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C S D

C B P - P D

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De novo Mythimna separata -

-Q C ', -P N , , F -F , L L , S '*, M -Q W '*

College of Plant Science and Technology, Huazhong Agricultural University, Wuhan 430070, People's Republic of China
Hubei Province Key Laboratory for Crop Diseases, Insect Pests and Weeds Control, Institute of Plant Protection & Soil Science, Hubei Academy of Agricultural Sciences, Wuhan 430068, People's Republic of China

A R T I C L E I N F O

Keywords:
A
C
E
Mythimna separata

A B S T R A C T

T *Mythimna separate*, . A 130 fi . T 32 - (OBP), 16 (CSP), 71 (OR), 8 (IR), 1 (GR) 2 (SNMP). Q-PCR fi *OBPs* ff , *MsepOBP19* 0- - *MsepOBP20* , *MsepOBPs* fi ( ), , , . T *MsepOBPs* ff (ff). *MsepOBP5* - 0- 5- - , 1- 3- - fi *MsepOBP7*, *20*, *24* *26*. I , *MsepOBP22* 0- 5- - , 3- - - . O fi *M. separata*.

1. Introduction

T , (F ., 2008; B ., 2009; P fl ., 2011; L ., 2015). T - - (S -G ., 2009). L - - (OBP) (CSP). T OBP (PBP) (V R , 1981), (GOBP) (V ., 1991) (ABP) (K ., 1996). T fl (P M , 1995; S , 1998; P ., 2006; ., 2013; S ., 2014). M (OR) - (O , O 83), - (G ., 1999; S ., 2008; T V , 2009). B , (GR), (SNMP), (IR), (S ., 2001; V ., 2009; C ., 2010; L , 2013).

T *Mythimna separata* (L : N) A 33 (, 1956; S D , 1983; A ., 1999; J ., 2011; ., 2013). C , fi *M. separata* (B ., 2009). A , *M. seprata* fi ( )-11- (11-16:A) ( )-11 - (11-16:OH) (T ., 1979), . (1987) *M. Seprata* ( )-11- (11-16:A). H - *M. Seprata*

* C .
E-mail addresses: 6410@163. (S.), @ . . . (M.-Q. W).

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R 28 A 2016; R 10 M 2017; A 16 M 2017
A 20 M h 2017
1744-117 / 2017 E I . A h .

Table 1
S RNA-S .

T	82,290,798
T	77,734,418
T ( )	6,996,097,620
Q20	98.29%
N	0.00%
GC	43.68%
T	123,094
T ( )	33,860,271
M ( )	275
N50	379
T	62,779
T ( )	31,579,378
M ( )	503
N50	734
D	15,727
D	47,052

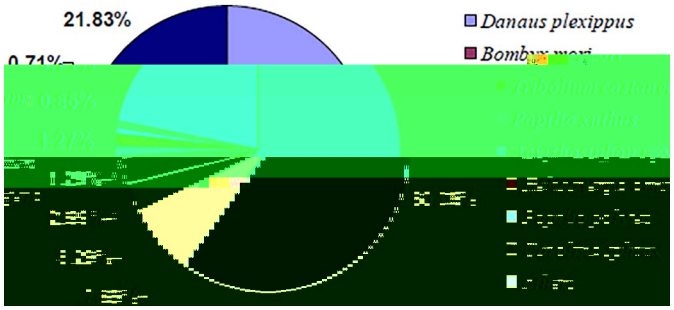

Fig. 1. P BLAST NR *M. separata* .

ff *M. Seprata* (M ., 2008). T - - , , RNA-S (A , 2009) - *M. separate* , fi OBP ff *M. separata* PCR.

2. Materials and methods

2.1. Insects and tissues collection

M. separata fi (111 57′E; 31 N 26′), P. R. C M 2013, (H 2152) 24 1 C 12 :12 . A - , 3000 ff − 70 C *de novo* . M , *M. separata* P (9) . B 10% (/) . A , ( ), , , 0-, 1-, 3-, 5- - − 70 C PCR. A .

2.2. Extraction of total RNA

F - RNA (T K R B I ., S , J), RNA - . T RNA N ND-2000 (N D , W , DE, USA).

