likely that OBPs play a key role in foraging, seeking mates and host recognition in *C. restitura* (Gu et al., 2019). In addition, we cloned the full-length of the cDNA encoding CresCSP3 and analyzed its tissue specific expression pattern. The CresCSP3 transcripts detected in heads, antennae, wings and legs indicate they may contribute to insect development, mating behaviour and host location (Li et al., 2018). In this study, sequence cloning and analysis of the patterns of expression of CresCSPs are used to determine the physiological roles of 7 other CSPs in *C. restitura*, which will help in the development of eco-friendly techniques to be used in the control *C. restitura* in the future.

MATERIALS AND METHODS

Insect rearing and sample collection

Clostera restitura eggs were collected from the leaves of 7-year-old *Populus euramericana* cv. I-72 trees in an agricultural afforestation area, Pukou District, Nanjing (32°180´N, 118°28´E), Jiangsu Province, China and kept in an incubator (26 ± 0.5°C, 70 ± 5% relative humidity, 16L : 8D photoperiod) at the Laboratory of Entomology at Nanjing Forestry University. On hatching, larvae were transferred to 15-cm-diameter sterilized Petri dishes and reared on fresh leaves of *Populus deltoides*. Pupae were placed in individual tubes. On emergence the adults were put into plastic boxes (15 × 10 × 10 cm) and fed ad libitum a 10% honey solution. The second generation eggs, larvae, pupae and adults were used in the experiments.

For the analysis of the pattern of expression, eggs (N = 30), 1st to 5th instar larvae (N = 3), pupae (N = 3), antennae of 1–6 day old virgin males and females (N = 30) and antennae of mated and virgin adults (N = 30) were collected. The antennae, heads (without antennae, N = 3), legs (N = 30) and wings (N = 6) were dissected from newly emerged male and female adults. All these samples were immediately frozen in liquid nitrogen and stored at –80°C.

RNA extraction, cloning and sequencing

Total RNA was isolated using TRIzol Reagent (Ambion, State of Texas, USA) following the manufacturer's instructions, before checking the quantity of RNA. First-strand cDNA for RT-PCR and RT-qPCR were synthesized from 1 µg total RNA using 1st Strand cDNA Synthesis Kit (TaKaRa, Dalian, China). Seven pairs of specific oligonucleotide primers (Table S1) were designed based on the transcriptome database for *C. restitura* (Gu et al., 2019) and used to amplify the complete open reading frames (ORFs). We performed PCRs to amplify the specific genes, following the manufacturer's protocol (Zoman, Beijing, China). Amplification products were purified using a DNA purification system (Tiangen, Beijing, China) and cloned into a pEasy-T1 cloning vector (TransGen Biotech, Beijing, China). Seven randomly selected positive clones per construct were sequenced.

Sequences and phylogenetic analyses

The ORFs of the putative chemosensory genes were identified using ORF Finder (http://www.ncbi.nlm.nih.gov/gorf/gorf.html) (Min et al., 2005). Similarity searches were performed using NCBI-BLAST (http://blast.ncbi.nlm.nih.gov/). Sequence alignments were performed using DNAMAN version 6.0. Signal peptides were identified using SignalP 4.0 (http://www.cbs.dtu.dk/services/SignalP/) (Petersen et al., 2011). The molecular weights and isoelectric points of mature proteins were calculated using the ExPASy server program (http://www.expasy.ch/cgi-bin/pi_tool).

Phylogenetic trees were constructed based on the cDNA sequences of CSPs from *C. restitura* and CSPs in other Lepidoptera in the UniGene database at NCBI. Maximum-likelihood phylogenetic trees were constructed using MEGA 6 and bootstrapping of 1,000 replicates (Tamura et al., 2011).

Real-time quantitative PCR

To determine the potential functions of the CSPs, we measured the relative levels of expression of these genes in the different developmental stages, virgin and mated individuals and different tissues using qPCR. We performed RT-qPCR with the previously mentioned cDNA templates. Reactions of each sample of the three biological replicates were run in triplicate. The qRT-PCR primers (Table S1) were designed online (https://www.genscript.

com/tools/real-time-pcr-tagman-primer-design-tool). The RPS13 gene was used as a reference gene (Gu et al., 2019). qRT-PCRs were performed in an Applied Biosystem 7500 System (USA) using SYBR Premix Ex Taq II (TaKaRa, Dalian, China), according to the manufacturer's protocol. The cycling conditions were (1) 95°, 30 s; (2) 95°, 5 s; (3) 60°, 34 s; (4) go to (2) for 40 cycles, and this procedure was followed by an analysis of melting curves ranging from 60 to 95°C to verify the presence of a single discrete peak for each reaction product. The cDNA templates in 10-fold dilution series were used to construct a relative standard curve to determine the PCR efficiency. In all experiments, all primers achieved amplification efficiencies of 95–100% (Table S1). The results of qRT-PCRs were analyzed using the $2^{-\Delta\Delta Ct}$ method (Livak & Schmittgen, 2001).

Statistical analysis

All data was processed using SPSS Statistics V20.0 (IBM). A one-way analysis of variance (ANOVA) with least significant difference (LSD) was used to analyze the patterns in the expression of genes in the various samples.

RESULTS

Identification of CSP genes in *C. restitura*

Based on the unigenes of the CSPs annotated in the *C. restitura* antennal transcriptome database (Gu et al., 2019), we used PCR to clone seven CSP genes from antennae of *C. restitura*, and the sequences of these genes were deposited in GenBank with accession numbers presented in Table S2. All of these CSPs had full-length ORFs with four conserved cysteines in the same corresponding positions according to multiple alignments of amino acid sequences of the seven CresCSPs (Fig. 1). The ORFs of CresCSP1-7 ranged from 321 to 387 bp in length and the predicted molecular weight varied from 11.81 to 14.73 kDa. In addition, they were all predicted to have signal peptides of 16 to 18 amino acids in length and isoelectric points from 5.35 to 8.58 (Table S2). The results of a BLASTX search showed that CresCSP1 to CresCSP7 were very similar to the CSPs in other Lepidoptera (> 64%), especially the CSPs in *S. litura* and *B. mori*, whereas CresCSP8 was not similar to the CSPs of these organisms (39%).

Phylogenetic analyses of the CSP genes in *C. restitura*

A phylogenetic tree was constructed based on the cDNA sequences of CSPs from *C. restitura* and other Lepidoptera, including *B. mori*, *Eogystia hippophaecolus*, *Grapholita* *molesta*, *H. armigera*, *Heliothis virescens*, *Lobesia botrana*, *Ostrinia furnacalis*, *Papilio xuthus*, *Plutella xylostella*, *S. exigua* and *S. litura* (Fig. 2). The Maximum-Likelihood (ML) tree indicated that these seven Cres CSPs occur on different branches. CresCSP1 and CresCSP6 were clustered with CSPs from *P. xuthus* (PxutCSP1 and PxutCSP7) in one subbranch, while CresCSP2 and CresCSP8 occurred on separate branches along with SexiCSP1-2 and SexiCSP6, respectively. CresCSP5 was very similar to LbotCSP13, whereas CresCSP4 was on a branch with CSPs from Noctuidae (Fig. 2).

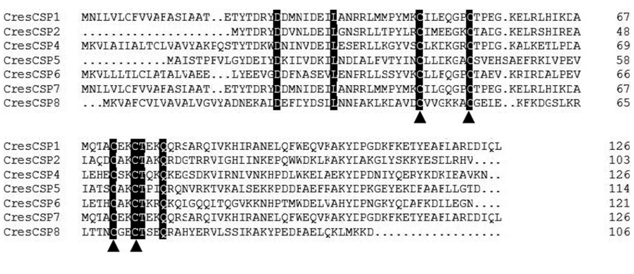

Fig. 1. Alignment of mature CresCSP01, CresCSP02, CresCSP04, CresCSP05, CresCSP06, CresCSP07 and CresCSP08 from *C. restitura*. Conserved amino acids in all CSPs are shown with a black background. Positions of the four conserved cysteine residues are indicated by triangles.

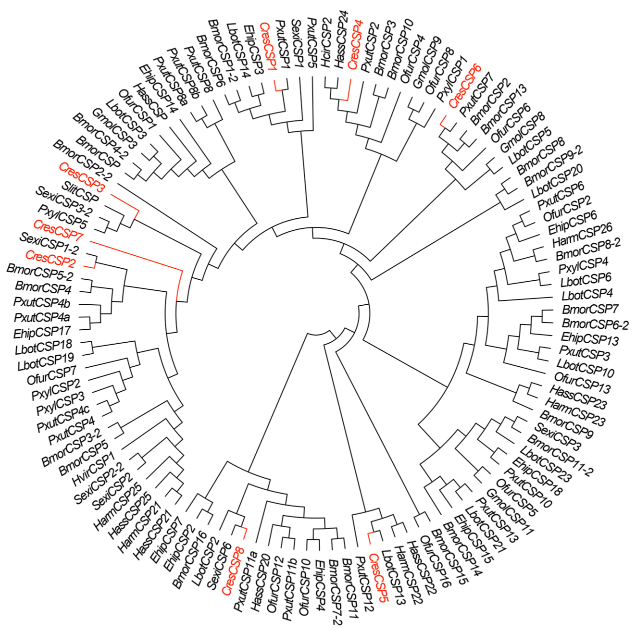

Fig. 2. Phylogenetic analysis of cDNA sequences of CresCSPs and those of other Lepidoptera using the maximum likelihood method with 1,000 bootstrap replications. The sequences used in the construction of this phylogenetic tree are listed in Table S3.

Patterns of expression of CSP in *C. restitura*

Stage-specific expression of CSPs in *C. restitura*

All seven CresCSPs were expressed throughout the life cycle of *C. restitura* (Figs 3–4). However, the expression patterns of CSPs in *C. restitura* differed in different stages. CresCSP7 was expressed in eggs at relatively high levels. In the first instar, CresCSP4, CresCSP5 and CresCSP6 were transcipted significantly. mRNAs of CresCSP1 and CresCSP2 were especially dominant in the second and third instar, while that of CresCSP8 was strongly detected in the fourth and last instar.

The expression patterns of CSP genes after adult emergence were shown in Fig. 4. CresCSP1 and CresCSP8 were expressed mainly in 3-day-old females and males. CresCSP2 showed high levels of expression in 4-day-old males, while CresCSP4 and CresCSP5 were abundant in 4-day-old females. In addition, in 1-day-old *C. restitura* females there were many transcriptomes of CresCSP6, CresCSP7 and CresCSP8.

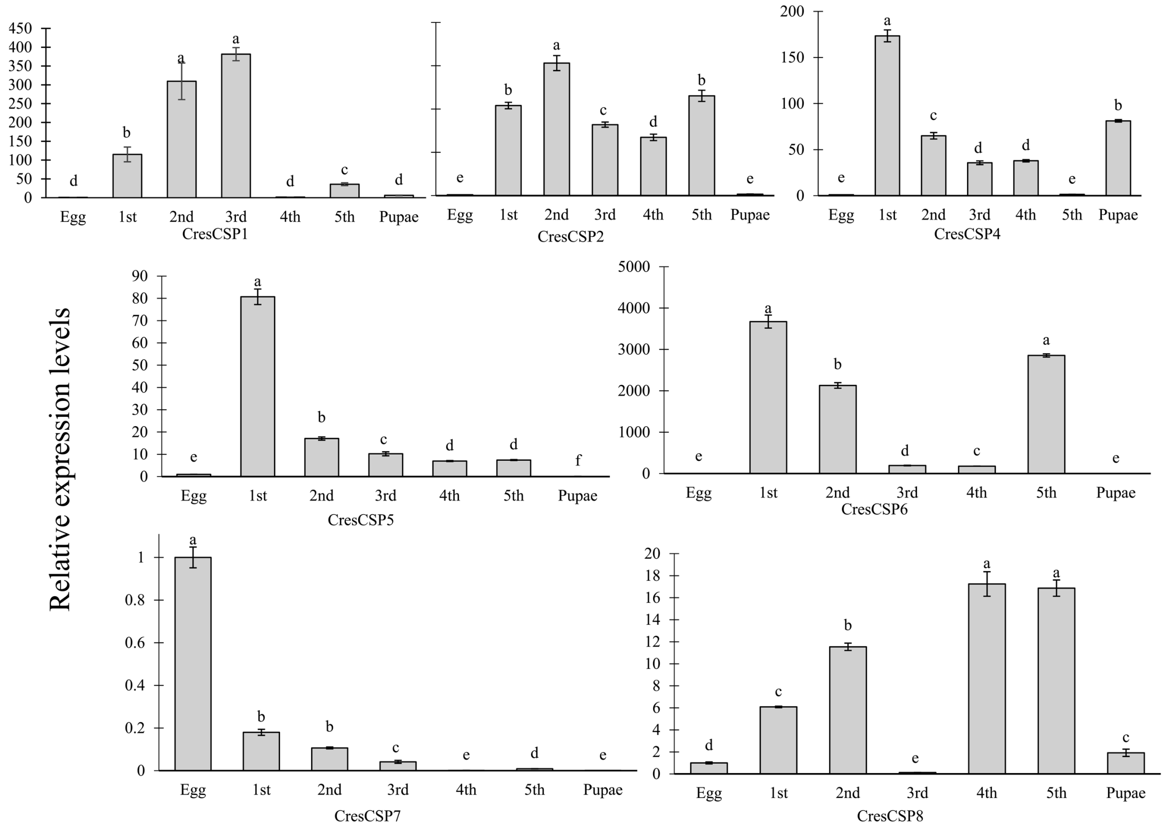

Fig. 3. Relative levels of expression of CresCSPs in eggs, larvae of different instars and pupae determined using qPCR. Data presented are the means of three replicates. Different lower case letters indicate significant differences (P < 0.05).

