ΤΕΧΝΟΛΟΓΙΚΟ ΕΚΠΑΙΔΕΥΤΙΚΟ ΙΔΡΥΜΑ ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ

ΣΧΟΛΗ ΤΕΧΝΟΛΟΓΙΑΣ ΓΕΩΠΟΝΙΑΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΡΟΦΙΜΩΝ ΚΑΙ ΔΙΑΤΡΟΦΗΣ

ΤΜΗΜΑ ΤΕΧΝΟΛΟΓΙΑΣ ΑΛΙΕΙΑΣ-ΥΔΑΤΟΚΑΛΛΙΕΡΓΕΙΩΝ

ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ

«Πειραματική εκτροφή της γαρίδας *Palaemon adspersus* σε κλειστό σύστημα εκτροφής χρησιμοποιώντας ως σιτηρέσιο εναλλακτική πηγή προέλευσης πρωτεΐνης»

Πολυξένη Ζώτου

Δρ Νικόλαος Βλάχος

Μεσολόγγι 2018

στην οικογένειά μου

Ευχαριστίες

,.0..031&00'0$120'12 #-EE #
1#12 .3&TE.E1.0E2 2&0!1.þ
E2 CE 2'0.2./#.2&2. 2 #'1#CE2.1
#$122+6). ýE&2C#$0!1."
.20CE2 12?.CE)12.2.)120E#.2.0CE2
. /1.21#CE2.1E#/0012)E&)E#.¶2
/0.0)E'2C#$0!1.'"+20#.!E #/&10
.0!1:2 #)..#22.$
#$12 + 2 #" 1 ú.2 . CE ú1.*
E!.2! 22'0 002.12" 02CTE1# #"
$0"#CE00" . . 2 0/.3! E 0CE . .2 2 / 0.
/0.&2&CE2&.2&1E#/-#
#$122 3 .1#3 22 12.002) # .2 ./ 20
0. E # CE300.2 2 0.212.1 2&CE2& . . .
2%#$#CE2!¶2/0.2 #CE2 "
#$122 1#3 22 . 3 ,0 $* 12. . 2 ./ 20
0. E # CE300.2 2 /0. 0)E'2'C#$0!1."
..20#E#CE1.0.22/0./00.2&/0.2 %+
"0#$122 0 # . 2 .12 1#CE2.1
1#013 ! .2.)1.. $¶2 $)/12.2&1E#/-#

Περιεχόμενα

ΠΕΡΙΛΗΨΗ

þ/. *Palaemon adspersus* 0../0Œ.!0/'2 Œ0
12 .11. 01 # .Œ#10 .# 0Œ0/.3!
122 Œ&.
)Œ2Œ'.0!12!2#$0!1.0..00210
2 .2# 2 .2.&1 2!3". 2 0&1 2".1." *Palaemon adspersus* 10 1#0".$&1."$ 1 Œ."&'2!3"1Œ 12.
Œ0.2.212.12 #$0#!#.)Œ .
÷2 /0.& 2 # Œ2 "$ Œ .1"1 #
!#" “ g .1 # #“ cm Œ2 Œ2. .
/. 2 . 10 .2 # ..Œ# ..1 * 10 2! 1#12.2.
0Œ$ Œ'0!'1# *) # 250 L 2. Œ#Œ2!2..)Œ
32!2Œ sump 0 1'12. .Œ0 2. .)Œ!0#/0. &3 #
) # 50 L 0 2. .2!3. 2 # ÷2".0" 2 # Œ2 " .1"
/.&12. 10 20'.2!3"/0"2 . /.)Œ23 2. 0
1Œ2 #1 #2 '#.1.')Œ&20a2.2.120
10/.3 02 0Œ. 0 2 . 2& 0/+ *Tenebrio molitor, Hermetia illucens, Musca domestica.*

þ0!!1. . ..2)22. /.2! 12.0'.¶) 2
/0.2 #Œ2 '12 #" 25°C . 30 ppt.212 $
..Œ01.2.2 #Œ2 '0.)2 .102 #0/ #" *Palaemon adspersus* (SGR) . .2.&1
2!3')2./.23 2.0 2. 121. 2 #02) # *Hermetia illucens* . 2 #
02) # *Musca domestica* *Tenebrio molitor.* 0&1
Œ#1.1. .10Œ/.23 2.02!3 Œ0$2 2 *Hermetia illucens* . 2. 10 .201 0 2"#)Œ/.2!3" /0"Œ
Œ#1.1.2)200&1

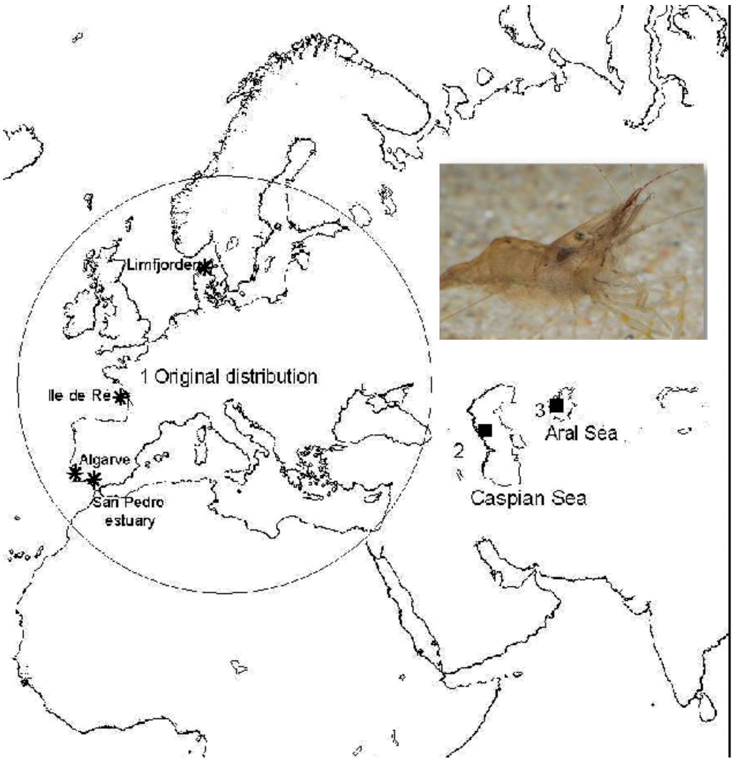
Λέξεις κλειδιά: *Palaemon adspersus,* /.2!3 0/)"#)".Œ# "
0&1.2.&12!32 .