2.3. Illumina sequencing and sequence assembly

B G I (S , G , C). F , RNA fi RNA (T), . F - DNA RNA , - DNA. A , PCR fi DNA . Q A 2100 B ABI S -O -P R - T PCR . F , DNA H S 2000 . T fi

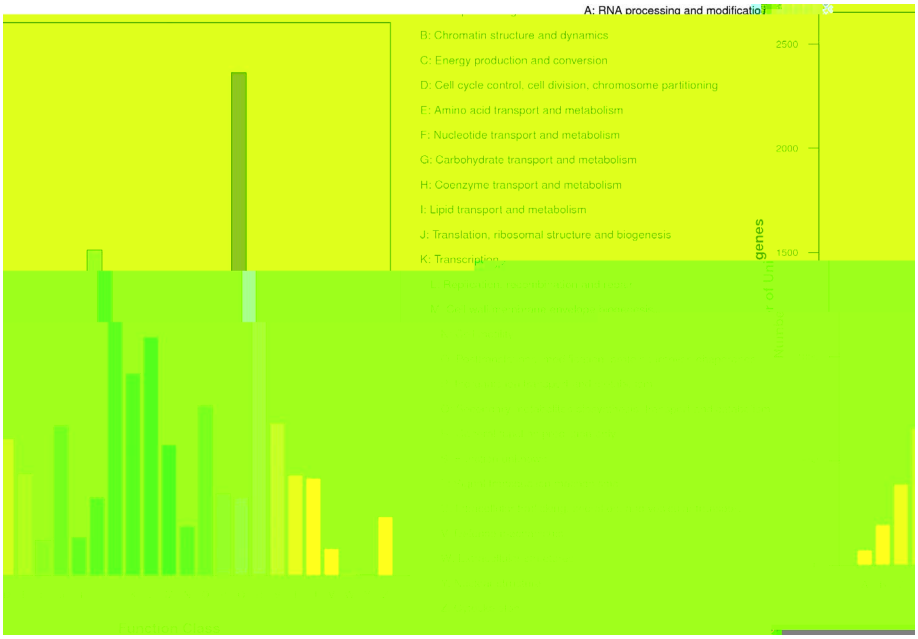

Fig. 2. COG fi *M. separata* .

T (G ., 2011).
C fi

Table 2
S OBP *M. separata*.

		G	ORF ( )	C -	ORF	SP ( )	H					
							S	S	N	A .	*E-*	I (%)
M	OBP1	CL645. 1	154			N	H , *Helicoverpa armigera*	-	OBP	AE 07280.1	2 -48	77
M	OBP2	CL1687. 2	132			N	A , *Sesamia inferens*	-	OBP6	AGS36748.1	2 -72	89
M	OBP3	CL1836. 1	165			23	H , *Mamestra brassicae*	M	PBP1	AAC05702.2	3 -95	81
M	OBP4	CL2797. 2	139	N		N	H , *Agrotis segetum*	-	GOBP1	ABI24159.1	7 -52	95
M	OBP5	CL4701. 1	148			21	H , *Heliothis virescens*	F	ABP	CAC33574.1	2 -65	69
M	OBP6	CL5731. 1	237			19	A , *Spodoptera exigua*	-	OBP25	AKT26502.1	4 -96	62
M	OBP7	CL7088. 1	248			22	A , *Spodoptera litura*	-	OBP1	AKI87962.1	3 -98	84
M	OBP8	CL7646. 1	149			21	*Helicoverpa armigera*	-	OBP5	AEB54581.1	4 -58	75
M	OBP9	CL7646. 2	146			21	*Mamestra brassicae*	-	PBP4	AAL66739.1	3 -82	84
M	OBP10	CL7647. 1	166			23	H , *Helicoverpa armigera*	A	OBP9	AEB54592.1	1 -41	48
M	OBP11	U 308	139			18	*Helicoverpa armigera*	A	OBP8	AEB54589.1	9 -85	88
M	OBP12	U 2752	129	N		17	S , *Antheraea yamamai*	-	ABP7	ADO95155.1	1 -08	36
M	OBP13	U 2871	333			20	B , *Bombyx mori*	M	GOBP71	P 004927370.1	4 -64	64