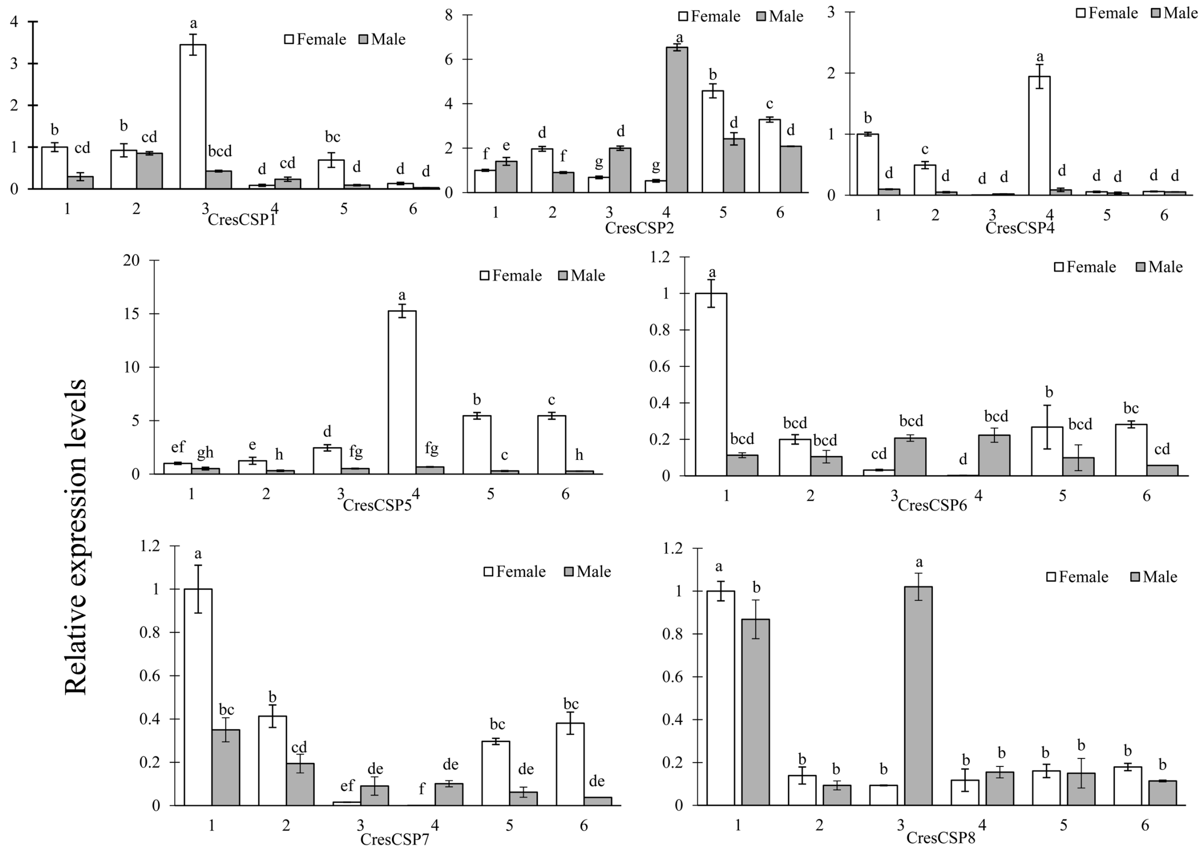

Fig. 4. Relative levels of expression of CresCSPs in 1 to 6-day-old female and male adults determined using qPCR. 1 – 1-day-old, 2 – 2-day-old, 3 – 3-day-old, 4 – 4-day-old, 5 – 5-day-old and 6 – 6-day-old. Data presented are the means of three replicates. Different lower case letters indicate significant differences (P < 0.05).

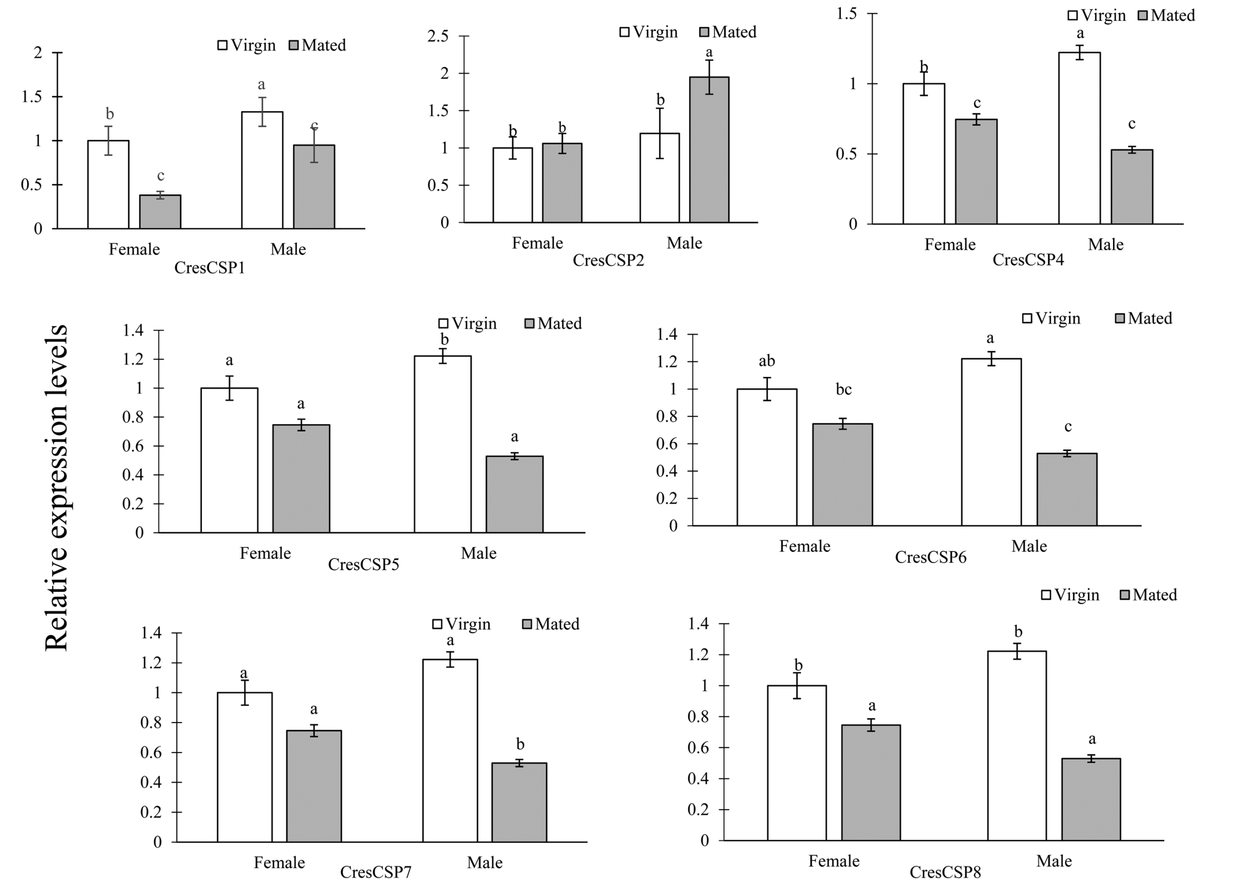

Fig. 5. Relative levels of expression of CresCSPs in virgin and mated adults determined using qPCR. Data presented are the means of three replicates. Different lower case letters indicate significant differences (P < 0.05).

Mating-specific expression of CSPs in *C. restitura*

The expression levels of CSP genes associated with mating status were shown in Fig. 5. Adult males had less mRNA of CresCSP1, CresCSP4, CresCSP6 and CresCSP7 after mating, but there were many transcripts of CresCSP2, CresCSP5 and CresCSP8 in mated males. There was an increase in the expression raised of CresCSP8 in mated females of *C. restitura* and decrease in the expression of CresCSP1 and CresCSP4 after mating.

Tissue-specific expression of CSPs in *C. restitura*

The qRT-PCR results revealed that seven genes in *C. restitura* were expressed at different levels in a wide range of tissues (Fig. 6). All seven CresCSPs, however, were mainly detected in antennae, with higher transcription levels of almost all the CresCSPs except for CresCSP2 in female antennae than in male antennae. We also recorded an enriched level of transcripts of CresCSP1, CresCSP7 and CresCSP8 in the wings of *C. restitura* and a recordable amount of those of CresCSP1, CresCSP2 and CresCSP8 in the legs.

DISCUSSION

We have compiled a library of the cDNA and thirteen CSPs in the antennae of *C. restitura* in order to identify the olfactory-related genes expressed in its antennae (Gu et al., 2019). Currently, eight CSPs with high levels of transcription among the thirteen CresCSPs from the antennae of *C. restitura* were cloned, which is fewer than that reported in other Lepidoptera. The number of CSPs varied among Lepidoptera. According to previous studies, there were twenty candidate CSPs in *B. mori* (Gong et al., 2007), 14 in third instar larvae of *E. obliqua* (Sun et al., 2017) and 24 in *H. armigera* (Li et al., 2015). These results indicated that the number of CSPs genes varied in insects and was associated with different ligands that enabled them to adapt to changing environmental conditions. BLASTX results indicated that CresCSPs were very similar to the CSPs in other Lepidoptera, e.g., CSPs in *S. litura* and *B. mori*, which implied that CSPs in insects were highly conserved. In addition, the bioinformatics analysis showed that CresCSPs have the same signature as other CSPs, low molecular weight, an N-terminal signal peptide sequence and four conserved cysteine residues, which supported the hypothesis that CSPs were highly conserved (Wanner et al., 2014).

The phylogenetic analysis showed that different CresCSPs had a distant genetic relationship. Similar results were reported for many Lepidoptera (Liu et al., 2010; Li et al., 2015; Zhu et al., 2015; Sun et al., 2017). The diversification of CSP-encoding genes in *C. restitura* might be correlated with the various functions of CresCSPs. Similarly, Gong et al. (2015) reported six of seven CsupCSP genes were in each branch with Papilionidae CSPs. We also found that

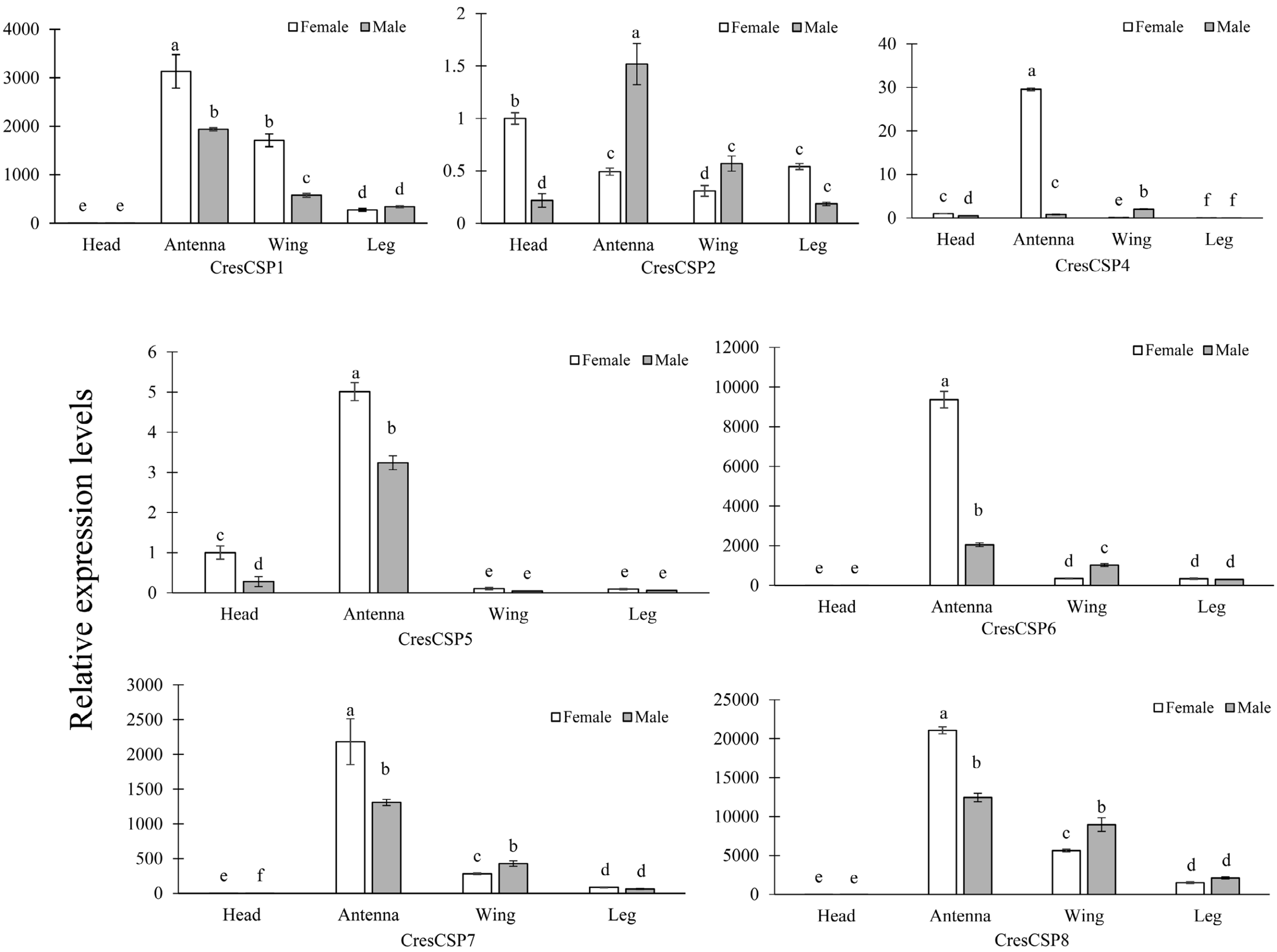

Fig. 6. Relative levels of expression of CresCSPs in head (without antennae), antennae, wings and legs determined using qPCR. Data presented are the means of three replicates. Different lower case letters indicate significant differences (P < 0.05).

six of eight CresCSPs form a branch with CSPs from other Lepidoptera, especially the Noctuidae, which suggests that CresCSP genes may have evolved similarly to that of CSP genes in other moths. Although these species belong to different families, the CSPs in these insects were conserved, indicating that the diversification of CSPs within a family might by duplication (Zhu et al., 2015).