ΚΕΦΑΛΑΙΟ ΠΡΩΤΟ

ΕΙΣΑΓΩΓΗ

1.1.Οικολογία του είδους *Palaemon adspersus*

þ. *Palaemon adspersus* .012./0Œ.!0/ .0 12.
..0! -2 m) 2)0."2".11.".1201)0 .11.
ü #"$0!*0"02..1200 10 Œ$0 0 "
(Hagerman & Ostrup Œ .Œ2. .)Œ.Œ0"0210"./+
Cymadocea nodoca . *Zostera marina* (Glamuzina *et al*. 2014).
Guerao & Abello, ..3!#)2 ./0".#2 *2 # 0/ #"
/!12!Œ2. 2 .2"/"0#2) "!1)" 10.201
0 2"&"0")Œ .1 2. . ! *2. .01. 12 .1Œ
Œ02/+ #) 10Œ$2".11."0Œ.3#2/121 þ
.2/!12 #.#21#01301 2Œ2.1.2"/..")Œ#2")&."
Œ0.2 .!21Œ Cabral & Costa 2001).



)i 0&!3 0Œ1 2". /." *Palaemon adspersus* (www. genustraithandbook.org.uk)

3&.02 Guerao & Ribera, (1995) 123 10 12 #"
10 C 2 . -0!#! . 12 #" C 2 #12 0!!1. 12
.11. 2'01 .'30 2 #" -12 C 2 #" 0!'0". 24-
26 C 2 #0!" 013&.0 2 #" Hotos & Avramidou 1
0!!1. 12 01 . #.02.)E C &" C Janas et al.
..3!#)2 12)0. .2 ,.11. 021. 0!!1.
#.0 2..)E C &" C.

E .!. *Palaemon adspersus*, E#10 .#
E!12)22. 10 ..2)220" 0.200".)E 45 ppt)&'0E. 10
)200" ..2) 220" (5-8 ppt E#1 2." .# . /.! ..E
(Conices et al., 1992).

Berglund (1985. Conides *et al* 02. 2#
0# 2 .)0 .1 , .212 $..3!#)2 .!.
Palaemon adspersus E#10 .# 0$ 02..120#2
/!12)22. .2 2 E/ ..&" 0.2."2& 0!!1.+
02. + (Hagerman & Ostrup, 1980). 02. ".#2"12 01)0
.11.0.2 02 #". .!3 &E!'0"0-2.
2 $.&2.$"'!" -E

1.2. Διατροφικές συνήθειες του είδους *Palaemon adspersus*

1.2.1. Διατροφικές ανάγκες στο φυσικό περιβάλλον

0/ " *Palaemon adspersus* /.2!3 $120 2. &"3 "
!1)". .102. . 1202. 2 2. .3 *1#10 . 2
2)22. Bilgin *et al.* 2009). Wickins & Lee, ..3!#)2 2.
.!0/ $12!2. .)0 /.2!3) 0*0.2.'2& 0#+
0& /.2 # 2. 1# # 12 6 . .)31 2"
2!3"

Figueras (1986 . Guerao . .3!#)2 /.2!3'2"
1#00"12 31 0 &. 12!+.. 0/ *Rissoa parva* . *Hydrobia ulvae)* *Nereidos sp*. *Har mot hoe sp*.),
/2 .&!33. 3*002)&
2 /. 02 Figueras (1986 ..30)2 2. # 2 . 2"
.!." 1 2. 10 .12.)2. 1 2. 12 ..& /. 10
.20102..102 .)/.23 2.01)20! .!0". .
02 12/ .#'12 1 2.#1 #/.3 02/.2!3
1#3 !+0. $12!2. &"3. 3* /2 .
2!$&. artemia, ./ 0!&2 .. 0$/0! . . #.2 3.
0!3#2 .&2. !1 .
.!0'#.2 # 2 2!3 # . # 0 2. 0*+
& 1#2 0.01..1# # 22!3/.1 #2'!"
2 #0!6#2..)2.$ (Martin & Davis 2001). .!0"
13&.02 #" Takeuki & Murakami (2007 12 2.12. 012."
. /.2 #) #'2 #"$1 *1%"2"2!3" .!212)
0. .200 2 0/ " *Penaeus japonicus*)/ .0"10 &20ø
#. 2..)&" 00&1#122!30 20 * 2
2)20 . 0106&20#0& &." 10%.
Takeuki & Murakami (2007 ..3!#)2 .10'2".!."
Penaeus japonicus 10#)/0.0#02 /)20 2.
0&12 ## *#2'!.2/.0 2..3!2. .0"
2 #0/ #" *Penaeus japonicus* 10)#. 2..)&'0+

.0"10 2.0" # 0 000'2& %.!+ þ0E2." C
122!30..0E22."0E//0CE21# 1 #
) " Ca/P 12. .!0/ 0E1.2) } 12 /.2!3 2 #" (Janas &
Bruska, 2010).