M	OBP14	U 3718	197	N		17	H , *Helicoverpa assulta*	-	OBP19	AGC92793.1	1 -76	60
M	OBP15	U 19982	101	N		N	A , *Spodoptera exigua*	-	OBP26	AKT26503.1	6 -42	75
M	OBP16	U 21183	87			N	*Spodoptera exigua*	-	OBP13	AGP03459.1	3 -16	42
M	OBP17	U 28320	140	N		19	*Spodoptera exigua*	-	OBP10	AGP03456.1	2 -69	74
M	OBP18	U 28508	141			18	*Spodoptera exigua*	-	OBP8	AGH70104.1	5 -80	86
M	OBP19	U 29008	145			17	*Spodoptera exigua*		OBP4	AD 17886.1	3 -80	80
M	OBP20	U 29069	147			15	*Spodoptera exigua*	A	OBP6	AFM77984.1	4 -58	60
M	OBP21	U 31160	142			21	*Helicoverpa armigera*	A	OBP2	AEB54586.1	3 -86	86
M	OBP22	U 31770	145			24	*Spodoptera exigua*	-	OBP12	AGP03458.1	2 -70	80
M	OBP23	U 32401	154	N		27	H , *Mythimna separata*	-	PBP	BAG71416.1	3 -97	98
M	OBP24	U 32404	162			21	H , *Heliothis viriplaca*	-	GOBP2	AFI25168.1	3 -95	91
M	OBP25	U 32426	164			20	*Spodoptera exigua*	-	OBP24	AKT26501.1	8 -118	98
M	OBP26	U 32708	141	N		20	N , *Agrotis ipsilon*	-	PBP3	AFM36758.1	2 -84	86
M	OBP27	U 33562	146			25	C , *Cnaphalocrocis medinalis*	-	OBP1	AFG72998.1	5 -76	74
M	OBP28	U 33672	100	N		N	A , *Sesamia inferens*	-	OBP4	AGS36746.1	4 -30	71
M	OBP29	U 34049	133			16	*Spodoptera exigua*	-	OBP9	AGH70105.1	2 -81	90
M	OBP30	U 34083	137			20	*Heliothis virescens*	A	ABP	CAA05508.1	6 -57	89
M	OBP31	U 34667	68	N		17	N , *Xestia cnigrum*	-	GOBP1	AGS41498.1	2 -28	100
M	OBP32	U 42513	71	N		N	*Spodoptera exigua*	-	OBP11	AGP03457.1	3 -35	79