Investigations of the expression patterns of chemosensory protein genes in the different development stages, sexes, individuals of different mating status and tissues in *C. restitura*, might provide new insights into the functions of CSPs. We found transcripts of all CresCSPs in all the developmental stages, but the levels of expression differed in each stage. For example, CresCSP7 was recorded mainly in eggs and CresCSP4, CresCSP5 and CresCSP6 mainly in 1st-larvae. Therefore, we speculated that CresCSP7 might be involved in the development of the eggs of *C. restitura* and CresCSP4, CresCSP5 and CresCSP6 in the searching for food after hatching. Our results were consistent with the study of CSP5 in *Apis mellifera* using RNAi, which shows that CSPs were involved in embryonic development (Maleszka et al., 2007). In addition, we found that CresCSP1, CresCSP2 and CresCSP8 were abundant in 2nd to 4th instar larvae. Under natural conditions, 2nd instar larvae of *C. restitura* rapidly consumed leaves and moved from defoliated trees to other trees in the vicinity in search of food (Sangha et al., 2005). These CresCSPs might contribute to perception by larvae of polar volatiles. An increasing number of studies indicated that insect CSPs were responsive to host plant volatiles (Liu et al., 2010; Hua et al., 2013; Yi et al., 2014b), thus, the CresCSPs might be responsible for the perception by larvae of polar volatiles.

After emergence, *C. restitura* males and females mated with each other when they were 3 to 4 days old (Sangha et al., 2005). Interestingly, most of CresCSPs, such as CresCSP1, CresCSP2, CresCSP4, CresCSP5 and CresCSP8 were mainly expressed in 3 to 4-day-old adults and, therefore, might be associated with mating behavior, in particular the secretion of sex-pheromone by females of *C. restitura* and their location by males. Many studies revealed that CSPs had a close connection with insect mating and egg-laying (Gong et al., 2012, 2015; Ju et al., 2014). Ligand-binding assays of CSPs in *Plutella xylostella* and *Sesamia inferens* reported higher binding to non-volatile oviposition deterrents and pheromone components, which supported the above suggestion (Liu et al., 2010; Zhang et al., 2014). Our results accorded with these studies and confirm the participation of CresCSPs in mating behaviour. Sower et al. (1973) certified that insect males and females produced sex-pheromones in order to attract each other and for release before mating (Sower et al., 1973). Recently, many studies suggested high levels of transcription of CSPs in the sex pheromone gland of females (Dani et al., 2011; Gu et al., 2013; Zhang et al., 2013). In this research, the low expression of CresCSP1 and CresCSP4 in mated adults indicated that CSP proteins could store pheromone components before release. The abundance of transcripts of CresCSP2, CresCSP5 and CresCSP8 in mated males reflected their role in mate seeking behaviour. It was worth noting that these three CresCSPs were more associated with mating behaviour than with ageing. Females of *C. restitura* normally couldn't automatically oviposit at spawning sites, but first examined them using their tarsal sensillae (Thompson, 1988; Singh & Sangha, 2012). The post mating up-regulation of the expression of CresCSP8 in females of *C. restitura* revealed that this gene might be involved in the search for oviposition sites.

Analysis of the patterns in the expression of chemosensory genes in insects might contribute to predicting their functions. Like OBPs, CSPs were mainly expressed in insect antennae. In our study, most CresCSPs were highly expressed in the antennae, especially in female antennae (except for CresCSP2), which manifested that CresCSPs might participate in chemosensory processes. These results were similar to patterns of expression of CSP18 in *Athetis lepigone* and CSP14 and CSP15 in *H. armigera* (Li et al., 2015; Zhang et al., 2017). Our previous studies discovered a high enrichment of two pheromone binding proteins PBPs (CresPBP1 and -PBP3) and three OBPs (CresOBP9, −10, and −16) in male antennae (Gu et al., 2019). We speculated that OBPs might contribute to recognition of pheromone molecules, whereas most CresCSPs play an important role in the recognition of spawning sites or binding host volatiles in females of *C. restitura*.

CresCSPs were widely distributed in chemosensory tissues in the head, antennae, wings and legs, which suggested they might be associated with physiological processes other than olfaction (Yang et al., 2014). Some CresCSPs (CresCSP1, CresCSP7 and CresCSP8) were highly transcribed in wings, which revealed they might be associated there with gustatory functions (Xu et al., 2009). In addition, there were high expressions of CSPs in the legs of many insects, such as, *S. litura*, *S. exiguas* and *Cyrtorhinus lividipennis* (Zhang et al., 2012; Zhu et al., 2015; Wang et al., 2017). A certain amount of CresCSP1, CresCSP2 and CresCSP8 was also recorded in the legs of *C. restitura*, which based on the conclusions of Kitabayashi et al. (1998), might indicate they were involved in regeneration or help in the regeneration of their legs. Some reports indicated the CresCSPs in the legs might have a gustatory function. To some extent, the expression of CresCSPs in legs could be associated with the creeping behavior occasionally related to feeding in adult *C. restitura*. This chemosensory function remained to be verified.

In this study, seven CresCSPs were identified in the antennae of *C. restitura*. Different levels of expression of the CresCSPs and a phylogenetic analysis indicated that these genes had particular functions. These genes were expressed in all the developmental stages and tissues tested, and the levels of expression changed after mating. It was possible they had an important role in olfaction and other physiological processes. We aim to further the understanding of the biological functions of these CSP genes in the future by ligand-binding, RNAi and CRISPR/Cas9 experiments. This study provides valuable information on the molecular mechanisms of olfaction in *C. restitura* and a possible novel way of controlling *C. restitura* and other Lepidoptera pest.

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Supplementary material follows (Tables S1–S3, Fig. S1).

Table S1. Oligonucleotide primers used for cloning ORFs and in the expression Analyses of CresCSPs.

Primer name	Primer sequence (5'→3')		
Specific primers for cloning CSP ORFs			
CSP1F	ATGAATCTACTAGTTTTATG		
CSP1R	TTAGTCATCACGGGCTAGGA		
CSP2F	ATGAAGTCCGTAGTTCTGTG		
CSP2R	TTATACGTGTCTTAGATCAC		
CSP4F	ATGAAGGTACTAGCTATTCT		
CSP4R	TTAATTTTTGACTGCTTCGA		
CSP5F	ATGAAGTTCTTCATAATGAC		
CSP5R	TTAGTCCGTCCCCAGAAGGA		
CSP6F	ATGAAGGTTTTATTACTCAC		
CSP6R	TTAATTTCCTTCCAATAAGT		
CSP7F	ATGAACACATTACTAGTCTT		
CSP7R	TTACTTTGATCCCTTAATGT		
CSP8F	ATGAAGGTCGCATTCTGCGT		
CSP8R	TTAATCTTTCTTCATTAACT		
Specific primers to determine expression patterns		Amplification efficiencies	R2
RPS13-F	CGCACCTGGTAAGGGTATTT	95%	0.997
RPS13-R	CACCAATTTGTGAGGGGAGTG		
CSP1qRT-F	AGCGCACGGCAAATTGTGAA	95%	0.996
CSP1qRT-R	CACGGGCTAGGAAAGCTTCG		
CSP2qRT-F	CCTTGGCAACTCACGACTGC	96%	0.995
CSP2qRT-R	CTTGTGCCAGCGCTTCTCTG		
CSP4qRT-F	GTGGCAGTGTACGCCAAACC	95%	0.996
CSP4qRT-R	AGGAGTGCATCGGCCTTTGT		
CSP5qRT-F	TGCCGAGTTCAGAAAGCTGGT	97%	0.996
CSP5qRT-R	TCGCTTAGGGCCTTGACAGT		
CSP6qRT-F	CCTGTGTCTGGCTACGGCTT	98%	0.996
CSP6qRT-R	GCAGTACACGGCCCTTGAAAC		
CSP7qRT-F	AGCGCACGGCAAATTGTGAA	96%	0.996
CSP7qRT-R	CACGGGCTAGGAAAGCTTCG		
CSP8qRT-F	AAGTTGAAGGACGCCGTGGA	95%	0.996
CSP8qRT-R	GCGCGTTGCTCTGAAGTACA		

Table S2. Summary of CSP genes identified in *C. restitura.*

Gene name	Acc. no.	ORF (bp)	Signal peptide	Isoelectric point	Molecular weight (kDa)	Best blastx match				
						Species	Gene	Acc. no.	E-value	Identity (%)
CSP1	MG518396	372	18	5.72	14.39	*Spodoptera litura*	CSP3	ALJ30214.1	5e-56	64
CSP2	MG518397	378	17	8.58	14.16	*Spodoptera litura*	CSP5	ABM67688.1	1e-50	70
CSP4	MG518399	381	17	6.73	14.49	*Bombyx mori*	CSP10	XP_012549237.1	5e-68	79
CSP5	MG518400	369	18	5.17	13.87	*Spodoptera exigua*	CSP16	AKT26491.1	5e-62	72
CSP6	MG518401	366	16	5.35	13.68	*Bombyx mori*	CSP2	AFF18035.1	7e-46	65
CSP7	MG518402	387	17	8.21	14.73	*Athetis dissimilis*	CSP9	AND82451.1	3e-56	68
CSP8	MG518403	321	18	5.85	11.81	*Helicoverpa armigera*	CSP7	AEX07268.1	2e-10	39

Table S3. Sequences used in the alignment and phylogenetic tree construction.

Gene	Name	Species	Accession number
CresCSP1	chemosensory protein1	*Clostera restitura*	MG518396
CresCSP2	chemosensory protein2	*Clostera restitura*	MG518397
CresCSP3	chemosensory protein3	*Clostera restitura*	MG518398
CresCSP4	chemosensory protein4	*Clostera restitura*	MG518399
CresCSP5	chemosensory protein5	*Clostera restitura*	MG518400
CresCSP6	chemosensory protein6	*Clostera restitura*	MG518401
CresCSP7	chemosensory protein7	*Clostera restitura*	MG518402
CresCSP8	chemosensory protein8	*Clostera restitura*	MG518403
BmorCSP1-2	chemosensory protein CSP1	*Bombyx mori*	AF509239.1
BmorCSP1	chemosensory protein1	*Bombyx mori*	DQ855507.1
BmorCSP10	chemosensory protein10	*Bombyx mori*	AB243753.1
BmorCSP10	chemosensory protein10	*Bombyx mori*	DQ855516.1
BmorCSP11	chemosensory protein11	*Bombyx mori*	DQ855517.1
BmorCSP11-2	chemosensory protein CSP11	*Bombyx mori*	AB243754.1
BmorCSP13	chemosensory protein13	*Bombyx mori*	DQ855519.1
BmorCSP14	chemosensory protein14	*Bombyx mori*	DQ855520.1
BmorCSP15	chemosensory protein15	*Bombyx mori*	DQ855521.1
BmorCSP16	chemosensory protein16	*Bombyx mori*	DQ855522.1
BmorCSP2-2	chemosensory protein CSP2	*Bombyx mori*	AF509238.1
BmorCSP2	chemosensory protein2	*Bombyx mori*	DQ855508.1
BmorCSP3-2	chemosensory protein CSP3	*Bombyx mori*	AB243746.1
BmorCSP3	chemosensory protein3	*Bombyx mori*	DQ855509.1
BmorCSP4-2	chemosensory protein CSP4	*Bombyx mori*	AB243747.1
BmorCSP4	chemosensory protein4	*Bombyx mori*	DQ855510.1
BmorCSP5-2	chemosensory protein CSP5	*Bombyx mori*	AB243748.1
BmorCSP5	chemosensory protein5	*Bombyx mori*	DQ855511.1
BmorCSP6-2	chemosensory protein CSP6	*Bombyx mori*	AB243749.1
BmorCSP6	chemosensory protein6	*Bombyx mori*	DQ855512.1
BmorCSP7-2	chemosensory protein CSP7	*Bombyx mori*	AB243750.1
BmorCSP7	chemosensory protein7	*Bombyx mori*	DQ855513.1
BmorCSP8-2	chemosensory protein CSP8	*Bombyx mori*	AB243751.1
BmorCSP8	chemosensory protein8	*Bombyx mori*	DQ855514.1
BmorCSP9-2	chemosensory protein CSP9	*Bombyx mori*	AB243752.1
BmorCSP9	chemosensory protein9	*Bombyx mori*	DQ855515.1
EhipCSP13	chemosensory protein13	*Eogystia hippophaecolus*	KX655948.1
EhipCSP14	chemosensory protein14	*Eogystia hippophaecolus*	KX655949.1
EhipCSP15	chemosensory protein15	*Eogystia hippophaecolus*	KX655950.1
EhipCSP17	chemosensory protein17	*Eogystia hippophaecolus*	KX655952.1
EhipCSP18	chemosensory protein18	*Eogystia hippophaecolus*	KX655953.1
EhipCSP2	chemosensory protein2	*Eogystia hippophaecolus*	KX655937.1
EhipCSP3	chemosensory protein3	*Eogystia hippophaecolus*	KX655938.1
EhipCSP4	chemosensory protein4	*Eogystia hippophaecolus*	KX655939.1
EhipCSP6	chemosensory protein6	*Eogystia hippophaecolus*	KX655941.1
EhipCSP7	chemosensory protein7	*Eogystia hippophaecolus*	KX655942.1
GmolCSP11	chemosensory protein 11	*Grapholita molesta*	KR003783.1
GmolCSP3	chemosensory protein3	*Grapholita molesta*	KR003780.1
GmolCSP8	chemosensory protein8	*Grapholita molesta*	KR003781.1
GmolCSP9	chemosensory protein9	*Grapholita molesta*	KR003782.1
HarmCSP21	chemosensory protein 21	*Helicoverpa armigera*	KY810185.1
HarmCSP22	chemosensory protein 22	*Helicoverpa armigera*	KY810186.1
HarmCSP23	chemosensory protein 23	*Helicoverpa armigera*	KY810187.1
HarmCSP25	chemosensory protein 25	*Helicoverpa armigera*	KY815026.1
HarmCSP26	chemosensory protein 26	*Helicoverpa armigera*	KY815027.1
HassCSP	chemosensory protein	*Helicoverpa assulta*	DQ285667.1
HassCSP20	chemosensory protein 20	*Helicoverpa assulta*	KY810189.1
HassCSP21	chemosensory protein 21	*Helicoverpa assulta*	KY810190.1
HassCSP22	chemosensory protein 22	*Helicoverpa assulta*	KY810191.1_
HassCSP23	chemosensory protein 23	*Helicoverpa assulta*	KY810192.1
HassCSP24	chemosensory protein 24	*Helicoverpa assulta*	KY810193.1
HassCSP25	chemosensory protein 25	*Helicoverpa assulta*	KY810194.1
HvirCSP2	chemosensory protein 2	*Heliothis virescens*	AY101511.1
HvirCSP1	chemosensory protein 1	*Heliothis virescens*	AY101512.1
LbotCSP10	chemosensory protein10	*Lobesia botrana*	MG788191.1
LbotCSP13	chemosensory protein13	*Lobesia botrana*	MG788194.1
LbotCSP14	chemosensory protein14	*Lobesia botrana*	MG788195.1
LbotCSP18	chemosensory protein 18	*Lobesia botrana*	MG788196.1
LbotCSP19	chemosensory protein 19	*Lobesia botrana*	MG788197.1
LbotCSP2	chemosensory protein2	*Lobesia botrana*	MG788184.1
LbotCSP20	chemosensory protein 20	*Lobesia botrana*	MG788198.1
LbotCSP21	chemosensory protein 21	*Lobesia botrana*	MG788199.1
LbotCSP23	chemosensory protein 23	*Lobesia botrana*	MG788201.1
LbotCSP3	chemosensory protein3	*Lobesia botrana*	MG788185.1
LbotCSP4	chemosensory protein4	*Lobesia botrana*	MG788186.1
LbotCSP5	chemosensory protein5	*Lobesia botrana*	MG788187.1
LbotCSP6	chemosensory protein6	*Lobesia botrana*	MG788188.1
OfurCSP1	chemosensory protein 1	*Ostrinia furnacalis*	LC027702.1
OfurCSP10	chemosensory protein 10	*Ostrinia furnacalis*	LC027711.1
OfurCSP12	chemosensory protein 12	*Ostrinia furnacalis*	LC027713.1
OfurCSP13	chemosensory protein 13	*Ostrinia furnacalis*	LC027714.1

