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RE EARCH AR ICLE

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G n i i y K n in - i n n M i 2017

P il ml ili y i n i - in i li P i y (*C* _ _ _) i n i im in in mn . D i ini n ili y, ml l m ni m in i m in l i n l limi . i y n i in- l n n m- i i n i in n in n DNA m yl in n n i li n ili y in i m ml l in m in. n l l mn ili y min y i l y ml l n ly i. G m n i i n in ili y i n l mn (II n III) i m i im imn in ml . QPCR ini n n in i n n ili n ili in n : _ , n *c* . G n in _ , ly in i- l i il *c* ili y i - in n i n ini n III. DNA m yl in n n in i- y i l n in . B n ili n ili y , n i n in l m yl in l l m in i i l l i i n n : ini n ly i m yl in l i 2284 in *c* in ili y i i - in i n . i y in i _ , n *c* mi l y l in i l il in ili *C.* _ . G n i n l l y m yl in n i in i i l l , i i - l n n i n ll l DNA m yl in l l.

y s i l i P i l ili y G n i n DNA m yl i n *C* _ _ _

r o io

ili i i n i n i n y in P i y (*C* _ _ _) im in - mn . i i n l m m i mn i i l ml n l ili y. i n in m n i mi n i n i l ll i n n y m n l l mn m i n i n (All n n D nin 1986; G ni -G l. 2002). B i , i l im m ili y i - in i i (i. . mm) n limi i n in i i l , in li l in n i n l n i i iy (N m n l. 2008). C n i in ll n , i l i y il ly l in i n n i A, A - li , C in , F n n C il (G 2004; H l. 2009; N ll 2002).

D i n n l ili y in i l i , m ni m in i m in l i . P i - i in n i l i l in l i i n l m m in i l i y i - in m m i n n ll i i i n n n l in l m n i (J l. 2010; Q l. 1997). B i l i l i n nn n l n n i n m l l m ni m l m . D illy l. (2014) n m- n i n i m lin in i l i n i l i

y , lin n m i n n ,
i i n m n l in m i n in m l l
m ni m. H , y in n n i
n im n i .
A in- l n n l n in
C. _ i m y n n i n i l .
G n in l in n l l m n -
n n i n . B i , n n i in
min i n l n i D illy l.
(2014) im li n n i l im i
m n i . Fin lly, i l n n (*C -D_ 1, C -*
2, C - , C -c , _ n *c*)
l min i n n n l l m n
n n i n in i m l l
m ni m n il in *C.* _ .
I i ll n n n il in i l i
in l n i n n , n i in n
i n, i n ly n -
l ? E l y n , n i n
i l n ll y i n i m i i n DNA
m yl i n, RNA in n n n (C n 2007;
m i l. 2010). An in in n m i

J P im n l im n i i PCR

G n	P im	n (5′-3′)
	EF	ACCACCC GG GAGA CAAG
	EF	ACGACGA CGCA C C
C -D_ 1	DM	CCA GGAG GG G CCGC
	DMA B	G GCC C GC A CAGGG
C - 2	F l2 2	AA A CAGGGA GGGCACAA
	F l2A 1	G CC GGG GCAGGAAC A
C -	E PCR 1	GCCA CAAGGAGAAAACGA
	E PCRA 1	G AAGAGC GG CCAGGA G
C -c	AG J/ n/A l (BDC1.92799997 0 ( ) JEMC(A)25(GG)8) J0 n/A m n n ( )BDC2.0150001 0 n( ) JEMC(A)25(CC) J/	

n ly n i n (Li n mi n 2001). l i mRNA l l n m li EF n i in ll in m l , N = 100 * 2^(C EF C C - n).

is o i i p ys is p i p ys is

G n mi DNA m m i RNA i l i n in m i n l l m - l (Li l. 2006). DNA n n i n n i n N n D (m Fi i n i) n in i y y l l i . n n n - m n mi DNA i l -m i y M - yl m DNA M i i n Ki (EPIGEN EK), in l mm n y m n . All i n i n l i n m il l n i n m in (m n n in i n n ll in 100 i in in i n, 2000 100) n ll n in nlin M P im i n (:// . n . /m im /in 1. ml).