1.2.2. Διατροφή με εναλλακτικές πηγές πρωτεΐνης

þ0&1 2& 3#1+0E2& .#.)0 21 .1 2"
0E&"/./.1." .# 2 1 2 # $0#!# /10 2
200#2../0.02.10..210..20E20ø2.121. .+
2 .2.212.1 2"0E20ø&"0E#1"0 0..2"0E
0E20ø0E. .0 #)0E% 2 . 2& 0203)0& 0/+
.0E21) #.1# 2008).

&'0E200'0&!2. 0E2. #%'/.2!3"..".
1#&"$ 0E2. . . .#1 # 2 0E0$0 2 # 1200 1 # 10
0E20ø120E&12&%.+0E0 *1.20E22"
0E20ø

þ1 2".2.&1'&+0E2&..02. . .#0 .2
60-&2 þ1.#2..0E20201 2 #)0E#'0/ #)2
& 2!3"0. 0E#100E20"0.2."2"0E1"/.01)22."2&
3#1+0E& 2& 1#0$0& .2+02. +2 # .2.&1 *
. .1.)12 '2& 1#.2+& 2!3+)0E"2 1 0#!. 2
$0#!0.0E%).0CE01)22.2 #'12 .0.
0E1 (Makkar *et al.* 2014).

þ 0E& 1 2& #/.2 .00+ .1 2" . " . 02!3
& 0/+ /10 12 .00E1 #0E212.2&$.0& . $ 2 #"
12 #/.2 .0. þ0&1 2"/.01)22."2 # $0#!# . 2 #
$0. # .+. .1 2& 2+ 2 #" / *12 ..21
0..2+0E&'0E20ø12'$ 2!3'0E. 0E//0 12 #"
0203)0 #"!1 2212/#.2.2E# Henry *et al.* 2015).

#/} 0203)0 & !1 %!. .!0/ 12
31 23 2 . 0 2 . .&'0 2 2 # 2 2 .0E00 . 0..2
0E0E20ø Barroso *et al.* 2014).

Barroso *et al.* (2014), ..3!#)22.2 .12 %3.2 #"

#%) 12) 20'+. 0 00 2 # 1 0#!# .

)20!#2& 0#& 12&

&&.&.)!.12 .

Sanchez-Muros *et al.* (2014), ..3!#)2 .0 2&

02)&&'0..2 202.121 .2&%.!2 .

03. #.2#2./1.)..2.2/.

et al. 2011) 2. 1# # 12.1'20.'&'2 # 1201 #

(Zhao *et al.* 2010).

2) 2" 20 02)& 12" & 2!3"

.0*2.)&2" 01. 1$0..3 !102.130..2

22.2&& 2!3+

. 0/ 02)& 0. 0#&"/0/ . . $ 2. &"

0..2 20 *Hermetia illucens, Musca domestica* .

Tenebrio molitor. 3&.02 Newton *et al.* (1997) 2 2 *Hermetia illucens*

20 .$ 00 2#$&"

1#12.2)12& 2!32&%.!+

0#0' .20!#2$ 2&2 -0#&

12.121.2&/0&.!0/+!0'12.2#.0&1

2 #" &12)1 ./0.$020' .002 2/.2!3

..2&02)&12./0.!0/

1.3. Σκοπός της πτυχιακής εργασίας

)2"0!1."0. . 00210 2 0 1 2+

/.3 02+ 2 120 1& 0 0..2'0#1'20

2! /.3 02 2 -0#! 12 0 1 2# . .2.&1 2"

2!3" 10 1#0" .$&1.'/ 12. 0!+

ΚΕΦΑΛΑΙΟ ΔΕΥΤΕΡΟ
ΥΛΙΚΑ ΚΑΙ ΜΕΘΟΔΟΙ

2.1. Προμήθεια ατόμων *Palaemon adspersus*

0E. /0$12 0!12! 2& #/0& 2 # .2 "
0$)& 0.". /.2 .00+2 # ÿ#2"ü"12
01) 02 0'2"./."02. 0 .0#2) 0!0 !
($ 0E2. . 2 .0. 2" ./." .)E2 .11. 2 #
01 #. 02.3!12 0!12!)E2 0E2. 10 0#/0
400 L 12 #" C …2)22. ppt .$)/12. 0!+20.
0.212 '12'1#00!12!#
+2".0"2 # 0E2 "$ CE 2 . ./."
Palaemon adspersus 2. 0E)E.$&&02)&E
/.2!2.12 0!12!100#/0 $ &2)22." L0!!1."
C …2)22." ppt ./12.0!+ ü* .