Table S3 (continued).

Gene	Name	Species	Accession number
OfurCSP16	chemosensory protein 16	*Ostrinia furnacalis*	LC027717.1
OfurCSP2	chemosensory protein 2	*Ostrinia furnacalis*	LC027703.1
OfurCSP4	chemosensory protein 4	*Ostrinia furnacalis*	LC027705.1
OfurCSP5	chemosensory protein 5	*Ostrinia furnacalis*	LC027706.1
OfurCSP6	chemosensory protein 6	*Ostrinia furnacalis*	LC027707.1
OfurCSP7	chemosensory protein 7	*Ostrinia furnacalis*	LC027708.1
OfurCSP8	chemosensory protein 8	*Ostrinia furnacalis*	LC027709.1
PxutCSP1	chemosensory protein1	*Papilio xuthus*	AB260116.1
PxutCSP10	chemosensory protein10	*Papilio xuthus*	AB260126.1
PxutCSP11a	chemosensory protein11a	*Papilio xuthus*	AB430775.1
PxutCSP11b	chemosensory protein11b	*Papilio xuthus*	AB430776.1
PxutCSP12	chemosensory protein12	*Papilio xuthus*	AB430777.1
PxutCSP13	chemosensory protein13	*Papilio xuthus*	AB430778.1
PxutCSP2	chemosensory protein2	*Papilio xuthus*	AB260117.1
PxutCSP3	chemosensory protein3	*Papilio xuthus*	AB260118.1
PxutCSP4	chemosensory protein4	*Papilio xuthus*	AB260119.1
PxutCSP4a	chemosensory protein4a	*Papilio xuthus*	AB430771.1
PxutCSP4b	chemosensory protein4b	*Papilio xuthus*	AB430772.1
PxutCSP4c	chemosensory protein4c	*Papilio xuthus*	AB430773.1
PxutCSP5	chemosensory protein5	*Papilio xuthus*	AB260120.1
PxutCSP6	chemosensory protein6	*Papilio xuthus*	AB260121.1
PxutCSP7	chemosensory protein7	*Papilio xuthus*	AB260122.1
PxutCSP8	chemosensory protein8	*Papilio xuthus*	AB260123.1
PxutCSP8a	chemosensory protein8a	*Papilio xuthus*	AB260124.1
PxutCSP8b	chemosensory protein8b	*Papilio xuthus*	AB430774.1
PxylCSP1	chemosensory protein CSP1	*Plutella xylostella*	EF186791.1
PxylCSP2	chemosensory protein CSP2	*Plutella xylostella*	EF186792.1
PxylCSP3	chemosensory protein CSP3	*Plutella xylostella*	EF202828.1
PxylCSP4	chemosensory protein CSP4	*Plutella xylostella*	EF202829.1
PxylCSP5	chemosensory protein5	*Plutella xylostella*	EF202830.1
SexiCSP1-1	chemosensory protein 1	*Spodoptera exigua*	KM275345.1
SexiCSP1	chemosensory protein1	*Spodoptera exigua*	EF186793.1
SexiCSP2-1	chemosensory protein 2	*Spodoptera exigua*	KM275346.1
SexiCSP2	chemosensory protein2	*Spodoptera exigua*	EF186794.1
SexiCSP3-1	chemosensory protein 3	*Spodoptera exigua*	KM275347.1
SexiCSP3	chemosensory protein3	*Spodoptera exigua*	EF186795.1
SexiCSP6	chemosensory protein 6	*Spodoptera exigua*	KM275350.1
SlitCSP	chemosensory protein	*Spodoptera litura*	DQ007458.1