N : ORF, ; SP, ; , . GOBP: - ; ABP: ; PBP: - . "-": .

3.2. Comparative analysis

P *M. separata* RNA-S *Danaus plexippus*, *Bombyx mori*, *Tribolium castaneum*, *Papilio xuthus*, *Acyrthosiphon pisum*, *Helicoverpa armigera* B P (*e-* $\leq 10^{-5}$). I , 23,309 NR . T *M. separata* *D. plexippus* (60.1%) *B. mori* (7.7%). O , *M. separata* N *H. armigera* (1.27%) *S. frugiperda* (0.68%) (F . 1).

3.3. Classification of clusters of orthologous groups

W COG (F . 2). F 25 COG , " " (2411, 17.36%), " , " (1561, 11.24%) " " (7, 0.05%) " " (4, 0.03%) .

3.4. Unigene GO classification

W GO B 2GO .

T WEBGO GO 4.96% .
ff
(F . 3). T
(47.57%) (39.56%),

3.5. Identification of putative chemosensory genes

W fi 32 OBP , 16 CSP , 71 OR , 8 IR , 1 GR 2

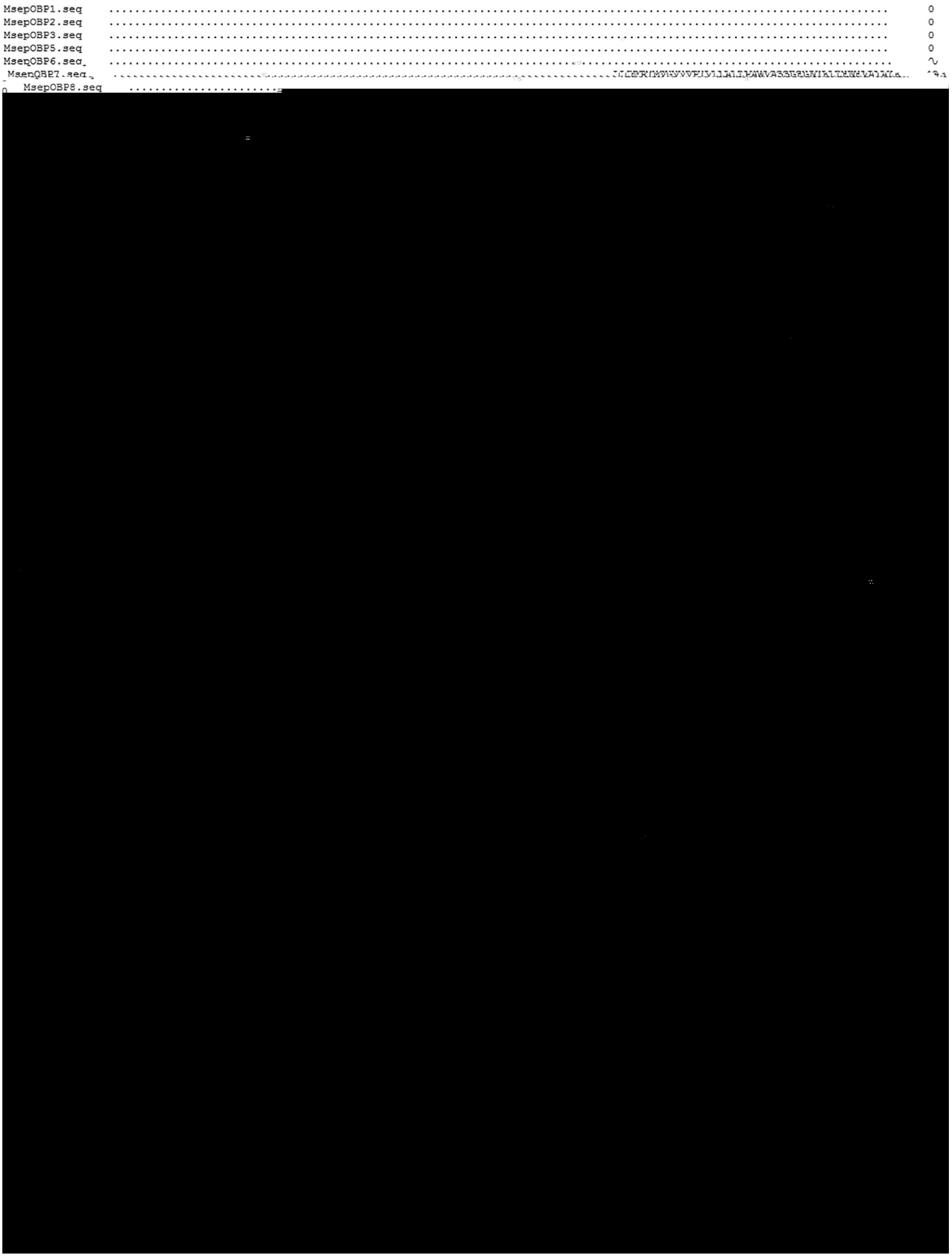

Fig. 4. A OBP *M. separata*. S C .

SNMP RNA-S . T OBP fi OBP 6 (C), OBP , -C OBP (4 C), -C OBP (8 C 1 P), (G ., 2009; H -S ., 2002). O 32 fi *M. separata* OBP , 22 ORF (T 2). A 25 OBP N- . A 22 ORF DNAMAN 6 (L C ., Q , C) 12 (M OBP2, -3, -5, -8, -9, -11, -18, -19, -20, -21, -24 -27) OBP (M OBP1, -6, -7, -10, -13, -16, -22, -25, -29 -30) -C OBP (F . 4); -C, , OBP . T OBP . A 32 OBP , 12 OBP 10 -C OBP . A OBP L M OBP4, -15, -28 32, (F . 5). A OBP T S2. A 16 CSP fi ORF (T S3). A CSP M CSP1, -10 -12, (F . 6 7). A CSP T S4. A 70 ff OR M OR1.1 – M OR71 (T S5); 24 ORF, (M OR38) TMD 13 TMD. I , M OR1.1, -3.1 -71 M OR1 (BAG71414.1), M OR3 (BAG71423.2) M OR2 (BAG71415.1) , fi *M. separata* OR OR (M ., 2008).

T OR M OR4 B OR3, M OR1, A OR4, S OR21 S OR29, (L , 2015; ., 2014) OR (M OR71, H OR2, S OR2 B OR2) (F . 8). A OR T S6.

E IR , GR SNMP fi (T S7 S8). 3 8 IR ORF 7 8 IR (73–97%) .