Bi l PCR (B -PCR) im i n n i l -m i DNA m li y C G i l n (l 2). All PCR n 1.5% l, i in nP C l m DNA G l E i n Ki (n n, C in) n n l n . n i- i m in n l ni m l n in Bi Dy min Cy l n in Ki (. 3.1, A li Bi y m) n n ABI PRI M 3730 (A li Bi y m) m i n . A i l - m n , nm yl y in min il il 5-m yl y in m in n n . B n i i i , m yl i n l min . C n- i in y in n C G in l i i l y nm yl , i n y i l m i i n l l y n m y in n il i i y l n m y in .

s s

is o i p ys is o i i p i i ys s

In *C. _* , n i i n i n m l in in in nn i i , n i i y m. E n i n n l l in n l i ly in y li l m n n i . G n n i i n y i l i l n ly i in B lin l. (2001). m l i 8 m n II n l l m n (Fi . 1), il i 10 m n III (Fi . 2). Di n in m - n i l i n i l i n i l i y i i l i i i in i m n i. All 34 i l i m l ll i ni n

M l n m l m n i II in i l i n i- l i C. _ . F m l in min l lin m ni (O) i ll ni y (O) i ( ) i ( ) l { , - _ .)/ { ,) n l i i l i n i l i y ,

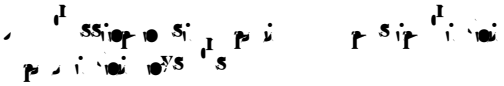
i y. M l i i in l min l lin in l in m ni ( ), m y (c) n m i ( ) i ( ) i ( ) l in n i l i n i l i y , - i y. C n L n i i

in in n l l m n, i min - n in J l. (2010).

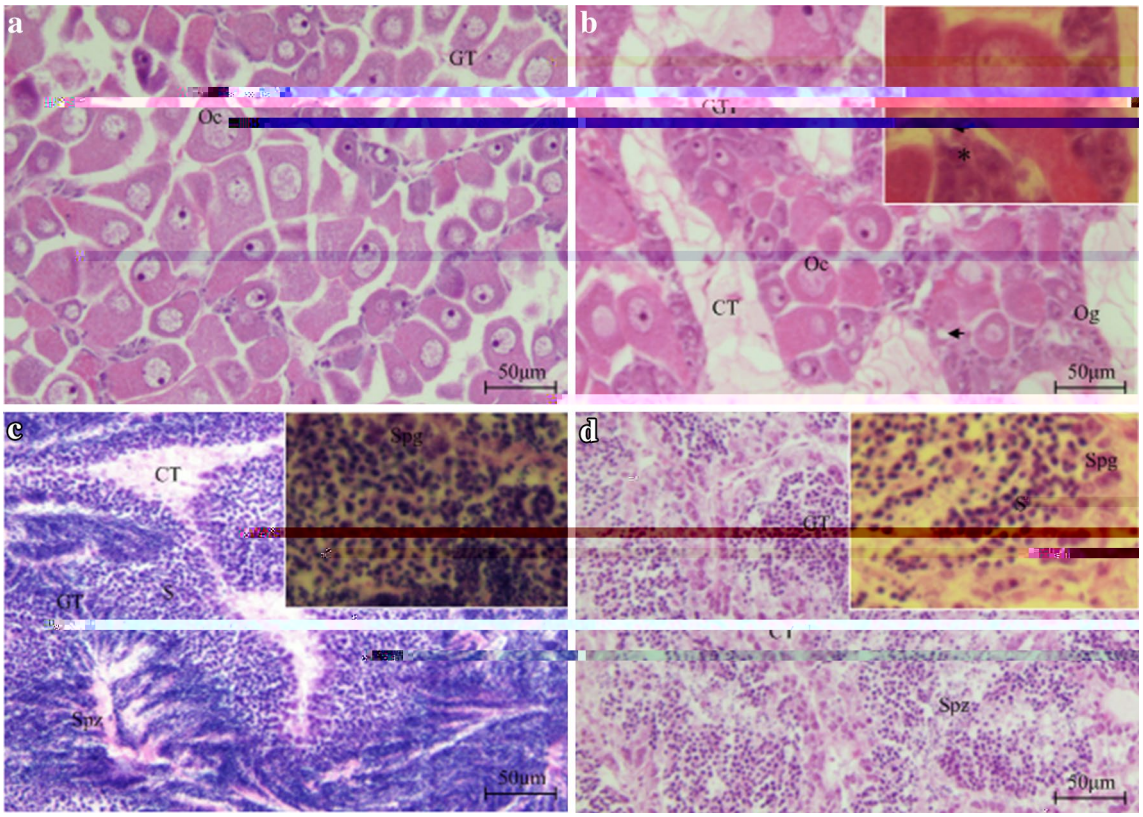
II i i i i ll n i in m l n n l min l lin in m l . A i , min i n i l i l i n i l i y . Di l i m l (Fi . 1) n - ni (O) n i ll ni y (O) i n in- ili n l l il i l i min l lin- i l n l i (Fi . 1). B i l i (Fi . 1) n i l i (Fi . 1) m l in II n min l ll lin in l in m ni ( ), - m y ( ) n m i ( ) il m mi- n l ll in i l i l m n i n l in n .