Fig. S1. Alignment of mature CresCSPs and CSPs of other Lepidoptera. Amino acids conserved in all CSPs are shown with a black background. The sequences used in the construction of this phylogenetic tree are listed in Table S3.

```
CresCSP1       ............MN...LLVLCFVVAFASLAAT....ETY    21
CresCSP2       ............MKS..VVLCVLGLAALAVAFPG.G.DMY    24
CresCSP3       ............MKG.AIVFCLLAVATIAVARPE...DKY    24
CresCSP4       ............MKVLAIL.ALTCLVAV.YAKPQ...STY    23
CresCSP5       ..............MKFFIMTLMAISTPFVLG.......Y    19
CresCSP6       ............MK...VLLLTLCLATALVAEE.....LY    20
CresCSP7       ............MN..TLLVFCIITVVAVSARPN...EQY    23
CresCSP8       ............MKVAFCVLVAVALVGVYADN........    20
HcirCSP2       ............MKFIVAV.ALLCLVAESWAAS.....TY    22
BMorCSP1       ..............M.KVLIVLSCVLVAVLADD.....KY    20
HvirCSP1       ...........................MALARPDGA..AY    11
PxylCSP4       ............MQ.TVTLLCLLAAVAAAAAAPA...DTY    24
PxylCSP3       ............MN..SLVLVCLALVAVAAARPQ...ATY    23
PxylCSP2       ............MQK.LTLACLLVAVAAAAARPNDS..HY    25
PxylCSP1       ............MKSAAFI..ALFLIGKAVCEDK...PTY    23
BMorCSP2       ............MK...LLLVFLGLFLAVLAQD.....KY    20
HarMCSP26      ............MK.SLLILCLVI...AAVWARP...ETY    21
HarMCSP25      ............MNS.LIVFCVVSLAALTIARPDGA..TY    25
HassCSP25      ............MNS.AIVLCVVALAGMVLARPDGG..TY    25
HassCSP24      ............MKLTVAV.ALLCLVAESWAAS.....TY    22
HassCSP23      ............MK.LLIVLALVAVV.AARP.DD...AFY    22
HassCSP22      ..............MKVLIVAVLALVAPSALG.......Y    19
HassCSP21      ............MNS.AIVLCVVALAGMVLARPDGG..TY    25
HassCSP20      ............MKILVLLLAAVVTAQYEEDT.......Y    21
HarMCSP22      ............MK.LLIVLALAAVV.AARP.DD...EFY    22
HarMCSP23      ..............MKVLMVAVLALVAPSALG.......Y    19
HarMCSP21      ............MNS.AIVLCVVALAGMVLARPDGDGDKY    27
GMolCSP11      ............ML..IASLALLSA...LSTVTA...DFY    20
GMolCSP9       ............MKRLVFL.VFLILLLCQSHAED...QTY    24
GMolCSP3       .............MM.LKYFVVLCVASWALADE.....KY    21
OfurCSP16      ............MSHRKVLVLSHLMVFLCVQCFA.....K    23
OfurCSP13      ............MR.AVVFLSCLVV..VLAADK......Y    19
OfurCSP12      ............MKFLVVLSAVLAVALARPDS.......Y    21
OfurCSP10      ............MKTIMLVAF.LVGLAMADEK.......Y    20
OfurCSP8       ............MKLVAFIPTFTYLLLGANAEES...PTY    25
OfurCSP7       ............MK..TFAICLLALVAVVSAYPQ...AKY    23
OfurCSP6       ............MK...LVIISLCLAAAVVAQE.....KY    20
OfurCSP5       ............MH..PQHFCMIVM...VTTAAA...DFY    20
OfurCSP2       ............MK.TIVALCALVA..VALARPE...DTY    22
PxutCSP10      ............MK..LILMILAST...IALVQG...DAT    20
PxutCSP8a      ............MVS.RNLMILCCLVVAVVAKP.....TY    22
PxutCSP8       ............MKS.KAALVLMCVLAAALAES......Y    21
PxutCSP7       ............MK...LIVLVLCVTALAYAED.....KY    20
PxutCSP6       ............MK.TIILLCTLA..AAALAAPA...DTY    22
PxutCSP4       ................MNTFLMVCLLALVAAVSA...DQY    21
PxutCSP3       ............MK.TLVVLACVLLS.VYAADK......Y    20
PxutCSP2       ............MKLFMVC.ALLCVAAVAWGKPA...STY    24
PxutCSP1       ............MN...SLLLFSLLTLFVVAFAN...EQY    22
PxutCSP4a      ............MKS.VVLLCLFVVLATAVAGPA...GQY    24
PxutCSP4b      .........................MAIATAMPSPS.ETY    14
PxutCSP4c      ............MK..VLVCFLLALVIIAQARSN...RKY    23
PxutCSP8b      ............MAS.KSLIIILLCVVASVWC.......TY    20
PxutCSP11a     ............MKTIVALTV.LVGLATTALA.......Y    20
PxutCSP11b     ............MKCLLLLPM..LMALVAAET.......Y    19
PxutCSP12      ...............MVFLSLVLAMLIPTALS.......Y    18
PxutCSP13      ............MR..QWLLCVFALTVVVSCSS...QQQY    23
BMorCSP11      ............MKGFYVLCFALFAAVYCKET.......Y    21
BMorCSP9       ............MKFVLALIALAVVV.AARPNDD...LFY    24
BMorCSP8       ............MRAVIFLYTCVFVVVGQDINAMMSMPKY    28
BMorCSP7       ............MK.SLIVLSCLLAA.CLAAD........    18
BMorCSP6       ............MK...CLTIAALLFVAGLSIA....EKY    21
BMorCSP5       ............MNS.LIAFCLFAVLAVALARPDDK...Y    24
BMorCSP4       .............MK.TVIVCLLALTAVALARPE....QY    22
BMorCSP3       .....................MACVAVT.WARPE...STY    15
SexiCSP1       ............MN...FLVLSIVVTMAAFVAA....ETY    21
SexiCSP2       ............MKS.MIVLCVLSVAALVVARPDDS..HY    25
SexiCSP3       ............MK..ADCVLIMAL...MTIVAA...DFY    20
SexiCSP6       ............MKVLVVLSVFLALTTAVPLTKD.....E    23
LbotCSP23      ..............................MVNA...NFY     7
LbotCSP21      ................MWGLFFLALTVVATSSA...QQQY    21
LbotCSP20      ............MRAV.FVFACVTFVVAQDINSVKDLPKY    27
LbotCSP19      ............MK...VIVFACLLAVVVSARPG...DKY    22
LbotCSP18      ............MNS.FLIVCVFALAAVAYARPG...DTY    24
LbotCSP14      ............MK...LLLLFCCG.LVGLSLAD...DLY    21
LbotCSP13      ..............MKVLLL..VALFSPLVLC.......Y    17
LbotCSP10      ............MK.ACIVLACLVAA.VFAADK......Y    20
LbotCSP6       ............MK.TVIILMLVG...LAASRPE...EGY    21
LbotCSP5       ............MK...TTLI.LCLVAFVVGDD.....KY    19
LbotCSP4       ............MK.VLVVLSVLMAV.GLARPDG...DHY    23
LbotCSP3       ..............M.MKYFIVLCLAALALADD.....KY    20
LbotCSP2       .........MR.....LLILLSLGLFAGTMAG.......D    19
PxylCSP5       ............MK...VVFLVFVLTAVVYSHPHDS..HY    23
SexiCSP3-2     ............MK...VVFLVFVLTAVVYSHPHDS..HY    23
SexiCSP2-2     ............MKS.MIVLCVLSVAALVVARPDDS..HY    25
SexiCSP1-2     ............MKS.FIVLCLFGLAAVAMARPD.G.STY    25
BMorCSP16      .....MIEWK.RFKILHFLSYLGLLVLVVVCAAQ....QN    30
BMorCSP15      MIENFYSKCT.ISKSVLFLCLIFLPYALNQKY.......Y    32
BMorCSP14      ............MK..SSLFCVLVLTVVVSSS....RQQS    22
BMorCSP13      ............MK...LLLVFLGLFLAVLAQD.....KY    20
BMorCSP11-2    ............MK..LTSFLLVG....MAMVSA...EFY    19
BMorCSP10      ............MKILIIV.VMACVAVT.WARPE...STY    23
BMorCSP9-2     ............MRAVIFLYTCVFVVVGQDINAMMSMPKY    28
BMorCSP8-2     ............MK.TILILCALVS..VVVCRPE...EYY    22
BMorCSP7-2     ............MKGFYVLCFALFAAVYCKET.......Y    21
BMorCSP6-2     ............MK.SLIVLSCLLAA.CLAAD........    18
BMorCSP5-2     .............MK.TVIVCLLALTAVALARPE....QY    22
BMorCSP4-2     ..............M.KVLIVLSCVLVAVLADD.....KY    20
BMorCSP3-2     ............MNS.LIAFCLFAVLAVALARPDDK...Y    24
BMorCSP2-2     ............MKS.VILICFLGVATVVIARP.......    20
BMorCSP1-2     ............MK...CLTIAALLFVAGLSIA....EKY    21
HassCSP        ..............M.KVLLVLCLFAAAVLADD.....KY    20
SlitCSP        ............MK...VVFLVCVLAAVVYAHPHES..HY    23
EhipCSP18      ............MK..SICTVILFV...LSLVYA...DFY    20
EhipCSP17      ............MKT.FIVVCFFALVAIATALPG...ARY    24
EhipCSP15      ............MR..NWLLCLCALTVVVSCSG...QQQH    23
EhipCSP14      ............MIM.KCVIALICVLGMVIADE.....KY    22
EhipCSP13      ............MK.VLIVLACLGVA.AYAAEK......Y    20
EhipCSP7       .........M.QILLLSVICACALSLWPVWAAPA....PP    26
EhipCSP6       ............MK.TIIAFCALVV..VVVAFPG...DTY    22
EhipCSP4       ............MKIFIILFAVMAIAIAAEET.......Y    21
EhipCSP3       ............MN...WLFLTIGLTLVCLSIG....EQY    21
EhipCSP2       ...............MQLCRVFLFCCVAAAAAAQ....AQ    21
Consensus
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CresCSP1      TDRYDDMNIDEILANRRLMMPYMKCILEQGPCTPE.GKEL   60
CresCSP2      TDRYDDVNLDEILGNSRLLTPYLRCIMEEGKCTAD.GKEL   63
CresCSP3      TDRYDNTNVQEIIDNDKLFEAYVKCVLEKGKCTAD.GKEL   63
CresCSP4      TDKWDNINVDEILESERLLKGYVSCLKDKGRCTPD.GKAL   62
CresCSP5      DEIYDKIDVDKILNDDALFVTYINCLLDKGACSVEHSAEF   59
CresCSP6      EEVGDDFNASEVLENPRLLSSYVKCLLFQGPCTAE.VKRI   59
CresCSP7      SDKYDSVDLKQILANKRLLHPYIKCLLDQGKCSPD.GKEL   62
CresCSP8      EKALDEFDYDSLLNNPAKLKDAVDCVVGKKACGEL..EKF   58
HcirCSP2      TDKWDNINVDEILESQRLLKAYVDCLLDRGRCTPD.GKAL   61
BMorCSP1      TDKYDKINLQEILENKRLLESYMDCVLGKGKCTPE.GKEL   59
HvirCSP1      TDKYDNVDLDEILSNRRLLVPYVKCILDQGKCAPD.AKEL   50
PxylCSP4      DAKYDSFNAHELVQNQRLLKSYGKCFLSKGPCTAE.GSDF   63
PxylCSP3      TSKYDGVNVDEILANDRLMMPYIKCALDHGRCSPE.AKEL   62
PxylCSP2      TDRYDNVNLDELISNRRLLVPYVKCVLDQGKCSPD.GKEL   64
PxylCSP1      TTKYDNIDLDEILSSERLLTGYVNCLLDQGPCTPD.GKEL   62
BMorCSP2      EPIDDSFDASEVLSNERLLKSYTKCLLNQGPCTAE.LKKI   59
HarMCSP26     DTRYDDFDAETLVENVRLLKAYGHCFLGTGPCTPE.GSDF   60
HarMCSP25     TDKYDNVDLDEVLSNRRLLVPYVHCLLEQGKCAPD.AKEL   64
HassCSP25     TTKYDNVDLDEILANDRLLVPYIKCLLDEGKCAPD.AKEL   64
HassCSP24     TDKWDNINVDEILESQRLLKAYVDCLLDRGRCTPD.GKAL   61
HassCSP23     DKKYDDFNVDEIIENVRLLKAYAHCIIGDGKCTPE.GNDF   61
HassCSP22     DEKYDKLDVDKIIGDDALFTAYTDCMLDKGPCTVEHSEDF   59
HassCSP21     TTKYDNVDLDEILANDHLLVPYIKCLLDEGKCAPD.AKEL   64
HassCSP20     GTDHDDLNIAAVVEDKEQFNSFVDCFIDEAPCDEV.ADTF   60
HarMCSP22     DKKYDDFNVDEIIENVRLLKAYAHCIIGDGKCTPE.GNDF   61
HarMCSP23     DEKYDKLDVDKIIGDDALFTAYIDCMLDKGPCTVEHSEDF   59
HarMCSP21     TSRWDDVDLDEILENDHLLIPYIKCSLDEGKCAPD.AKEL   66
GMolCSP11     SSKYDDFDIQPLLANDRILLGYTKCFLDQGPCTPD.AKDF   59
GMolCSP9      TTKYDGIDLDEILASSRLLTGYVNCLLDLRPCTPD.GKEL   63
GMolCSP3      TDKYDKIDLDEILGNKRLLQAYVNCILDKGKCTPE.GKEL   60
OfurCSP16     LHNYDNFDMETLLLNTTRSRALFECVRDETKCANKEDKEM   63
OfurCSP13     NSKYDNFDVETLISNDRLLKAYINCFLEKGRCTPE.GADF   58
OfurCSP12     KTDHDGLDIEGIVNNPEALAKVTACFLEKAPCTPI.AAEF   60
OfurCSP10     TSENDNFDVEALVNNTEELQKFSGCFLDKNDCDAV.SGDF   59
OfurCSP8      TTKYDGVNLDEILENDRLLTSYVNCLLETGPCTPD.GKEL   64
OfurCSP7      TDRYDSINLDEIVGNRRLLVPYIKCILDQGKCSPE.GKEL   62
OfurCSP6      DSIDDNFDISEVLNNERLLNSYTKCLLDKGPCTPE.VKKV   59
OfurCSP5      SAKYDDFDIQPLLENDRILQGYTKCFLDQGPCTPD.AKDF   59
OfurCSP2      STAFDSFNAQELVDNIRLLKNYGKCFLDQGPCTPE.GSDF   61
PxutCSP10     KQRYDAFDIQTALQNDDIILSLINCFGDTTPCSPE.MKAF   59
PxutCSP8a     TDKYDNIDLEEFKENKRLLLAYVDCILDKGKCTAE.GKAL   61
PxutCSP8      SDKYDNIDLQEIADNDRLLDAYANCLLEKGKCSPE.GKEL   60
PxutCSP7      EDIEDNFNLQELLENDRLLTGYIKCLLNKGPCTPE.VKKI   59
PxutCSP6      NSQYDNFDATELVGNTRLLKSYGRCFLGQGPCTAE.GSDF   61
PxutCSP4      TDRYDNVDLDEILSNRRLLVPYLNCILEEGKCSPD.GKEL   60
PxutCSP3      NSKYDNFDVETLITNERLLKSYINCFLDKGRCTAE.GTDF   59
PxutCSP2      TDKWDYINVDEILESQRLLKGYVDCLMDRGRCTAD.GKTL   63
PxutCSP1      TDRYDNINIDEILSNKRLLTSYIKCILDKGRCTPE.GKEL   61
PxutCSP4a     TDRYDSINIDEILGNRRLLIPYVHCLLDQGKCTPE.GKEL   63
PxutCSP4b     TDRFDNIDLDEIIGNRRLLVPYIHCVLDKGKCTPD.GKEL   53
PxutCSP4c     TSRYDNIDLDDVLANRRLLVSYIKCLLDLGKCSSE.GKEL   62
PxutCSP8b     TNKYDNINYEEVVSNEKLLNKYADCILDRGRCTAE.AKEL   59
PxutCSP11a    STEHDDLDIAAIVADKNELQKFIDCFTEKAPCTKL.TQDF   59
PxutCSP11b    STENDDLDIEAVVGDLNTLKSFMDCFNDKKPCDAV.QADF   58
PxutCSP12     DAAYDKVDANKVLADDALFRSYVDCFLDRKPCTADFSEEF   58
PxutCSP13     VNRYDNFNADSIIQNERILLAYYKCVMEKGPCTKD.GKNF   62
BMorCSP11     SSENDDLDIEALVGNIDSLKAFIGCFLETSPCDAV.SGDF   60
BMorCSP9      DKKYDNFNVDEIIDNPRLLKAYTFCFNDKGKCTAE.GNDF   63
BMorCSP8      DERYDYLDVDDIFRNKRLVRNYVDCLINAQRCTPE.GKAL   67
BMorCSP7      LSKYENFDVEPIVTSDRLLKAYINCFLDKGRCTPE.ASDF   57
BMorCSP6      TDKYDNIDVDEILENRKLLVPYIKCVLDEGRCTPD.GKEL   60
BMorCSP5      TDRYDNVNLDEVLSNSRLLKPYIKCILDKDRCAPD.AKEL   63
BMorCSP4      TDKYDTVDLDQLISNRRLLIPYVHCILEKGQCTAE.GKEL   61
BMorCSP3      TDKWDNINVDEILESNRLLKGYVDCLLGKGRCTPD.GKAL   54
SexiCSP1      TDRYDHINIDEIIENRKLLVPYIKCTLDQGRCTPE.GREL   60
SexiCSP2      TDRYDNVDLDEILSNRRLLVPYIKCILDQGKCAPD.AKEL   64
SexiCSP3      NSKYDSFDVQPLLENDRILLSYTKCFLDQGPCTPD.AKDF   59
SexiCSP6      LAILEAFDYDAIFAKEENRKIVFDCLLNKGDCGDY..KQI   61
LbotCSP23     SSKYDDFDIQPILDNDRIMLSYTKCFLDQGPCTPD.AKDF   46
LbotCSP21     YNRYDNVNADSIVQNERVLLAYYKCVMDKGPCTKD.GRNF   60
LbotCSP20     DKRYDYLSVDAILENKRLVRNYVDCLINAKPCTPE.GKAL   66
LbotCSP19     TDRYDNVDLNEILNNRRLLVPYVKCLLGQGKCTPD.GKEL   61
LbotCSP18     TDKFDNVNLDEILENRRLLVPYVKCVLDQGKCTPD.GKEL   63
LbotCSP14     TDRYDNLNIDEILENRRLLIPYVKCMLDQGRCTPE.GKYL   60
LbotCSP13     DAKYDSIDVDKILADEAQFDAYIKCMLDKGPCALEHSADF   57
LbotCSP10     NAKYDNFDVETLITNDRLLKSYINCFLDKGRCTPE.GTDF   59
LbotCSP6      STRYDSFDAQELVENVRLLKSYGNCFLDKGPCTAE.GSDF   60
LbotCSP5      DSSHDNIDLSEVLGNERLLVSYTNCLLDKGPCTPE.VKQL   58
LbotCSP4      DSKYDDFDVQTLIDNPRLLKAYTLCLLSKGSCTAE.GSSF   62
LbotCSP3      TDKYDNINLDEILENKRLLQAYVNCILDKGKCTPE.GKEL   59
LbotCSP2      IEDMFKVDPEPLLKDQDKWKVLFECLMDRAPCGEY..QIV   57
PxylCSP5      TDKYDNIDLDEILNNKKILTSYINCCLDLGKCTPD.GKEL   62
SexiCSP3-2    TDKYDNIDLDEILNNKKILTSYINCCLDLGKCTPD.GKEL   62
SexiCSP2-2    TDRYDNVDLDEILSNRRLLVPYIKCILDQGKCAPD.AKEL   64
SexiCSP1-2    TDRYDNINLDEILGNRRLLTPYIKCILEEGKCTPD.GKEL   64
BMorCSP16     RPQVTDTALDEALNDKRFIQRQLKCALGEAPCDPI.GKRL   69
BMorCSP15     DSRYDYYDIDHLVQNPRLLKKYLDCFLGKGPCTPI.GRLF   71
BMorCSP14     YPRNDNININAILQNDRILLGYFKCVMDRGPCTKD.GKTF   61
BMorCSP13     EPIDDSFDASEVLSNERLLKSYTKCLLNQGPCTAE.LKKI   59
BMorCSP11-2   SSRYDDFDVKPLVENDRILQSYTNCFLDKGPCTPD.AKEF   58
BMorCSP10     TDKWDNINVDEILESNRLLKGYVDCLLGKGRCTPD.GKAL   62
BMorCSP9-2    DERYDYLDVDDIFRNKRLVRNYVDCLINAQRCTPE.GKAL   67
BMorCSP8-2    SSQYDNFDVEQLVGNLRLLKNYAKCFLDQGPCTAE.GTEF   61
BMorCSP7-2    SSENDDLDIEALVGNIDSLKAFIGCFLETSPCDAV.SGDF   60
BMorCSP6-2    LSKYENFDVEPIVTSDRLLKAYINCFLDKGRCTPE.ASDF   57
BMorCSP5-2    TDKYDTVDLDQLISNRRLLIPYVHCILEKGQCTAE.GKEL   61
BMorCSP4-2    TDKYDKINLQEILENKRLLESYMDCVLGKGKCTPE.GKEL   59
BMorCSP3-2    TDRYDNVNLDEVLSNSRLLQPYIKCILDKDRCAPD.AKEL   63
BMorCSP2-2    KTPFDNINIEEIFENRRLLLGYINCILERGNCTRA.GKDL   59
BMorCSP1-2    TDKYDNIDVDEILENRKLLVPYIKCVLDEGRCTPD.GKEL   60
HassCSP       TDKYDNINLDEILENKRLLLAYVNCVMERGKCSPE.GKEL   59
SlitCSP       TDKWDNIDLDEILNNKKILASYVKCCLDQGKCTPD.AKEL   62
EhipCSP18     NSRYDDFDIRPLLENDRILLSYTKCFLDQGPCTPD.AKDF   59
EhipCSP17     TDRYDNIDLDEILGNPRLLNPYILCLLEQGKCTAE.GKEL   63
EhipCSP15     YNRYDNFNTDSIIQNERILLAYYKCVMDKGPCTKD.GKIF   62
EhipCSP14     TDKYDNINLDEILGNKRLLQAYVNCVLDKGKCSPE.GKEL   61
EhipCSP13     HSKYDNFDVDTLISNDRLLKSYINCFLDKGRCTPE.GSDF   59
EhipCSP7      VPQMTDAQLERSLADRATMQRHLRCALGEGPCDPV.SRRL   65