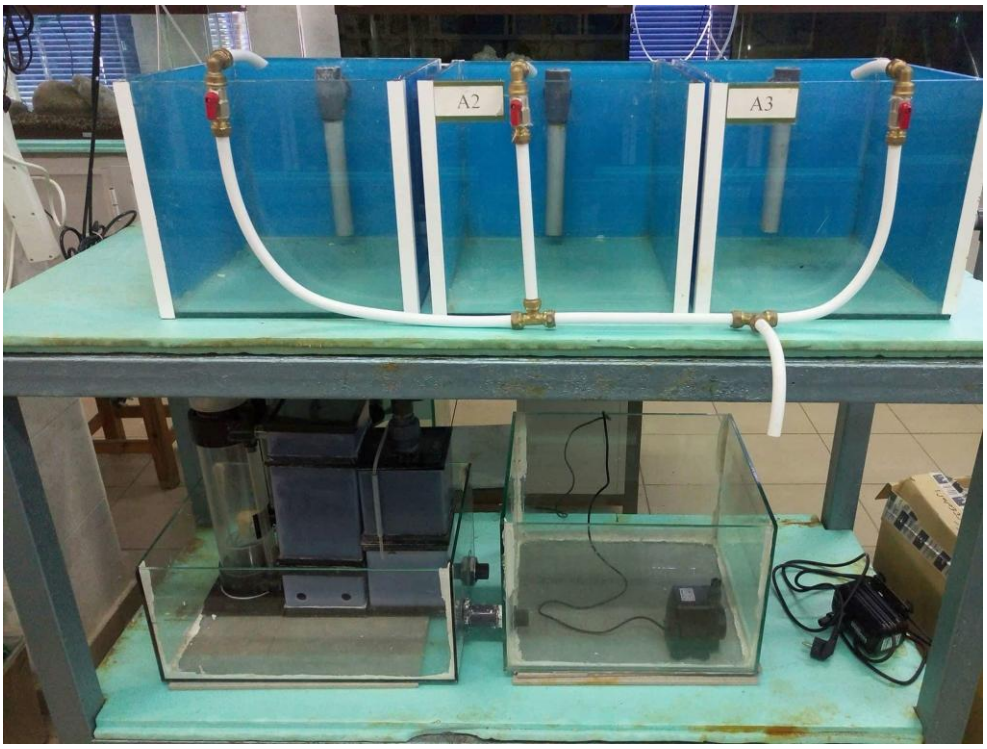
2.2. Σύστημα εκτροφής-Συνθήκες εκτροφής

+. 2".0'2 #0E2 '$ CE 2 . ./."

1 #0!1 # **#** cm 0E&!12.
. 2 . 10 /.2!3"/0'2 0E2. 10 .#2) . 012
1#12.2.0)32!2E sub ü01'12..0E0 2.
.)E!0#/0.0/.1210" x 36 x 30,5 cm .1# &3 #) #
50 L ü 1) +2 .E# ..1 * Mente, 2& ./&
.2.10#12. .#2) . 0/ & /.1210& x 9 x 8,5 cm .
1# '0E0." cm^2 ü 2) 2. 0E2 0E2. . 10 0
0#/0 . 1'12. 02!3"0E 2 0E1 2& &+12.
0E.2 1#12.2. 02!3'0 0 1)E2 /.131 2'E"
2& ./& 10 .#2 +2) .#2) .2.10#1. 0/'#0'10"
% #" cm 0E'2 0E2. 10 0 0#/ 0 0E 12"10"
2 0E2.2. #)E2 12 % '2 #'3.02 12 % '2 #

0#/0 # þ/$1 2 # .! 12. 0#/0. /.13.12 0 0 2 (E

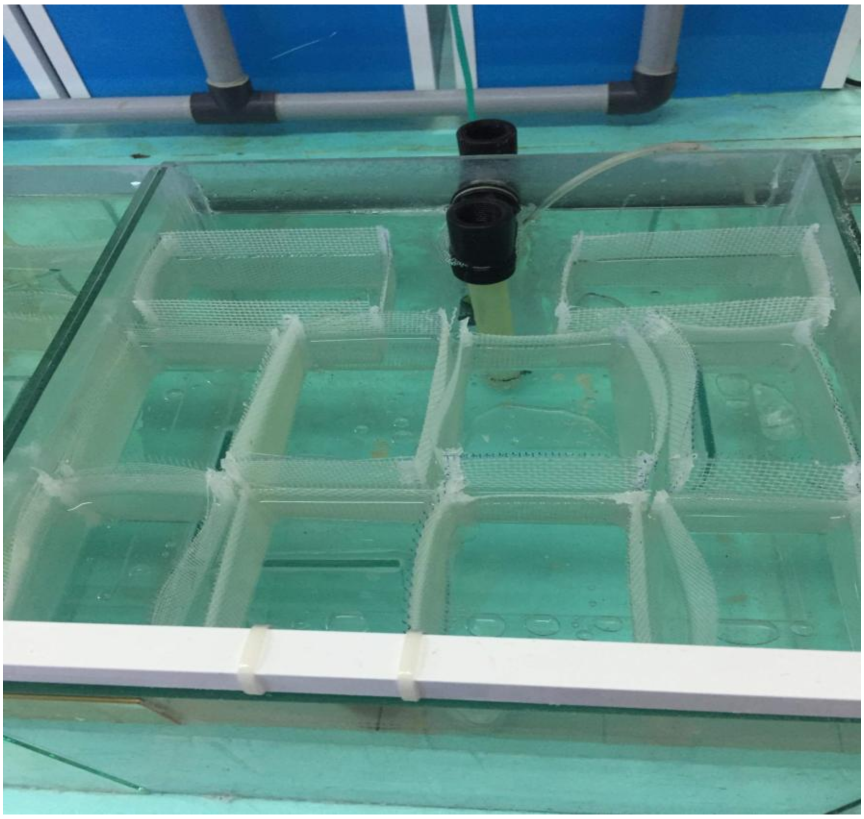
.0)(E2&&) # /.1210& x 25 mm ú* .