III n i n n inin m inly m y m . Di l i m l y (Fi . 2) ly n l in , llin n l l . In i l i i n (Fi . 2), m m l y n l n m i l in n in n l i min l ll . O i n in i l i y n n in m min l ll lin i m ni n i ll ni y i i min

2 n in J l. (2010). In m l y , n in m min l ll lin i l m L i y m i n m in i l i n i l i . In i l i m l (Fi . 2), n n l l ll m m , i l i (Fi . 2) n n m m m n n l n- in l n L n i i n i- l i m l .



i n l min i n n n l l- m n (*C -D_ 1, C - 2, C - , C --c* , _ n c) n n i n . B n n n n l l m n, ll m- l l i in : i n II (O . II), i n III (O . III), i l II (. II) n i l III (. III). i- i n n i n n l l m n in i l i n i l i y n in Fi . 3.



i M l n m l m m n i in i l i
n i l i C. _ . Di l i m l n n l l (G)
ll m m , i l i . i i l in n
(l n l i:_ ; l y l mi :_). Di l i
ml n n l l ll m m i -
li i i l ( ). C nLn i i ; O ni ;
cO y ; m ni ; m i ; m

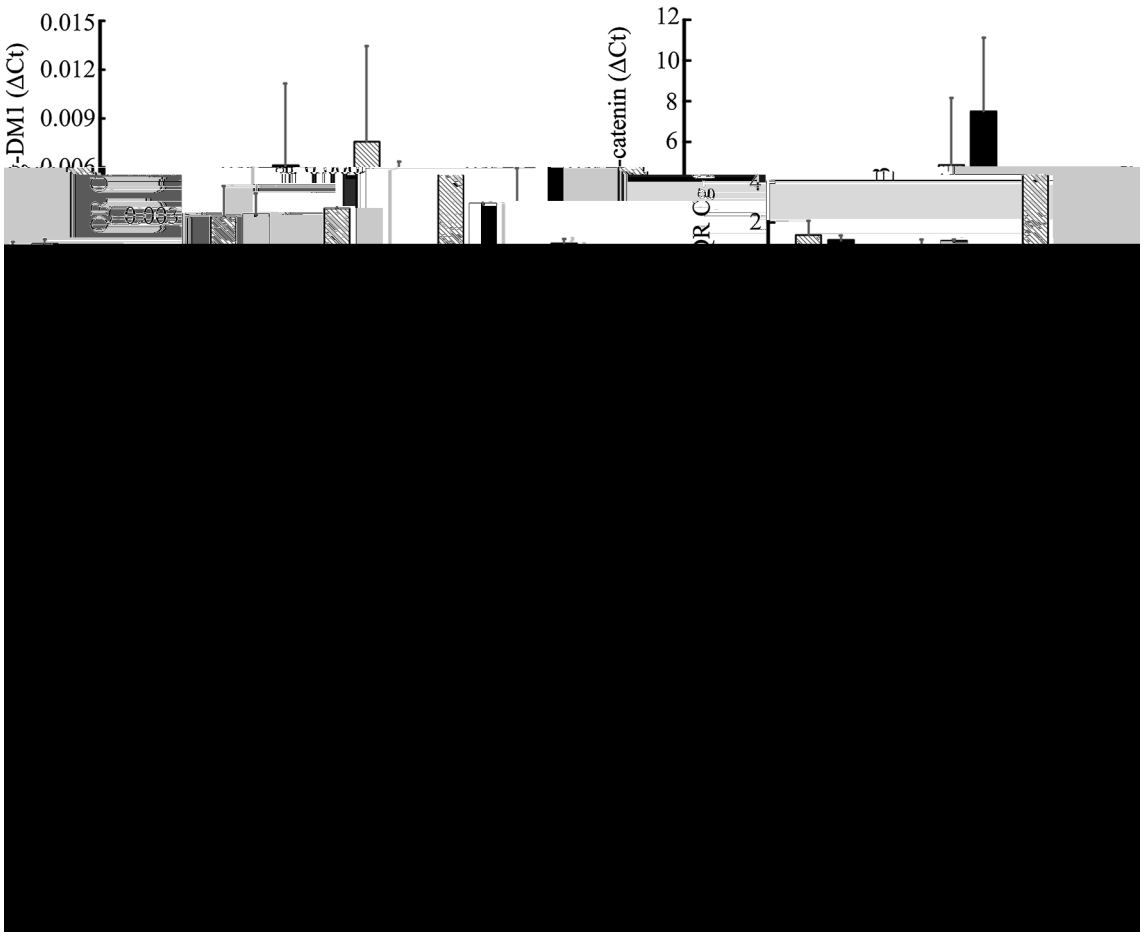
In ll n , nly n i l y ini n i -
in n i l i n i l i y : _ .
in l m n II n c in l -
m n III. F i n n ,
m in i i l in niy