EhipCSP6      DPRYDNFNAQELADNLRLLKSYGKCFLDEGPCTPE.GADF   61
EhipCSP4      SSEYDNLDVEAVVNNPQTLQAYFGCFIDRDNCEKE.PGNF   60
EhipCSP3      TDRYDNINVQEVLDNKRLFNAYMKCILDKGSCTPE.GREL   60
EhipCSP2      RPQVTDTALEDALNDKRFIQRQLKCALGEAPCDPI.GKRL   60
Consensus                             c      c
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CresCSP1      RLHIKDAMQTACEKCTEKQQRSARQIVKHIRANELQFWEQ   100
CresCSP2      RSHIREALAQDCAKCTAKQRDGTRRVIGHLINKEPQWWDK   103
CresCSP3      KSHITDALENDCSKCTDPQKDGVRLVIKHLVNKEPAIWEE   103
CresCSP4      KETLPDALEHECSKCTQKQKEGSDKVIRNLVNKHPDLWKE   102
CresCSP5      RKLVPEVIATSCAKCTPIQRQNVRKTVKALSEKKPDDFAE    99
CresCSP6      RDALPEVLETHCAKCTKRQKQLGQQLTQGVKKNHPTMWDE    99
CresCSP7      KSHIKEALENYCAKCTETQQKGTKEVIGHLINNEPGYWQE   102
CresCSP8      KDGSLKRLTTNCGECTSEQRAHYERVLSSIKAKYPEDFAE    98
HcirCSP2      KETLPDALENECSKCTEKQKAGSDKVIRYLVNKRQDLWKE   101
BMorCSP1      KDHLQEALETGCEKCTEAQEKGAETSIDYLIKNELEIWKE    99
HvirCSP1      KEHIIEALENECGKCTEAQKKGTRRVIGHLINNEADYWNE    90
PxylCSP4      KRVIPEALKTTCGKCTRKQRELVRVVVKGFQEQLPQVWTE   103
PxylCSP3      KSHIKEALENNCAKCTDKQKPAVRKVIAHLINHKPAEWRQ   102
PxylCSP2      KEHIQEALENNCGKCTDKQREGTRKMIGHLINHEQEFWDQ   104
PxylCSP1      KHTLPDAIDNDCRKCTQKQKEGSDRVMGYIIEYRPNDWAK   102
BMorCSP2      KDKIPEALETHCAKCTDKQKQMAKQLAQGIKKTHPELWDE    99
HarMCSP26     KKTIPDALRTGCGKCTAKQRHLIRVVVQGFRSKTPDLWQQ   100
HarMCSP25     KEHIREALENACGKCTNAQQSGTRRVIGHLINKEPEFWKQ   104
HassCSP25     KEHIKEALENGCAKCTDKQKEGTRRVIAHLIKKKLQEWEK   104
HassCSP24     KETLPDALENECSKCTDKQKSGSDKVIRHLVNKRPEMWKE   101
HassCSP23     KRWVPEATKSSCGKCTEKQKVLVAKTIKAIQEKCPEEYTT   101
HassCSP22     KKLLPEVIQTACAKCSGIQKTNVRKTVKALSDKKPDDFAK    99
HassCSP21     KEHIKEALENGCAKCTDKQKEGTRRVIAHLIKHKNADWQK   104
HassCSP20     KSVIPEAVLEACAKCTPAQKHIVRVFNESFKKKMPEKFQK   100
HarMCSP22     KRWVPEATKSSCGKCTEKQKVLVAKTIKAIKEKCPEEYTT   101
HarMCSP23     KKLLPEVIQTACAKCSGIQRTNVRKTVKALSDKKPDDFAK    99
HarMCSP21     KEHIQEALETGCAKCTDKQKEGTRRVIAHLIKHKNADWQK   106
GMolCSP11     KKVIPEALETICGKCTPKQKQLIRQVIRAIMDRHPESWKQ    99
GMolCSP9      KKNLPDAISNDCIKCTERQKQGADKVMHYIIDHRPDDWEK   103
GMolCSP3      KDHLEEALQTGCEKCTEAQKKGTSKVIDHLIKNELPIWRE   100
OfurCSP16     KDDIFEMVTTSCANCTAKEKQKFGDAMKALHRSMGESQII   103
OfurCSP13     RKALPEAVETTCAKCTEKQKNNIRKVIRAIQQKHPKQWEE    98
OfurCSP12     KSVLPDATETACSKCTAAQKHMLKLYLLKVRETAPDDLKA   100
OfurCSP10     KKDIPEAFQQACAKCTDAQKHLFKRFLNGLKEKLPQDFEA    99
OfurCSP8      KNNLPDAIQNDCKKCSERQREGADQVMEYIIDHRPDDWEK   104
OfurCSP7      KSHIKEALENYCAKCTETQRDGTRKVIGHLINNESEYWNQ   102
OfurCSP6      KDKLPEALATRCAKCTDKQKQIGKQLAKEVKAKRPDLWKE    99
OfurCSP5      KKVIPEALETSCGKCTPKQKILIKKVIRAVMERHPDSWKE    99
OfurCSP2      KKKIPEALKTDCGKCTPKQRELIKTVVHGFQSKLPDMWAE   101
PxutCSP10     KNDIPTALQTACGKCSDRQREVIRHVIRTVMKKYPDAWTY    99
PxutCSP8a     KDNLLDATETGCEKCTEKQKEGSYEMIEHLIKNEPEIWNE   101
PxutCSP8      KGHMKDAIETGCEKCTDAQKKGTNFMIDHLIRKKPEIWNQ   100
PxutCSP7      KEKLPEALATNCAKCTDKQKQMGKVLVKQVKKAHPELWDE    99
PxutCSP6      KKTIPEALRTTCAKCTPKQRELVRVVVRGFQTKLPEIWEE   101
PxutCSP4      KSHIKEALENNCGKCTETQKSGSRKVIGHLINNEKEYWGK   100
PxutCSP3      KKALPEAIETTCGKCTEKQKLNIRKAIRAIQQKYPGQWED    99
PxutCSP2      KETMPDALEHECSKCTEKQKESSDKVIRFLINKRPELWKE   103
PxutCSP1      KLHIKDGMQNSCSKCTDFQKNGARKVVKYIRANEKESWEE   101
PxutCSP4a     KSHIKEALENNCAKCTPPQRTRSRQVIGHLINHEPTFWNE   103
PxutCSP4b     KSHIAEAIENDCAKCTEVQRKGTRKVLGHLINNEQEFWDE    93
PxutCSP4c     KSHINDALEDNCAQCTDVQKSGFRRVIGHLINHEKDYWGK   102
PxutCSP8b     KEHLKEAIENGCKECTEKQKEGTNYVIRYLIENKRNLWEE    99
PxutCSP11a    KTKLPEVVREACEKCNPTQKQKLKIFLDGLNEKFPEEYNA    99
PxutCSP11b    KKDLPEAFQNACAKCTAAQKHIFKRFLEESEKKVVDDLNA    98
PxutCSP12     KKILPEVIKEACAKCSEPQKKNVRKIVKALYEKYPDDAIK    98
PxutCSP13     KRVLPETISTACGRCSPKQKVVVRKLLLGIRAKSEPRFFE   102
BMorCSP11     KKDIPEAVAEACGKCTPAQKHLFKRFLEVVKDKLPQEYEA   100
BMorCSP9      KKWIPESLQTSCGKCSEKQKYLVAKFVHAIKDKMPDEFDI   103
BMorCSP8      KRILPEALRTKCIRCTERQKRTSVKVIRRLKNEYPEEWAK   107
BMorCSP7      KKALPDTIATNCGKCTEKQKANVRKVIKVIQQKHSTEWEK    97
BMorCSP6      KAHIKDGMQTACAKCTDKQKVSARKIVKHIKQHEADYWEQ   100
BMorCSP5      KEHIREALETECAKCTEAQKKGTRRVIGHLINNESKSWNE   103
BMorCSP4      KSHIKEALETNCAKCTKAQKGGTEKMIGHLINHEAEFWEE   101
BMorCSP3      KETLPDALEHECVKCTGKQKSGADKVIRHLVNKRPDLWKE    94
SexiCSP1      KAHIKDTMQTSCSKCTEKQKKGARKVVKHIRAKEQEYWKQ   100
SexiCSP2      KEHIREALENECGKCTETQKKGTRRVIEYLINNEEEYWNE   104
SexiCSP3      KKIIPEALETTCGKCSPKQKQLIKKVIKAVIAKHPKAWEQ    99
SexiCSP6      VDLSLQTIQSNCAECTPNQKEKYDHVLKLLQENYASFFDE   101
LbotCSP23     KKVIPEALETTCGKCTPKQRKLIKQVIQAIMDKHPEAWKQ    86
LbotCSP21     KRVLPETLSTACGRCSPKQKAIVRTLLLGIRAKSEPRFNE   100
LbotCSP20     KRILPEALRTKCVRCTESQKQTAVKVIRRVKAEYPEDWQK   106
LbotCSP19     KSHIKEALENGCAKCTESQRVATRQVIGHLINKESAYWNQ   101
LbotCSP18     KSHIKEALENNCAKCTETQRRGTRRVIAHIINNESDYWNQ   103
LbotCSP14     KTNVKDAMISSCLKCTDWQRKNARKVVNHLKEKEAEYWEQ   100
LbotCSP13     RQLLPEVIATACEKCSDIQKTNVRKSVKALQERKPAEFTE    97
LbotCSP10     KKTLPEAVETTCAKCTEKQKGNIKKVIKAIQQRHPKQWDE    99
LbotCSP6      KKTIPDALRTSCEKCSPKQRNLVRVVVKGFQTKLPELWTE   100
LbotCSP5      KDKLPEALETRCAKCTDKQKTAGKQLVKEVKQKHPDLWKQ    98
LbotCSP4      KKILPEAVATTCGKCTPKQRVLVRTVIKALQEKLPQEWQE   102
LbotCSP3      KDHLEDALQTGCEKCTEAQKKGASKVIEHLIKNELPIWRE    99
LbotCSP2      RDTLPKVLASKCEQCTPEQKEKLDNVVKAYLDKYPKDYAE    97
PxylCSP5      KSHIREALENKCGKCTEAQKNGTRKVMTHLINFEPDYWNQ   102
SexiCSP3-2    KSHIREALENKCGKCTEAQKNGTRKVMTHLINFEPDYWNQ   102
SexiCSP2-2    KEHIREALENECGKCTETQKKGTRRVIEYLINNEEEYWNE   104
SexiCSP1-2    KSHIREALEQNCAKCTDAQRNGTRRVLGHLINNEEESWNR   104
BMorCSP16     KTLAPLVLRGACPQCSPQETKQIQKTLSYVQRNFPQHWAK   109
BMorCSP15     KQVMPEVITTACAKCTPTQKRFARKTFNAFRRYFPETLME   111
BMorCSP14     KRALPEALPTACARCSNKQKAAFRTLLLAIRARSEPSFLE   101
BMorCSP13     KDKIPEALETHCAKCTDKQKQMAKQLAQGIKKTHPELWDE    99
BMorCSP11-2   KKVIPEALETTCGKCSPKQKQLIKTVIKAVIERHPEAWEE    98
BMorCSP10     KETLPDALEHECVKCTGKQKSGADKVIRHLVNKRPDLWKE   102
BMorCSP9-2    KRILPEALRTKCIRCTERQKRTSVKVIRRLKNEYPEEWAK   107
BMorCSP8-2    KKRIPEALRTKCAKCNPKQRHLIRTVVKAFQTKLPDLWEE   101
BMorCSP7-2    KKDIPEAVAEACGKCTPAQKHLFKRFLEVVKDKLPQEYEA   100
BMorCSP6-2    KKALPDTIATNCGKCTEKQKANVRKVIKVIQQKHSTEWEK    97
BMorCSP5-2    KSHIKEALETNCAKCTKAQKGGTEKMIGHLINHEAEFWEE   101
BMorCSP4-2    KDHLQEALETGCEKCTEAQEKGAETSIDYLIKNELEIWKE    99
BMorCSP3-2    KEHIREALETECAKCTEAQKKGTRRVIGHLINNESKSWNE   103
BMorCSP2-2    KSSLKNVLEENCDKCSEDQRKSIIKVINYLVSSEPESWNQ    99
BMorCSP1-2    KAHIKDGMQTACAKCTDKQKVSARKIVKHIKQHEADYWEQ   100
HassCSP       KEHLQDAIETGCTKCTEAQEKGAYKVIEHLIKNELDIWRE    99
SlitCSP       KSHIKEALENRCGKCTPAQKDGTRKVLTHLINHEPEMWNQ   102
EhipCSP18     KKVIPEALETSCGKCTVKQKQLIRKVIKAVMKQHSDAWNQ    99
EhipCSP17     KSHIHESLENYCENCTEAQRKGARRVIGHLINNEPESWEK   103
EhipCSP15     KRVLPETLTTACSRCSSKQKLVVRKMLLGIRAKSEPRFLE   102
EhipCSP14     RDNVEEALQTGCAKCTEAQDKGASRVIEHLIKNEKEIWGE   101
EhipCSP13     KKTLPEAVETVCGKCTEKQKVNIKKVIKAIQQRHPKQWEE    99
EhipCSP7      RILAPLVLRGACPQCSPQEARHIRRTLAYVQKNYPWEWAK   105
EhipCSP6      KKSIPEALRTTCAKCTPKQRELIRIVVRAFQTKLPDVWEQ   101
EhipCSP4      KKDLSEAIKTACAKCTPAQKHILKRFTEGLKEKFPQDYET   100
EhipCSP3      KSHIKDAIQSSCSKCTDKQKQGARLVVNHIRDKEPKYWEE   100
EhipCSP2      KTLAPLVLRGACPQCSPQETKQIQRTLSYVQRNYPQEWAK   100
Consensus                c  c
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CresCSP3     LCAKYDPKKVYASKYEKELKEVTA................  127
CresCSP4     LAEKYDPDNIYQERYKDKIEAVKN................  126
CresCSP5     FRAKYDPKGEYEKDFAAFLLGTD.................  122
CresCSP6     LVAHYDPNGKYQDAFKDLLEGN..................  121
CresCSP7     LSKKYDSEGKYVHKYEDELRHIKGSK..............  128
CresCSP8     LQKLMKKD................................  106
HcirCSP2     LSAKYDPNNIYQDRYKDKIEAVKGQ...............  126
BMorCSP1     LTAHFDPDGKWRKKYEDRAKAKGIVIPE............  127
HvirCSP1     LTAKFDPEKKYVQKYEKELKEVKA................  114
PxylCSP4     IVSKEDPKGEYKDSFAKFLEGSD.................  126
PxylCSP3     LSDKYDPAGKYTAQYEDQLRAVKA................  126
PxylCSP2     LIAKYDPERKYVSKYEKELKEVKASCCWLV..........  134
PxylCSP1     LEKKYLSDGSYKKKYLEKKNASENNGDSKSTEAKNKDDEE  142
BMorCSP2     FITFYDPQGKYQTSFKDFLES...................  120
HarMCSP26    LVKKEDPNGQYKEVFTRFLNGSD.................  123
HarMCSP25    LNAKYDPNNKYTKKYEKELKEVQEEHH.............  131
HassCSP25    LKAKYDPEGKYAKKYEKELEEVKNA...............  129
HassCSP24    LSAKYDPNNIYQDRYKDKIEAVKGQ...............  126
HassCSP23    LVKQIDPENKYAEDLKNYLAKYGH................  125
HassCSP22    FRAKFDPKGEYEKDFSAFMLATD.................  122
HassCSP21    LKAKYDPEGKYTHKYEKELEEVQH................  128
HassCSP20    FKNKYDPEGKYFDNFEAAVAAF..................  122
HarMCSP22    LIKQLDPENKYADDLKNYLAKYGH................  125
HarMCSP23    FRAKFDPKGEYEKDFSAFMLGTD.................  122
HarMCSP21    LKAKYDPEGKYTHKYEKELEEVQH................  130
GMolCSP11    LTGKFDPEDKHKDDFDKFLAENRK................  123
GMolCSP9     LEKKYDSDGSYKQKYLDSKEHKEEKATESEKPAENENAVE  143
GMolCSP3     LSARFDPEGKFKKTYEQRAREHGITIPEE...........  129
OfurCSP16    TMFINKMTNMFQGGLSDTEKTT..................  125
OfurCSP13    LVKKTDPSGKHRAGFDKFIQSN..................  120
OfurCSP12    LKTKYDPDSKHIDALIAAIKDA..................  122
OfurCSP10    FKKKYDPEDKFFAALDKAINA...................  120
OfurCSP8     LEKKYNSDGSYKKKYLERKEARNQ.SNSAEKSQENDSKSK  143
OfurCSP7     LTAKYDPQRKYVVKYEKELRTVS.................  125
OfurCSP6     LVAHYDPEGKYQEAFQDYLKP...................  120
OfurCSP5     LEDKFDKDKKFRDSFNKFLEEKD.................  122
OfurCSP2     LVKKHDPEGQYTESFDAFLNSK..................  123
PxutCSP10    LIDKYDPENKYRDGFYQFIGQDD.................  122
PxutCSP8a    LCAKYDPTGKWRKEYEEKAKAKGIKIPQKISTK.......  134
PxutCSP8     LANKYDPTGKWRKVYEDRAKEHGIVIPH............  128
PxutCSP7     LKNLYDPQGKYQKEFQQFLSD...................  120
PxutCSP6     LVKQQDPKGEFKEAFDRFLNSSD.................  124
PxutCSP4     LTAKYDPERKYVTKYESELRKIAA................  124
PxutCSP3     LVKKNDPSGKHRANFDKFIQGS..................  121
PxutCSP2     LATKYDPDNVYQQRYKDKIEAVKEH...............  128
PxutCSP1     MKKKYDPKDEYKEKYEAFLAADN.................  124
PxutCSP4a    LCQKYDPTSKYTRKYEEELRTIAA................  127
PxutCSP4b    LTARYDPEHKYSVKYENELRTSK.................  116
PxutCSP4c    LTAKYDPERKYVLKYERDLREISA................  126
PxutCSP8b    LCAKFDPDGKWRKHYEEEAKAKGIKIP.............  126
PxutCSP11a   LKKQFDPTGKLFEALNAALAKA..................  121
PxutCSP11b   LKKKYDPESKHYAALLSAISKS..................  120
PxutCSP12    FADKYDPKRDYESAFAAFVAEE..................  120
PxutCSP13    LLDKYDPSRLNREALYTFLVTGN.................  125
BMorCSP11    FKTKYDPQGKHFDALLSAVANS..................  122
BMorCSP9     LRKLHDPKGEYTENLDKFLETYGH................  127
BMorCSP8     LASRWDPTGDFTRYFEDYLAKEHFNTIPGSGPTVNVLSLQ  147
BMorCSP7     LVKKHDPSGKHRADFDKFLLGS..................  119
BMorCSP6     MKAKYDPKDEFKEIYEGFLAGQN.................  123
BMorCSP5     LTAKYDPENKFTAKYEKELREIKA................  127
BMorCSP4     LKAKYDPTNEFTKKYETELKRVTA................  125
BMorCSP3     LAVKYDPDNIYQARYKDKIDAVKGSA..............  120
SexiCSP1     ILAKYDPEDQYKENYETFLAAED.................  123
SexiCSP2     LTAKYDPERKYTAKYEKELKKIKA................  128
SexiCSP3     LSDKYDKDKKYKDSFDKFLAEQD.................  122
SexiCSP6     FMQKMATKKE..............................  111
LbotCSP23    LIQKYDPENKRKEDFDKFLSENK.................  109
LbotCSP21    LLDKYDPDRSNRDDLYKFLVTGN.................  123
LbotCSP20    LASRWDPTGDFTRYFEEVLTRDHFNTIPNSNEIPGSSPLP  146
LbotCSP19    LVTKYDSQRKYVAKYESELRAVRA................  125
LbotCSP18    LCVKYDPDRKYVTKYESELKTVKA................  127
LbotCSP14    MKAKYDPGDVHKASYEAFLSRSD.................  123
LbotCSP13    FRAKYDPKGEYEQKFAAFILESK.................  120
LbotCSP10    LVKKNDPTGKYIANFNKFIDS...................  120
LbotCSP6     LAAKEDPKGEYKDAFNKFINGSD.................  123
LbotCSP5     LVSKYDPSGKYHKSFEDFLKN...................  119
LbotCSP4     LVKLHDPEGKYKESFGKFLTSTD.................  125
LbotCSP3     LSNRFDPEGKFKKIYEDRARAHGIVIPEEH..........  129
LbotCSP2     IMNKYFPKPE..............................  107
PxylCSP5     LCAKYDPEGKYKAMYEKEYKTLVH................  126
SexiCSP3-2   LCAKYDPEGKYKAMYEKEYKTLVH................  126
SexiCSP2-2   LTAKYDPERKYTTKYEKELKKIKA................  128
SexiCSP1-2   LKAKYDPQSKYTVKYELELRKLKQ................  128
BMorCSP16    LVRQYAG.................................  116
BMorCSP15    LRRKFDPESKYYDAFEKVITNA..................  133
BMorCSP14    LLDKYDPSRSNRELLYTFLATGL.................  124
BMorCSP13    FITFYDPQGKYQTSFKDFLES...................  120
BMorCSP11-2  LVNKYDKDRKFRPSFDKFINEDD.................  121
BMorCSP10    LAVKYDPDNIYQARYKDKID....................  122
BMorCSP9-2   LASRWDPTGDFTRYFEDYLAKEHFNTIPGSGPTVNVLSLQ  147
BMorCSP8-2   LAIKEDPKGQYKHEFTAFINAMD.................  124
BMorCSP7-2   FKTKYDPQGKHFDALLSAVANS..................  122
BMorCSP6-2   LVKKHDPSGKHRADFDKFLLGS..................  119
BMorCSP5-2   LKAKYDPTNEFTKKYETELKRVTA................  125
BMorCSP4-2   LTAHFDPDGKWRKKYEDRAKAKGIVIPE............  127
BMorCSP3-2   LTAKYDPENKFTAKYEKELREIKA................  127
BMorCSP2-2   LKSKYDPEGKYLIKYEAKMESN..................  121
BMorCSP1-2   MKAKYDPKDEFKEIYEGFLAGQN.................  123
HassCSP      LAAKYDPKGDWRKKYEDRARANGIQIPE............  127
SlitCSP      LCEKYDAEGKYRKMYEDEYKSVKH................  126
EhipCSP18    LVEKYDKERKYRDSFNKFLEED..................  121
EhipCSP17    LNAKYDPEHKYTKKYEDELRTIKQ................  127
EhipCSP15    LLDKYDPDRSNRDALYNFLVTGN.................  125
EhipCSP14    LTAKYDPEGKYRKKYEDLAKSKGIEIPEN...........  130
EhipCSP13    LVQKNDPSGKHRADFDKFIQSS..................  121
EhipCSP7     IVRQYG..................................  111
EhipCSP6     LAKKEDPNGEYKESFEAFLNRSD.................  124
EhipCSP4     FKQKFDPEGKYFVALEPVLAKA..................  122
EhipCSP3     LKIKYDPDDQYKEIYEAFLIAKD.................  123
EhipCSP2     IVRQYAG.................................  107
Consensus
```