)ú 1*2 .02!3" .2(E.2 02!3 2"./." *Palaemon adspersus* 100!12!1#0!1&(6

. 1#12.2.)(E"..30 /.&12. 10 20"/.2!3" (E.2"/013&.02 2(6$02!3'100 1*2. 2 ú1*2.$0&'121 2!3(E(0(6$2 2 *Tenebrio molitor* 12 1*2.ú/.2.(E(0(6$2 2 *Hermetia illucens* þ12 1*2.2!3(E(0(6$2 2 *Musca domestica* D).

0).2. 1#12.2.0!!1.#12012 #" C 00!1220" 22. # Aquamedic, HTC:02 0.0)"#120!!1." T-controller HC, Aquamedic (E2 (E2.12)32! 2 #0 1#12.2 ".1#0!1 2 0#/0 1#2&1'2 #..!* 0!* Reservoir tank. H .2.21'2'"'.&.'2&2&/+)& $_2$2&2þ2& $_3$)2..3 20/ /.02012 kit &.2 02!" pH .2 /.# #) 0$2. .3 !2 0/ /.002!) pH 2!. #)02! HACH HQ 40d).



))i 2i2 #Œ#1$ Œ1 2Œ.2/./.1.2"

./." *Palaemon adspersus* 100!12!1#0" Œ&)Œ).

2.3. Σιτηρέσιο και χορήγηση τροφής

Œ .2#2"./." *Palaemon adspersus* /!10

0'/0.2 #Œ2 '2.&1'2!3'2.0"

0Œ /.2!3'Œ/ 12012 2 #1 #2 '#2"

./." (Vlahos *et al.* 2016), 0-0!1.Œ)22.2!3')2.0Œ0

0'Œ - 02 $!3#)2.10#).0." A &

D HR- 0.0.22.2 #/0./ %3 #Œ2!3/.2!2.

12 #" C 10 0/ / $. 0 0" 2. 0ŒŒ/ 1)'2 #

120!1 #2&./&0*2 #1 #!#'0+!Œ0"

/.2!2. 10 120. . . . 0 2 .1 0ŒŒ/ !2.

Œ)22. 2" $0" 2!3" þ$1*2.1 2" 2!3 " Œ

$ Œ.¶2/0.2 #Œ2 Œ#102.12 ..

þ0Œ2& 2!3+12 Œ.2 /./.1. 0 0 2! 2

1#02)22. . . 2 /.#2 Œ Œ Œ#1.. 2!3"

1# 2.02 2)Œ #2)12.20!#.21# 2&#Œ2&
22!3"
þ1# .#2)2. . /12. 0#12 0!12! 2&
0#/0& 0 0")2. ..12 Œ2& .!& 10 #2) 0
$..12 * -3. -0#.) ml/L 01)Œ21 2 #1 #
!#2"!." W. #2"!." L).
þ01. Œ)22. 2!3'Œ$2. 12"!0'#Œ120
.)Œ2 2Œ

F=MB x E.Δ% x Αριθ.Ατομ ,

Œ F2!3 g)
ú !" g)
0Œ /.2!3"
1.)"2)&.!."

2 Œ$2.10/*1)Œ. 0*2.
þ!3Œ!1002 $000#/0 # 2.10#)0
.0.22.2 #/0./ %3 #.2 Œ2 2.10Œ2/ $. tubes).
ŒŒ2 Œ)21.)2.13&1)"22!3'100 #
. 2 1# #Œ2& 2!3" 10 &/ Œ#" Œ2 *
#!1#20"0".!0'.2!2.10120.01)Œ
..12 Œ2 #". 2 21 2 # !#". 0ŒŒ/ 1) 2 #
1201 #

.." *12.1 2& 1 201& Œ$ Œ12 Œ.2
/./.1. *Tenebrio molitor* þ *Hermetia illucens* D: *Musca domestica).*

Χημική σύσταση τροφών	**TM**	**HI**	**MD**
&20ø	53,3	53,4	53,3
Œ	17,4	17,4	17,4
3!	9,6	9,8	9,8
NFE (kj/kg)	19,7	19,4	19,5
0. (%)	22,0	22,1	22,1
#1 (%)	4,7	4,7	4,7
00 (%)	2,5	2,5	2,5

..''1)22.2!3Œ‰0.¶2/0.2 #Œ2 ''

0''

Συστήματα εκτροφής	TM (gr/γεύμα)	HI (gr/γεύμα)	MD (gr/γεύμα)
0-15 0''	ù	ú	+
	ù	ú	+
	ù	ú	+
15-30 0''	ù	ú	+
	ù	ú	+
	ù	ú	+
30-45 0''	ù	ú	+
	ù	ú	+
	ù	ú 09	+
45-60 0''	ù	ú	+
	ù	ú	+
	ù	ú	+

2.4.Μετρήσεις μορφομετρικών χαρακτηριστικών

þ21 2 # *#'' W) (ü .3.12 2 2 #Œ2 0

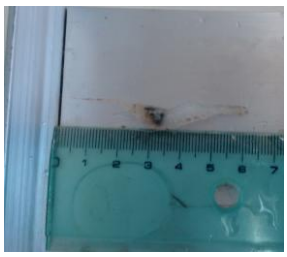
0#).0./02!0!#/0./ * AND company, limited 300g /0.01g, FX- 300

iVP0÷2.21 2 # *#'' L00$)02! ü .

2 #03. ÷0.212 $0Œ2!02!10''2.0

0''.)Œ2 .!2 # Œ2 ''0 2.#2)$ ..12 Œ 2&

./0 2-3. -0#.) (0,2 ml/L).