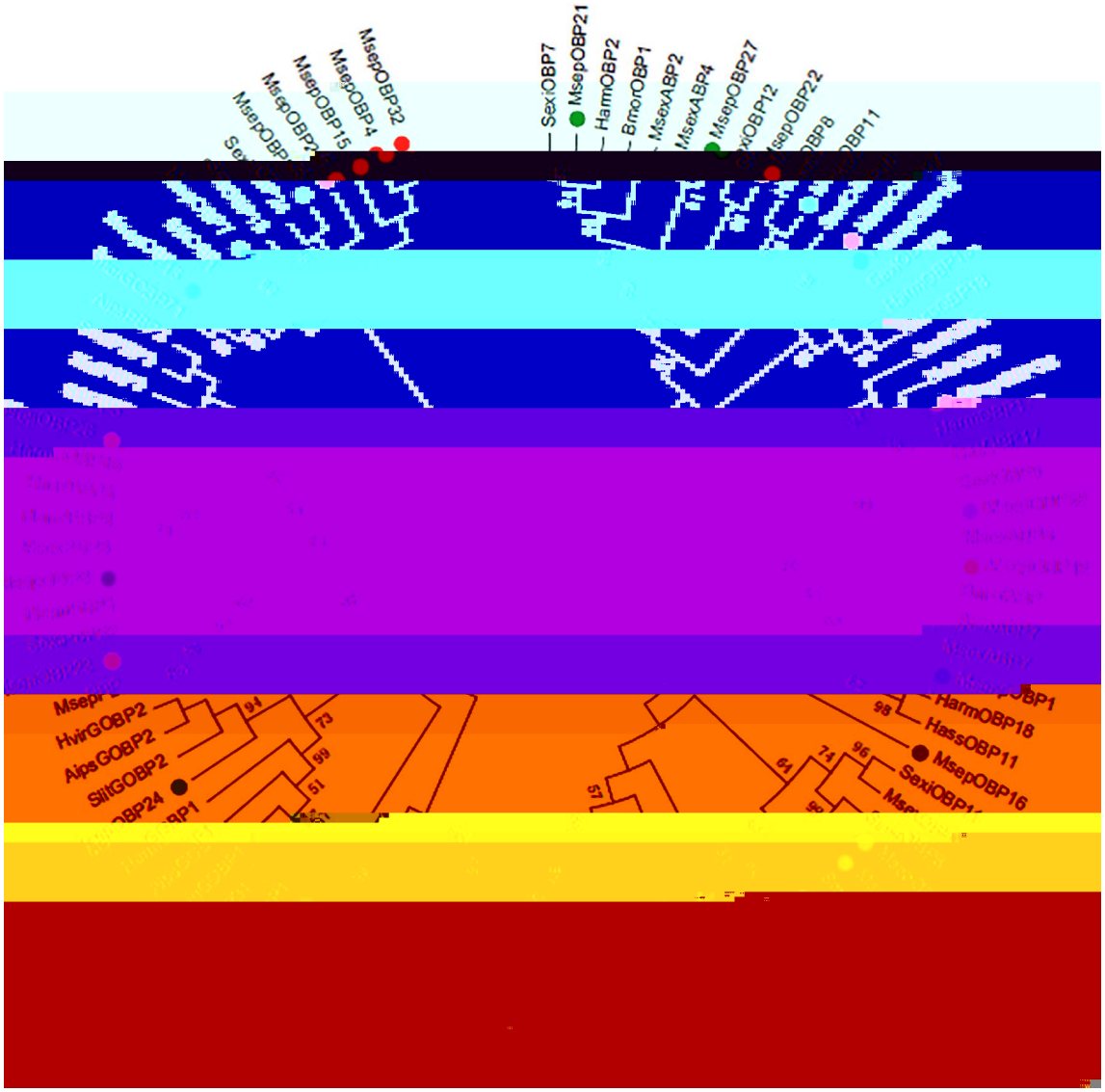

Fig. 5. P OBP *M. separata* . B M -C OBP OBP *M. separata* , OBP *M. separata*. (F fi , .)