CresCSP1	....	123
CresCSP2	....	125
CresCSP3	....	127
CresCSP4	....	126
CresCSP5	....	122
CresCSP6	....	121
CresCSP7	....	128
CresCSP8	....	106
HcirCSP2	....	126
BMorCSP1	....	127
HvirCSP1	....	114
PxylCSP4	....	126
PxylCSP3	....	126
PxylCSP2	....	134
PxylCSP1	KKSKGDGEEK...............................	152
BMorCSP2	....	120
HarMCSP26	....	123
HarMCSP25	....	131
HassCSP25	....	129
HassCSP24	....	126
HassCSP23	....	125
HassCSP22	....	122
HassCSP21	....	128
HassCSP20	....	122
HarMCSP22	....	125
HarMCSP23	....	122
HarMCSP21	....	130
GMolCSP11	....	123
GMolCSP9	TKTEISLEQQDK.............................	155
GMolCSP3	....	129
OfurCSP16	....	125
OfurCSP13	....	120
OfurCSP12	....	122
OfurCSP10	....	120
OfurCSP8	E..	144
OfurCSP7	....	125
OfurCSP6	....	120
OfurCSP5	....	122
OfurCSP2	....	123
PxutCSP10	....	122
PxutCSP8a	....	134
PxutCSP8	....	128
PxutCSP7	....	120
PxutCSP6	....	124
PxutCSP4	....	124
PxutCSP3	....	121
PxutCSP2	....	128
PxutCSP1	....	124
PxutCSP4a	....	127
PxutCSP4b	....	116
PxutCSP4c	....	126
PxutCSP8b	....	126
PxutCSP11a	....	121
PxutCSP11b	....	120
PxutCSP12	....	120
PxutCSP13	....	125
BMorCSP11	....	122
BMorCSP9	....	127
BMorCSP8	TTPPP...PPPPPSRPASVFTNPPPP.............V	171
BMorCSP7	....	119
BMorCSP6	....	123
BMorCSP5	....	127
BMorCSP4	....	125
BMorCSP3	....	120
SexiCSP1	....	123
SexiCSP2	....	128
SexiCSP3	....	122
SexiCSP6	....	111
LbotCSP23	....	109
LbotCSP21	....	123
LbotCSP20	TPPPTRPSPPPPPPPTTRRIFTPPPPPPPPTLPPAPSTFQPA	186
LbotCSP19	....	125
LbotCSP18	....	127
LbotCSP14	....	123
LbotCSP13	....	120
LbotCSP10	....	120
LbotCSP6	....	123
LbotCSP5	....	119
LbotCSP4	....	125
LbotCSP3	....	129
LbotCSP2	....	107
PxylCSP5	....	126
SexiCSP3-2	....	126
SexiCSP2-2	....	128
SexiCSP1-2	....	128
BMorCSP16	....	116
BMorCSP15	....	133
BMorCSP14	....	124
BMorCSP13	....	120
BMorCSP11-2	....	121
BMorCSP10	....	122
BMorCSP9-2	TTPPP...PPPPPSRPASVFTNPPPP.............V	171
BMorCSP8-2	....	124
BMorCSP7-2	....	122
BMorCSP6-2	....	119
BMorCSP5-2	....	125
BMorCSP4-2	....	127
BMorCSP3-2	....	127
BMorCSP2-2	....	121
BMorCSP1-2	....	123
HassCSP	....	127
SlitCSP	....	126
EhipCSP18	....	121
EhipCSP17	....	127
EhipCSP15	....	125
EhipCSP14	....	130
EhipCSP13	....	121
EhipCSP7	....	111
EhipCSP6	....	124
EhipCSP4	....	122
EhipCSP3	....	123
EhipCSP2	....	107
Consensus		

```
CresCSP1       ........................................   123
CresCSP2       ........................................   125
CresCSP3       ........................................   127
CresCSP4       ........................................   126
CresCSP5       ........................................   122
CresCSP6       ........................................   121
CresCSP7       ........................................   128
CresCSP8       ........................................   106
HcirCSP2       ........................................   126
BMorCSP1       ........................................   127
HvirCSP1       ........................................   114
PxylCSP4       ........................................   126
PxylCSP3       ........................................   126
PxylCSP2       ........................................   134
PxylCSP1       ........................................   152
BMorCSP2       ........................................   120
HarMCSP26      ........................................   123
HarMCSP25      ........................................   131
HassCSP25      ........................................   129
HassCSP24      ........................................   126
HassCSP23      ........................................   125
HassCSP22      ........................................   122
HassCSP21      ........................................   128
HassCSP20      ........................................   122
HarMCSP22      ........................................   125
HarMCSP23      ........................................   122
HarMCSP21      ........................................   130
GMolCSP11      ........................................   123
GMolCSP9       ........................................   155
GMolCSP3       ........................................   129
OfurCSP16      ........................................   125
OfurCSP13      ........................................   120
OfurCSP12      ........................................   122
OfurCSP10      ........................................   120
OfurCSP8       ........................................   144
OfurCSP7       ........................................   125
OfurCSP6       ........................................   120
OfurCSP5       ........................................   122
OfurCSP2       ........................................   123
PxutCSP10      ........................................   122
PxutCSP8a      ........................................   134
PxutCSP8       ........................................   128
PxutCSP7       ........................................   120
PxutCSP6       ........................................   124
PxutCSP4       ........................................   124
PxutCSP3       ........................................   121
PxutCSP2       ........................................   128
PxutCSP1       ........................................   124
PxutCSP4a      ........................................   127
PxutCSP4b      ........................................   116
PxutCSP4c      ........................................   126
PxutCSP8b      ........................................   126
PxutCSP11a     ........................................   121
PxutCSP11b     ........................................   120
PxutCSP12      ........................................   120
PxutCSP13      ........................................   125
BMorCSP11      ........................................   122
BMorCSP9       ........................................   127
BMorCSP8       MSTSPRPVVLNRFRR.........................   186
BMorCSP7       ........................................   119
BMorCSP6       ........................................   123
BMorCSP5       ........................................   127
BMorCSP4       ........................................   125
BMorCSP3       ........................................   120
SexiCSP1       ........................................   123
SexiCSP2       ........................................   128
SexiCSP3       ........................................   122
SexiCSP6       ........................................   111
LbotCSP23      ........................................   109
LbotCSP21      ........................................   123
LbotCSP20      ASTSPRPVILNRFGDDGELMVNGQPAPTQNARPTTVRPVY   226
LbotCSP19      ........................................   125
LbotCSP18      ........................................   127
LbotCSP14      ........................................   123
LbotCSP13      ........................................   120
LbotCSP10      ........................................   120
LbotCSP6       ........................................   123
LbotCSP5       ........................................   119
LbotCSP4       ........................................   125
LbotCSP3       ........................................   129
LbotCSP2       ........................................   107
PxylCSP5       ........................................   126
SexiCSP3-2     ........................................   126
SexiCSP2-2     ........................................   128
SexiCSP1-2     ........................................   128
BMorCSP16      ........................................   116
BMorCSP15      ........................................   133
BMorCSP14      ........................................   124
BMorCSP13      ........................................   120
BMorCSP11-2    ........................................   121
BMorCSP10      ........................................   122
BMorCSP9-2     MSTSPRPVVLNRFRR.........................   186
BMorCSP8-2     ........................................   124
BMorCSP7-2     ........................................   122
BMorCSP6-2     ........................................   119
BMorCSP5-2     ........................................   125
BMorCSP4-2     ........................................   127
BMorCSP3-2     ........................................   127
BMorCSP2-2     ........................................   121
BMorCSP1-2     ........................................   123
HassCSP        ........................................   127
SlitCSP        ........................................   126
EhipCSP18      ........................................   121
EhipCSP17      ........................................   127
EhipCSP15      ........................................   125
EhipCSP14      ........................................   130
EhipCSP13      ........................................   121
EhipCSP7       ........................................   111
EhipCSP6       ........................................   124
EhipCSP4       ........................................   122
EhipCSP3       ........................................   123
EhipCSP2       ........................................   107
Consensus
```

```
CresCSP1      ........................................   123
CresCSP2      ........................................   125
CresCSP3      ........................................   127
CresCSP4      ........................................   126
CresCSP5      ........................................   122
CresCSP6      ........................................   121
CresCSP7      ........................................   128
CresCSP8      ........................................   106
HcirCSP2      ........................................   126
BMorCSP1      ........................................   127
HvirCSP1      ........................................   114
PxylCSP4      ........................................   126
PxylCSP3      ........................................   126
PxylCSP2      ........................................   134
PxylCSP1      ........................................   152
BMorCSP2      ........................................   120
HarMCSP26     ........................................   123
HarMCSP25     ........................................   131
HassCSP25     ........................................   129
HassCSP24     ........................................   126
HassCSP23     ........................................   125
HassCSP22     ........................................   122
HassCSP21     ........................................   128
HassCSP20     ........................................   122
HarMCSP22     ........................................   125
HarMCSP23     ........................................   122
HarMCSP21     ........................................   130
GMolCSP11     ........................................   123
GMolCSP9      ........................................   155
GMolCSP3      ........................................   129
OfurCSP16     ........................................   125
OfurCSP13     ........................................   120
OfurCSP12     ........................................   122
OfurCSP10     ........................................   120
OfurCSP8      ........................................   144
OfurCSP7      ........................................   125
OfurCSP6      ........................................   120
OfurCSP5      ........................................   122
OfurCSP2      ........................................   123
PxutCSP10     ........................................   122
PxutCSP8a     ........................................   134
PxutCSP8      ........................................   128
PxutCSP7      ........................................   120
PxutCSP6      ........................................   124
PxutCSP4      ........................................   124
PxutCSP3      ........................................   121
PxutCSP2      ........................................   128
PxutCSP1      ........................................   124
PxutCSP4a     ........................................   127
PxutCSP4b     ........................................   116
PxutCSP4c     ........................................   126
PxutCSP8b     ........................................   126
PxutCSP11a    ........................................   121
PxutCSP11b    ........................................   120
PxutCSP12     ........................................   120
PxutCSP13     ........................................   125
BMorCSP11     ........................................   122
BMorCSP9      ........................................   127
BMorCSP8      ........................................   186
BMorCSP7      ........................................   119
BMorCSP6      ........................................   123
BMorCSP5      ........................................   127
BMorCSP4      ........................................   125
BMorCSP3      ........................................   120
SexiCSP1      ........................................   123
SexiCSP2      ........................................   128
SexiCSP3      ........................................   122
SexiCSP6      ........................................   111
LbotCSP23     ........................................   109
LbotCSP21     ........................................   123
LbotCSP20     TTRPTYQTSWAGAASDVIPTRFSLRPTKDIMPPYTTAITL   266
LbotCSP19     ........................................   125
LbotCSP18     ........................................   127
LbotCSP14     ........................................   123
LbotCSP13     ........................................   120
LbotCSP10     ........................................   120
LbotCSP6      ........................................   123
LbotCSP5      ........................................   119
LbotCSP4      ........................................   125
LbotCSP3      ........................................   129
LbotCSP2      ........................................   107
PxylCSP5      ........................................   126
SexiCSP3-2    ........................................   126
SexiCSP2-2    ........................................   128
SexiCSP1-2    ........................................   128
BMorCSP16     ........................................   116
BMorCSP15     ........................................   133
BMorCSP14     ........................................   124
BMorCSP13     ........................................   120
BMorCSP11-2   ........................................   121
BMorCSP10     ........................................   122
BMorCSP9-2    ........................................   186
BMorCSP8-2    ........................................   124
BMorCSP7-2    ........................................   122
BMorCSP6-2    ........................................   119
BMorCSP5-2    ........................................   125
BMorCSP4-2    ........................................   127
BMorCSP3-2    ........................................   127
BMorCSP2-2    ........................................   121
BMorCSP1-2    ........................................   123
HassCSP       ........................................   127
SlitCSP       ........................................   126
EhipCSP18     ........................................   121
EhipCSP17     ........................................   127
EhipCSP15     ........................................   125
EhipCSP14     ........................................   130
EhipCSP13     ........................................   121
EhipCSP7      ........................................   111
EhipCSP6      ........................................   124
EhipCSP4      ........................................   122
EhipCSP3      ........................................   123
EhipCSP2      ........................................   107
Consensus
```