.   

)ü . ù12 Œ./÷21 !#'' gr 21 #''

(cm21 03. ÷ cmŒ&)Œ

2.5. Μετρήσεις φυσικοχημικών παραμέτρων

02!10"2& 3#1 $0E2& 2. . 3 !2
0/ /.0$2&3#1 $E2&)2 #1.00/ test kit
&.2 02!þ!!1.00$2..0002!)0)02!
pH . 2 /.# #) 0$2. 1&/) 0 02!))!
(HACH- 02!10"2 # pH . 2 # #) # O_2)2. 0 02!
1#10# 0&2!#. #)02!# HACH HQ 40d "21 2"
..2)22.")2. 0 2 $ /..102!# VEE GEE-BX1). 3 &21)"
. # !023#13&2 0E/ 2 #ÿ# #

2.5.1. Προσδιορισμός ολικής αμμωνίας-αζώτου (T.A.N.)

þ21 2"".&." T.A.N) (mg/L 2. . 3 !2
0/ /.&.2 020 test kits (API) ü 02 / .2/!12! &
3.)".)"10 0/&2) /#. . 1/!$.2.2 Liddicoat *et al.*1974)
þ/.1.21 2"".&.0E302.&0"

- !&% ml 00)2 #0#/0 #
- !þE Ammonia #1
- û sec
- !þE Ammonia #2
- û sec
- ù min 0 /0..&.2120. .
- &

2.5.2. Προσδιορισμός νιτρωδών ιόντων (NO^-_2-N)

NO_2^--N) (mg/L

test kits (API)

Liddicoat *et al.*

- ml
- Nitrite
- sec
- min

ù 2112&/)2&!1&

2.5.3. Προσδιορισμός νιτρικών ιόντων (NO^-_3-N)

2 1 2& 2)2& NO_3^--N) (mg/L 2. . 3 !2 0/ /.$ &.2 02 0 test kits (API) ü 0 2 / .2/!12& 3.)".)'10 0/&2) /#. . 1/!$.2.2 Liddicoat *et al.*

- ! % ml 00)2 #0#/0 #
- !1 Nitrate #1
- sec
- Nitrate #2
- sec
- ù min &2 /0..&.2120. .
-

2.6. Προσδιορισμός κατανάλωσης τροφής

$$K.T_{(\text{γαρίδας})} = \Xi O_{\text{χορηγούμενης τροφής}} - \Xi O_{\text{εναπομείνασας τροφή}}$$

þ1$ 02.* !'#.". ##."1#E#

. !1201&2+1$0&

GE

$0" 2!3" !0 CE)22. 2!3 " 10 ! #1.

.3.!0 #2 #CE 12 #!1."

0.CE.1.2!3" ïCE.1.CE)22.2!3'10!#1.02.)E

!1

þ21$2!'#!'#1.2&1#2&þ

MD #CE12. .212 $.)E#E10"CE 1)220" 1#2&

CE'2 CE2. 10 3 !*12 #" C . h .0CE# 2. .

. !12.1&2&!1#1$210&&0"

Ξ.O $_{\text{συμπήκτου (TM)}}$= 0.8628 * Y.O $_{\text{συμπήκτου (TM)}}$ + 0.0026 (R^2=0,996, n=10)

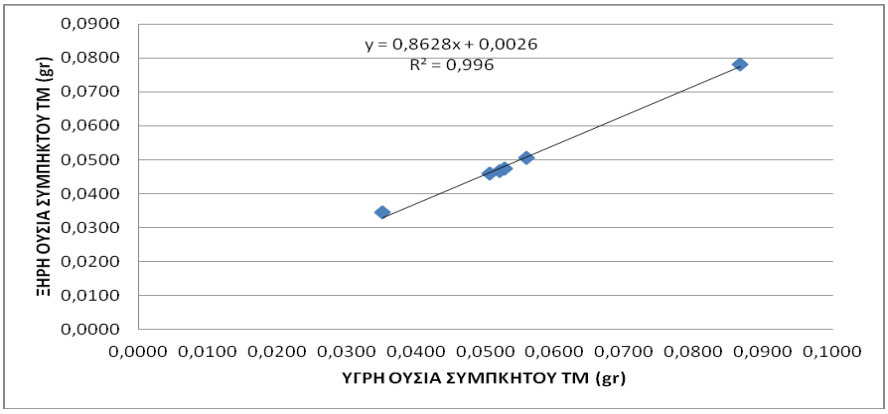
Ξ.O $_{\text{συμπήκτου (HI)}}$= 0.9134 * Y.O $_{\text{συμπήκτου (HI)}}$ – 0.0012 (R^2=1, n=10)

Ξ.O $_{\text{συμπήκτου (MD)}}$= 0.9129 * Y.O $_{\text{συμπήκτου (MD)}}$ + 0.0001 (R^2=0,999, n=10)

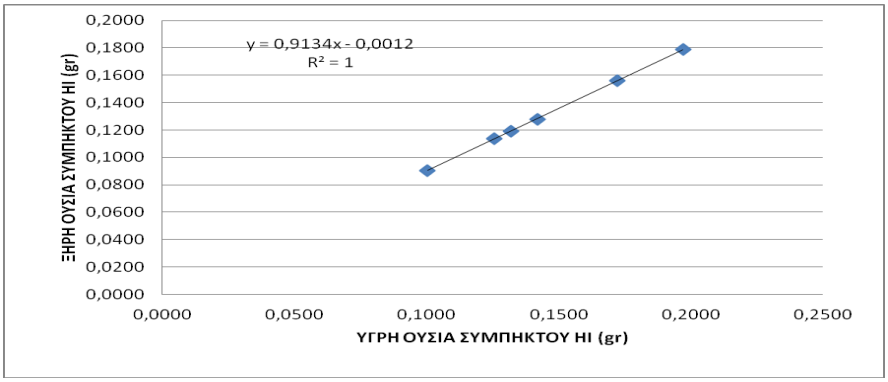
2 $. /02. ! 1#1$1 2'!. 2'#!'