n i n n l ll i m l (in l -
in i) i n in l 3 i
n m y. l l y m -
ni m in n i n, DNA m yl i n in
n n ly in ll in .

y i p y o i s o i i o p

In l in y i l m i -
in , y in n i n
n C G in l i min . n in
l lm ll y in mi-
lly n il i in y 99%.
i n i n in y in i li i y
i l m i i n n n y l -
l in l .

N - y i o p y s i s o , p I p y I ss, p s

DNA m yl i n n ly i n n n
(_ , in l m n II n c
in l m n III) i i n ly
in i l i n i l i y . i C G i l n
n in _ , i n in i m
i n (213 97) n in n (n 5, 7, 8, 9,
13). In c , nly C G i l n n in n
(i l n in n 1 n n in n 2, 6, 10) n
n n n in i m in.
l 2 im n m li y C G
i l n . in ER-C G2 i l n i l n -
lly m li y n l n , i m li in im-
. in i l m i i n n n in , DNA
m yl i n n ll C G i l n -
i n l i n in l 4. F _ ,
DNA m yl i n ly in l i
C G i l n i lm ll y in n -
il. l m yl i n n i n in i l i n
i l i y in i i n n in. F
c , C G i l n (ER-CG4 n ER-CG5) l in



R l im R -PCR n i n i i n l i l n- il II, . il III, l i n i y, i n in l m n l i l i n i l i y- i y n i . l m n EM i li . . i n II, . i n III, .