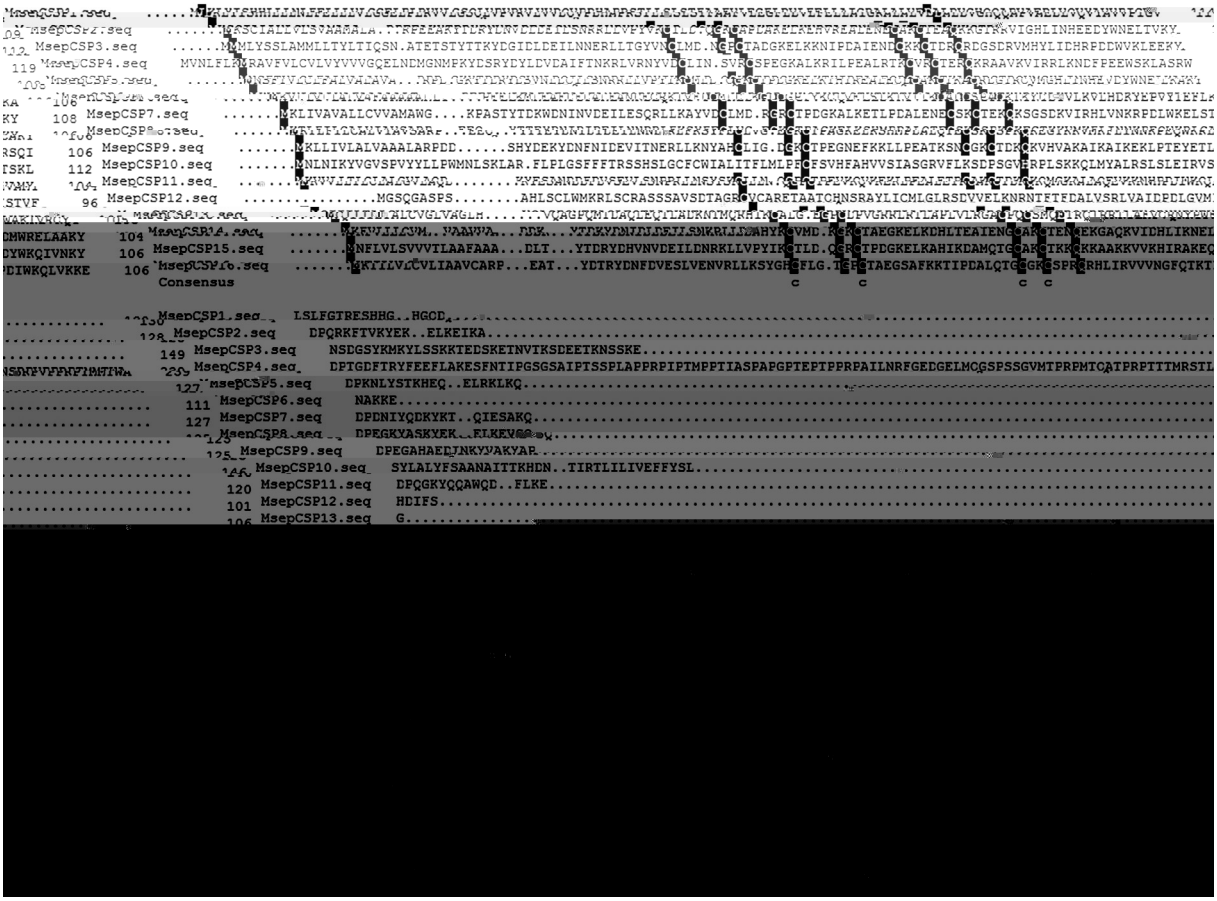

Fig. 6. A CSP *M. separata*. F C .

M GR1 SNMP1 *M. seprata* 93 98% N .

3.6. Expression patterns

T *MsepOBP5, -7, -22, -24 -26* fi ( ), , , . *MsepOBP20* , *MsepOBP19* , 0- - (F . 9; F . S1).

E *MsepOBP24*, *MsepOBP* ff - . F , *MsepOBP5 -19* fi 0- 5- - (*P* < 0.05), *MsepOBP26* fi 1- - (*P* < 0.05). F , *MsepOBP19* fi 0- - (*P* < 0.05), *MsepOBP5, -22, -7 -26* fi 1- 3- - (*P* < 0.05) (F . 9). F *MsepOBP19*, fi 0- - ( ), , , (F . S1).

W , *MsepOBP5* - 0- 5- - , 1- 3- - , fi *MsepOBP7, 20, 24 26*. W *MsepOBP22* 0- 5- - , - 3- - .

4. Discussion

A 130 fi , 32 OBP , 16 CSP , 71 OR , 8 IR , 1 GR 2 SNMP . E OBP23, OR1.1, OR3.1 M OR71, 126 *M. separata*. A - *M. separata*. T fi N *Spodoptera littoralis* 26 OBP , 36 OR , 5 GR (J -J ., 2012), *H. armigera* 26 OBP, 12 CSP , 47 OR , 12 IR 2 SNMP (L ., 2012), *Sesamia inferens* 24 OBP , 24 CSP , 39 OR , 3 IR 2 SNMP (., 2013) *Athetis dissimilis* 60 OR 12 IR (D ., 2016). T fi *M. separata* , OBP , ffi (K ., 2006; L ., 2012).

A *M. separata* H , OBP *M. separata* , H A N (T 2). T (M ., 2008). I *OBPs* ff - . T *Cnaphalocrocis medinalis* (., 2013) *Nilaparvata lugens* (., 2014), 24 OBP *S. littoralis* (M ., 2008) *Plutella xylostella* (., 2009) . W , *MsepOBP5* - 0- 5- - , 1- 3- - , fi *MsepOBP7, 20, 24 26*. *MsepOBP22*