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CresCSP1      ............................      123
CresCSP2      ............................      125
CresCSP3      ............................      127
CresCSP4      ............................      126
CresCSP5      ............................      122
CresCSP6      ............................      121
CresCSP7      ............................      128
CresCSP8      ............................      106
HcirCSP2      ............................      126
BMorCSP1      ............................      127
HvirCSP1      ............................      114
PxylCSP4      ............................      126
PxylCSP3      ............................      126
PxylCSP2      ............................      134
PxylCSP1      ............................      152
BMorCSP2      ............................      120
HarMCSP26     ............................      123
HarMCSP25     ............................      131
HassCSP25     ............................      129
HassCSP24     ............................      126
HassCSP23     ............................      125
HassCSP22     ............................      122
HassCSP21     ............................      128
HassCSP20     ............................      122
HarMCSP22     ............................      125
HarMCSP23     ............................      122
HarMCSP21     ............................      130
GMolCSP11     ............................      123
GMolCSP9      ............................      155
GMolCSP3      ............................      129
OfurCSP16     ............................      125
OfurCSP13     ............................      120
OfurCSP12     ............................      122
OfurCSP10     ............................      120
OfurCSP8      ............................      144
OfurCSP7      ............................      125
OfurCSP6      ............................      120
OfurCSP5      ............................      122
OfurCSP2      ............................      123
PxutCSP10     ............................      122
PxutCSP8a     ............................      134
PxutCSP8      ............................      128
PxutCSP7      ............................      120
PxutCSP6      ............................      124
PxutCSP4      ............................      124
PxutCSP3      ............................      121
PxutCSP2      ............................      128
PxutCSP1      ............................      124
PxutCSP4a     ............................      127
PxutCSP4b     ............................      116
PxutCSP4c     ............................      126
PxutCSP8b     ............................      126
PxutCSP11a    ............................      121
PxutCSP11b    ............................      120
PxutCSP12     ............................      120
PxutCSP13     ............................      125
BMorCSP11     ............................      122
BMorCSP9      ............................      127
BMorCSP8      ............................      186
BMorCSP7      ............................      119
BMorCSP6      ............................      123
BMorCSP5      ............................      127
BMorCSP4      ............................      125
BMorCSP3      ............................      120
SexiCSP1      ............................      123
SexiCSP2      ............................      128
SexiCSP3      ............................      122
SexiCSP6      ............................      111
LbotCSP23     ............................      109
LbotCSP21     ............................      123
LbotCSP20     IDQIGYKIIRTTELVTDILRNTVRAVVG      294
LbotCSP19     ............................      125
LbotCSP18     ............................      127
LbotCSP14     ............................      123
LbotCSP13     ............................      120
LbotCSP10     ............................      120
LbotCSP6      ............................      123
LbotCSP5      ............................      119
LbotCSP4      ............................      125
LbotCSP3      ............................      129
LbotCSP2      ............................      107
PxylCSP5      ............................      126
SexiCSP3-2    ............................      126
SexiCSP2-2    ............................      128
SexiCSP1-2    ............................      128
BMorCSP16     ............................      116
BMorCSP15     ............................      133
BMorCSP14     ............................      124
BMorCSP13     ............................      120
BMorCSP11-2   ............................      121
BMorCSP10     ............................      122
BMorCSP9-2    ............................      186
BMorCSP8-2    ............................      124
BMorCSP7-2    ............................      122
BMorCSP6-2    ............................      119
BMorCSP5-2    ............................      125
BMorCSP4-2    ............................      127
BMorCSP3-2    ............................      127
BMorCSP2-2    ............................      121
BMorCSP1-2    ............................      123
HassCSP       ............................      127
SlitCSP       ............................      126
EhipCSP18     ............................      121
EhipCSP17     ............................      127
EhipCSP15     ............................      125
EhipCSP14     ............................      130
EhipCSP13     ............................      121
EhipCSP7      ............................      111
EhipCSP6      ............................      124
EhipCSP4      ............................      122
EhipCSP3      ............................      123
EhipCSP2      ............................      107
Consensus
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