#1.2&1#2&þ MD .212 $

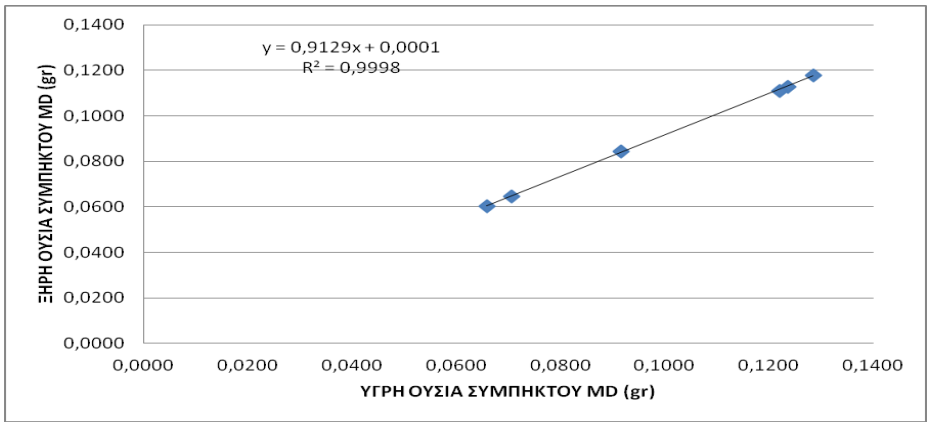
(α)



(β)



(γ)



$!+1#1$1 02.*'#1.".#!'#1."
2 # 1#2E# (E $ (E 12 (E.2 /./.1. . 2 #
1201 #2 #1201 #2 #1201 # MD).

2.7. Δείκτες ανάπτυξης και αξιοποίησης της τροφής

#C1)'2".2# 2& ./-2 # # *2.&1'2"
2!3". 2& C2& . C'2"2!3"0 03.) 2."2"
C2&..21$0"

-
  WG (g 0)!" ±

-
  SGR ! > ln(wt)-ln(wi)/t] x)C
  W_t 0)!"
  W_i "
  t "

-
  FCR= C
  .2..&01.2!3 g)
  ABZ .12 !#" g)

- DFI !
  DFI ! >.2.&1 2!3".1 !#0"
  121@

- CF)
  CF= (WX L^{-3})X100

- C
  S 20)'1'7-$1)'7+ x 100

-
  PER ů)C
  ů1!#" (g)
  .2..&010C200" (g)

- FC, g)

  g)

  g)

  g)

2.8. Στατιστική Επεξεργασία

SPSS one-way ANOVA *P<0,05.*

ΚΕΦΑΛΑΙΟ ΤΡΙΤΟ

ΑΠΟΤΕΛΕΣΜΑΤΑ

3.1. Ποιότητα νερού στα πειραματικά συστήματα εκτροφής

Θ2!2 #0!*ù $^{2-}$ $^{3-}$, pH, O_2) $2.*

2& 2+/.2!3+02.$10& 10). 2. 1#12.2. 02!3"/0

Θ#1 #1.2 12.212 /.3 ! (ANOVA, P>0,05). #) $_2$)

Θ#1012.2121. 2/.3 ! .01.12"0Θ1212.0

2.121. TM, HI . MD. .2+)2. $ /.2!10/0

0Θ. .12"20/.2!3"02.$10" 0 2.2)2. #.

.)E .&" .4 mg/L.212 $ $

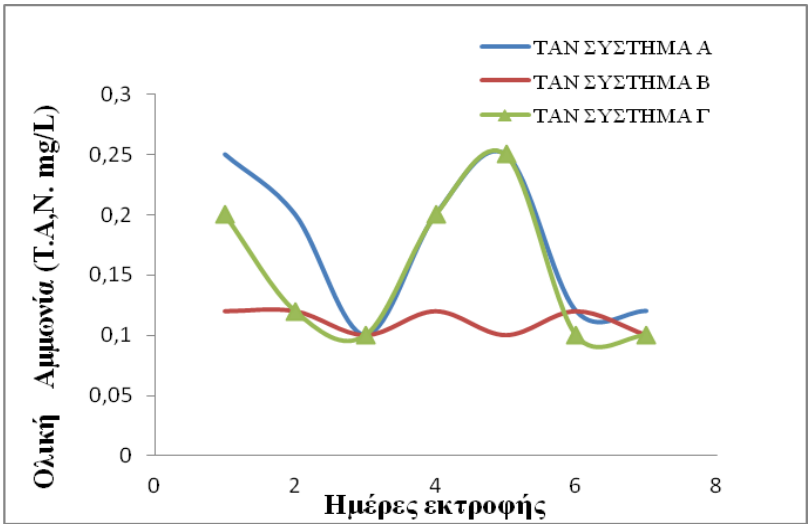
..-#1 $21122 #0!02!3"