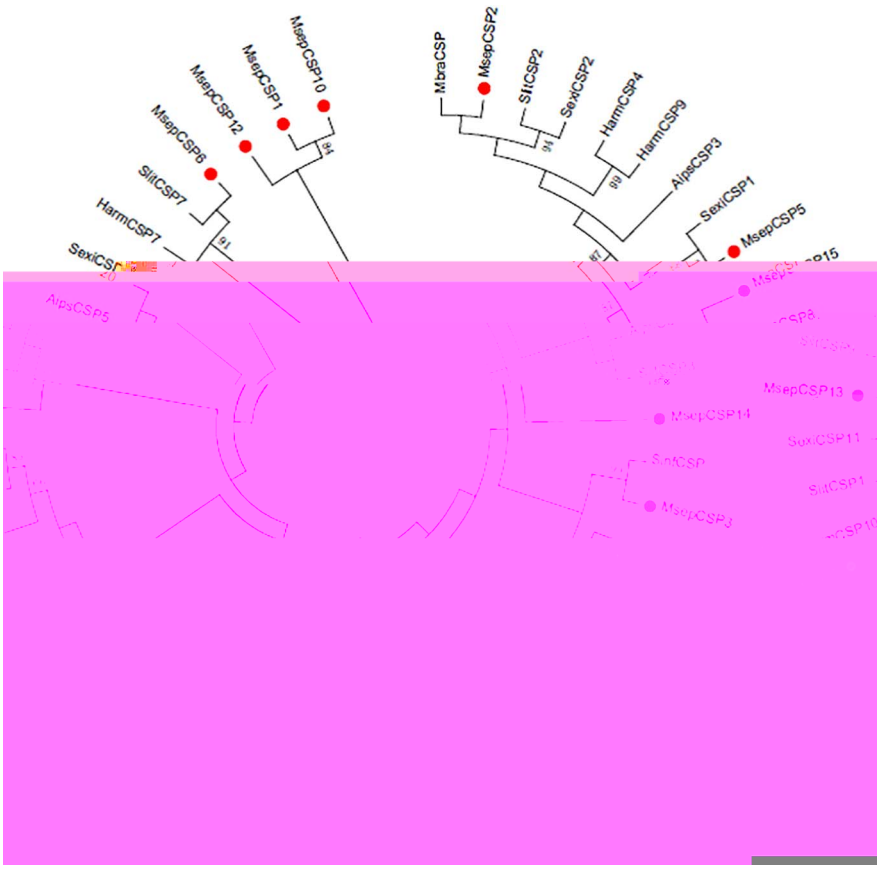

Fig. 7. P CSP *M. separata* . R CSP *M. separata*. (F fi , .)

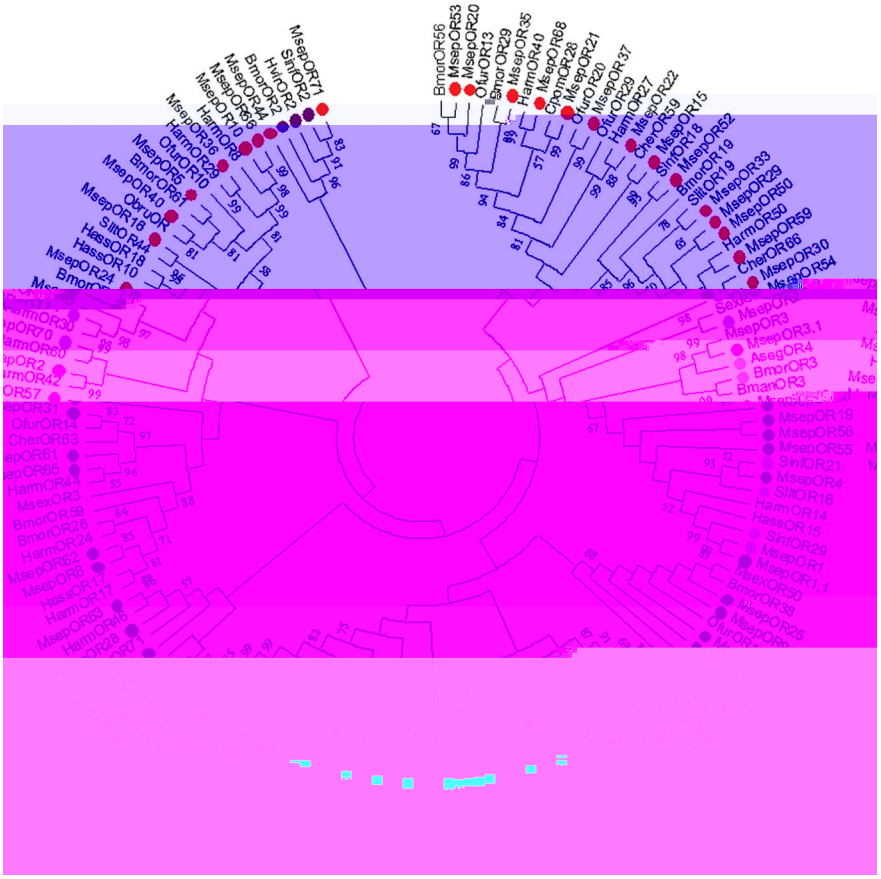

Fig. 8. P OR *M. separata* . R OR *M. separata*, P R (PR) OR . (F fi , .)