R l im R -PCR n i n i i n l i l n i n in _ n c

m l ID	_		c	
	i	Di	i	Di
1	0.0850	11.3446	0.0069	0.0014
2	0.0380	6.3813	0.0034	0.0016
3	0.0531	3.9370	0.0036	0.0024
4	0.0236	3.6503	0.0085	0.0011
5	0.0130	7.0858	0.0050	0.0017
6	0.0642	6.7123	0.0071	0.0009
A	0.0461 0.0225	6.5186 2.3470	0.0057 0.0017	0.0015 0.0004

N = 100 * 2^(C EF CC - n)

n 6 n 10 i ly m yl , il in i l i (95.47%), i n n i ni n . il n ly m yl . m yl i n n D i imil i y m yl i n l l n ER-CG4 imil n i l i n i l i y i l i n i l i y , l i n DNA m yl- i n m yl i n l l 96.67% (Fi . 4). i n i i n: i C G l i ll imil i ER-CG4, y in in C G in l i m yl in i l i il in i l i, m l i lm m yl in ER-CG5 (Fi . 5). m yl- nm yl , n i i i n in i n l l in i l i (96.90%) li l i n l C G l i; l i 2284, m yl i n in

.T , DNA m yl in n l l _ , n c in i l i n i l i y

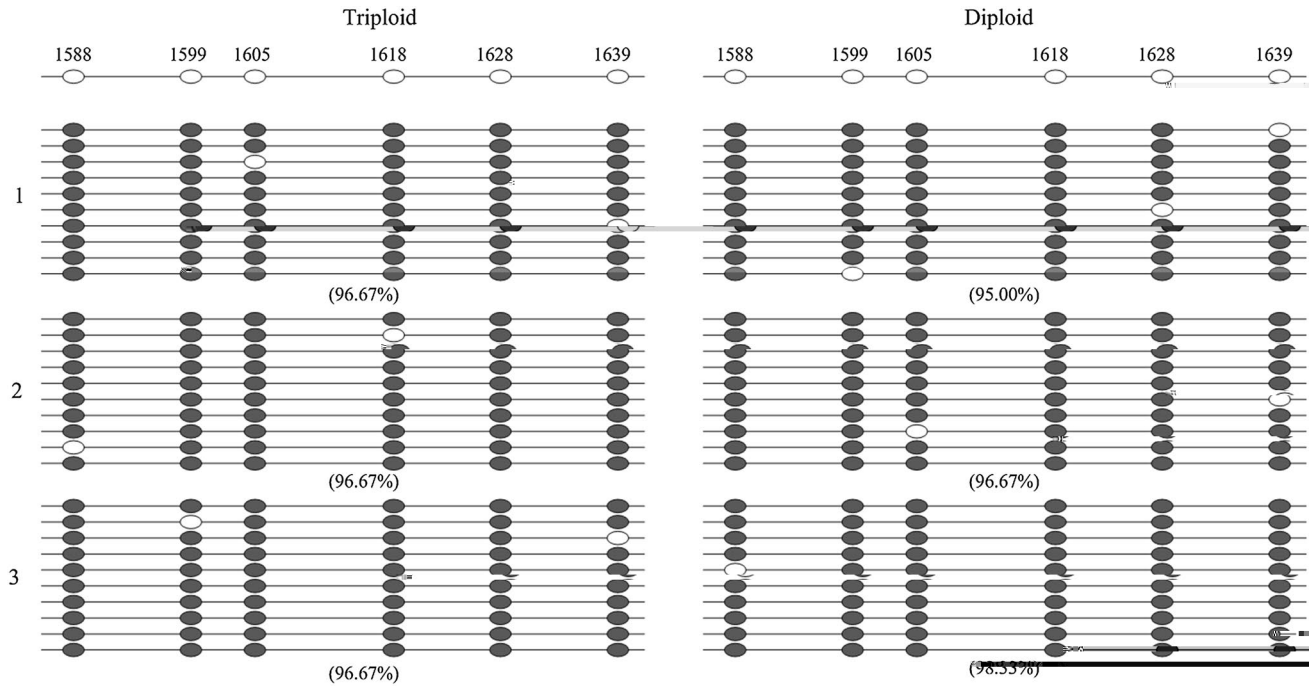
C G i l n ID	i (%)	Di (%)
-CG1	1.11	2.22
-CG2	0.91	0.91
-CG3	3.00	2.00
-CG4	2.86	3.57
-CG5	0.00	0.91
-CG6	1.81	2.73
ER-CG1	0.00	0.00
ER-CG2	3.08	3.85
ER-CG3	3.33	1.67
ER-CG4	96.67	96.67
ER-CG5	96.90	95.47

i l i i n i n l y i n i n i l i i i n n i n i n i n n i l i n i l i .

! is ssi

i l i nim l n lly n i il i n il m . In *C.* _ , y m ni n i y J l. (2010): - n, in n n m i lm m n i y i l i n - n, i i - i i l m n i n nly m m l l m i y. All i l i y in in i y - n i i mm n n m n n in - n - n i m l in n . Hi l i- l in in i y m n i m m i in m l n m l i i in n i J l. (2010). H , in in im n n i l i n i l i y , i l i m l m ny n i l i m l (G 2004). C n i in li lly - n m n n, l in y y i l i m l mi m il n m y i l i m l .

i ll nin( ) i y l in i i n i n in ly l m n m y- ni l m n. ^{p} _ , n nly in m l y n n in m l . In i l i y , in i n l y . A II, ^{p} _ - , ly in i l i i i i ni n ly l n in i l i m l , , III, in in i ly n m - in l l i i l i . l y in ^{p} _ ,



. DNA m yl in n ER-CG4 (n 6) in i - i n i l i y in III. in i l li in i C G i l n c in in. i n y . n m ni n i y J l. (2010): - n, in n n m i lm m n i y i l i n - n, i i - i i l m n i n nly m m l l m i y. All i l i y in in i y - n i i mm n n m n n in - n - n i m l in n . Hi l i- l in in i y m n i m m i in m l n m l i i in n i J l. (2010). H , in in im n n i l i n i l i y , i l i m l m ny n i l i m l (G 2004). C n i in li lly - n m n n, l in y y i l i m l mi m il n m y i l i m l . i ll nin( ) i y l in i i n i n in ly l m n m y- ni l m n. ^{p} _ , n nly in m l y n n in m l . In i l i y , in i n l y . A II, ^{p} _ - , ly in i l i i i i ni n ly l n in i l i m l , , III, in in i ly n m - in l l i i l i . l y in ^{p} _ , . , . c c n m yl n nm yl i , i ly. _ c , n n n l n. n- in i m yl in l l(, ,), l l n m m yl C i i y l n m C in ll C G i

mi in l y yn i y l in n n l. infl n m n i .

n (ER) i m m n l mily, i l in n n l i n m in in n . F n i n ER i l ly li in - (P l l. 1991). H , li l n n in in , i lly in m ll . In n y , n in in n m y i n i , i n lin y n n i n i n i n n l i i m i ni n ER in i n n . i in ll i in ll m y i i i n ER in l m i n (n n C ll 2003, 2007). N - l , in in in i n n l i n in n - i n n n n n ER n n in *A* _ *c* . . . . *c* (n n l. 2003), *c* _ . (K y

P i i in *C.* _ ii n n i l i n (Ol n n R 2014; Ri i l. 2013). In y, i n ly n (_) n i l i n i l i n im DNA m yl i n l l, i in i DNA m yl i n mi n l i n in m n . In *c* , , i imil l m - yl i n l l, m yl i n n in in i i ll n i n n i n i n. i i in min n n ly l m yl i n l l l in i i ll in i .

i y y n m N i n l N l i n F n i n C in (31372524), n n P L , n n n P in (2014GH; 115002).

Q n Ji n l n n - fli in . Qi Li l n nfli in . H n l n nfli in . Lin n K n l n nfli in .

n in n ny i l i n i nim l .

All n K, D nin L (1986) P m n i l i P i y - , *C* _ _ (n). I. i l, , ly- n n n, n l m i n in y lin . J E M Bi l E l 102:197 208

B lin CH, L in y J, E in J, M in O, H n n G, M i M, K lln K (2001) n i - y in *C* _ _ m i n in (N m n y n A l n i , F n). In R D 40:79 86

C n J (2007) G n i n i n i m ni m n - i n n n y i i i n in l n ly l i . Ann R Pl n Bi l 58:377 406

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G ni -G PH, N i i-G n ; B i , M l A, H l M, K l G, H in A, G A (2002) Infl n i - l i y, n n n i i y n P i y *C* _ _ in n in n l n i n- m n . M l E l 11:1499 1514