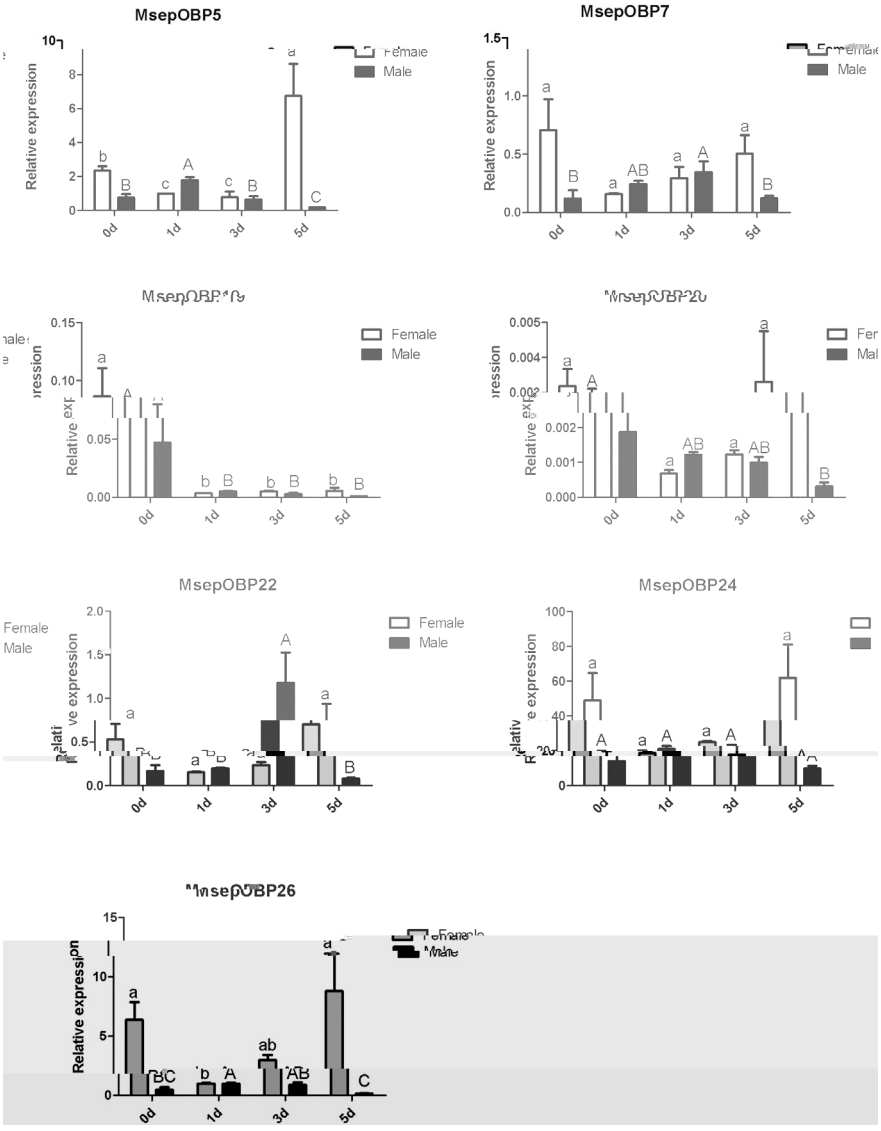

Fig. 9. R fi *M. separata* OBP ff - .N : 0 , 1 , 3 , 5 0, 1, 3 5- . T fi ff , , *P* < 0.05. T F . S1.

(C ., 2010; ., 2015).
GR
, , (S ., 2001; S ., 2011). H , GR
, , *B. mori* (S ., 2011), *S. littoralis* (J -J ., 2012), *A. dissimilis* (D ., 2016) *Eogystia hippophaecolus* (H ., 2016). W fi GR *M. separata*, fi GR
.
SNMP , -
- fi OSN ,
(N V , 2008). T fi SNMP *M. separata* ≥ 80% SNMP ,
(., 2013; L ., 2015).

5. Conclusion

T *M. separata*
130 fi . T
PCR OBP fi
. T -
M. separata.

Acknowledgments

T P W P V
M A (201403031).

Appendix A. Supplementary data

S :// .
. /10.1016/V .2017.03.001.

References

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D ff -
fi
Sesamia inferens (W). PL S O 8, 69715.
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