G (2004) Oy in n i n l y. B ll A A C n 104:26 33

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J A, H -B lin C, in P, M i M, K lln K (2010) G m ni in i l i y *C* _ _ _ : i l l in ni l li i n n n - i . J E M Bi l E l 395:162 170

K y J, B i m J , n n J (2006) O l- i n i n i i n i i n l i - : l i n y n n i n l im li i n. En in l y 147:3861 3869

Li Q, ; H, ; R (2006) G n i i ili y y mi - lli in l l i n P i y (*C* _ _) in C in . A l 259:95 102

Li KJ, mi n D (2001) An ly i l i n i n in l- im n i i PCR n 2 C m . M 25:402 408

M m , N m AM, M i K, A iy m I, Hi H, - i ; (2007) Oy n : DNA l nin n imm n l li i n. G n C m En in l 151:195 201

N imi A, M in A- , M-L, Di B, M i M, in P (2009) M l l l nin n n i n *C* - *2* in l m n n l m n i y l in y *C* _ _ _ . C m Bi m P y B 154:134 142

N imi A, M in A- , M-L, M A, Di B, M i M, in P (2009) I n i i n n i n DM mily in y *C* _ _ _ . C m Bi m P y A 152:189 196

N ll JA (2002) F min i l i y . A l 210:69 88

N m n J, L P nn M, B y P (2008) C m i i l i- l y m n i in i l i n i l i P i y (*C* _ _ _) in n in min i in F n in 2003 . A l 282:124 129

O n M, B ll D , H DA, Li E (1999) DNA m yl n Dnm 3 n Dnm 3 n i l n m yl i n n m mm li n l m n . C ll 99:247 257

Ol n CE, R B (2014) G n m - i lin DNA m - yl i n n n i n in *C* _ _ _ m l m . F n P y i 15:1 7

P l F, F n , L G F, L M nn F, l i ; (1991) In i n in i n i n mRNA n - l i n i i ll nin mRNA in in . M l C ll En in l 75:205 212

P in n AM, L i P, Hill EM, O M, Ki i M, N R, N ill A, C ll IP, R ll JM (2006) L y 17 - i l il in i ll nin n n n i n in m in in _ - . A i l 79:376 383

Q H, G , n F, All n K (1997) C m m - i n in ili m i l i P i y , *C* _ _ _ (n), ll in in i i i n l y 1. Bi l B ll 193:14 19

R n l , F y N, B - l mi , M K (2011) - i n i y i i n(H) n l im PCR l i n i l n i n in P i y , *C* - _ _ _ , ll n i O i i 1. D C m Imm n l 35:725 735

Ri i G, G-C, F ll A, G D, in P, F l P (2013) DNA m yl i n i i l ly l m n in Oy *C.* _ . M Bi n l 15:739 753

n C, in P, A lin B, M in A- (2014) *C* - n *C* --*c* , n n i l - minin y in m i l n, P i y *C* _ _ _ . C m Bi m P y A 167:68 76

m i M, N, B n m B (2010) DNA m yl i n l - l in 5′ fl n in i n i ll nin I n in li

n in l (D) n i i - n n 17- inyl i l . A i l 98:275 281
n n J , N E, C D (2003) R in n l i : n i n i in n i n lin . i n 301:1714 1717
n CD, C ll RP (2003) E i n in i m l in ll , _ c c _ _ c . In R D 44:89 100
n C, C ll RP (2007) E n in in i in ll : i i n n i l in l m n in i - l i n. C m Bi m P y B 148:303 313
n A; ; F, n P, Li J, DD, H, M D; , n PJ (2014) C G m yl i n m l n y 19 m in l - i n i l im i i n in J n fl n- _ _ c c . J Fi Bi l 84:193 205
n , ; i J, n n A, C , C n L, C n H, H n- n IR, inn P, P ll ini M, J n E, E JR (2006) G n m - i i - l i n m in n n i n l n ly i DNA m yl i n in A . C ll 126:1189 1201