	TM	HI	MD
Διαλυμένο O_2 (mg/L)	9.“ .17[b]	8.“ .09[b]	7.“ .21[a]
pH	8.“ .08[a]	8.“ .11[a]	8.“ .10[a]
T.A.N(mg/L)	0.“ .02[a]	0.“ .02[a]	0.“ .00[a]
Μη Ιονισμένη αμμωνία[1]	0.“ .06	0.“ .06	0.“ .01
Ιονισμένη αμμωνία[2]	0.“ 0	0.“ .00	0.“ .00
$NO2^-N$(mg/L)	0.“ .01[a]	0.“ .00[a]	0.“ .00[a]
$NO3^-N$(mg/L)	2.“ .35[a]	2.“ .29[a]	2.“ .26[a]

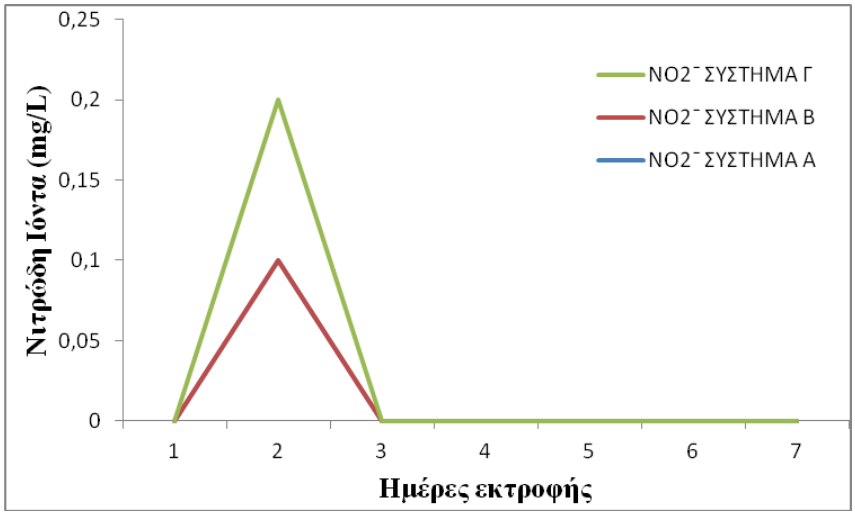
[1]þ 1 .&. #Θ1120 .)E2 1$ ÿ1 .&. ù -
ÿ1.&.

[2] þÿ1 .&. #Θ1120 .)E2 1$ ÿ1 .&. .)Θ.

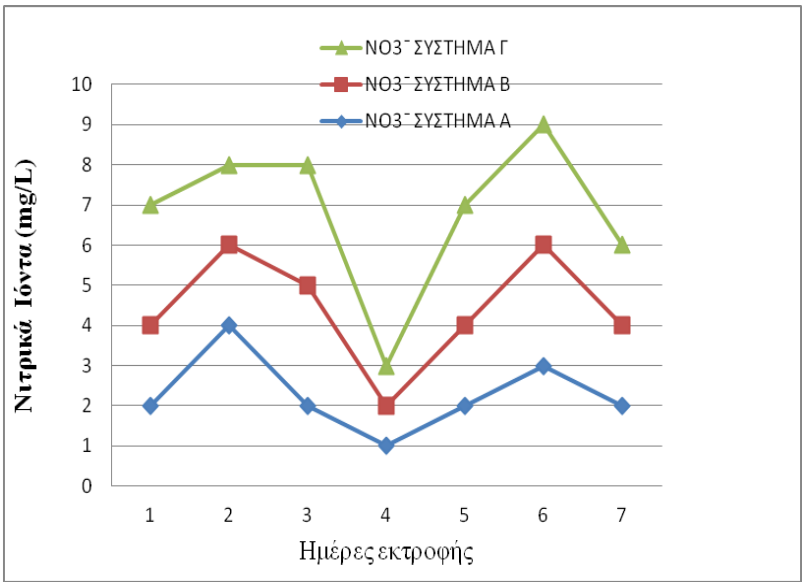
! !) 1. /1Θ"2".&.". #Θ02. .)EΘ"10
1#2102 pH .20!!1. . 2/"2.“ 2#Θ



$1"12"!&.')2/0.02!3"



$%12&2&/)2&.¶2/0.20Œ.202!3"



$%12&2&/)2&.¶ 2/0.20Œ.202!3"

3.2. Επιβίωση

þ#%)201Œ1 03.12012"./0"Œ/.23 2.02
2!3þ2. 10.20102"./0"Œ1212.02 121
Œ 2. þ)20!0Œ1 Œ112 0 12"./0"Œ
/.23.02 121 MD .2.

3.3. Βάρος και μήκος σώματος

.2 2 .!2'Œ.2'/./.1." 1)! 2 # 2 "
!#". #'2&.!/&/0Œ#1.1.1.2'12.212'/.3 !"
(ANOVA, p>0.05) .!0'Œ23. 0 121. TM . MD
Œ#1.1.12.212 0.2!1 20)!" 42“0.02 gr . 47“0.02
gr 10 .201 0 2".!0'Œ23. 0 2 121 HI Œ0$1
20)!" 41“0.02 gr (ANOVA, P<0.05)Œ.!0'Œ23.0
2 2!3 HL .0 2 2!3 MD Œ#1.1.12.20.2!1 20)
" 0.“ .0 cm . “ 0 cm 10.201.)2".!0'Œ23.0 TM
Œ0$1 20) " “ 0 cm

..!u $1 !'0)1 !" g), $1 FP
0) 1 " cm) 2".!." *P.adspersus* Œ2Œ
TM, HI, MD.

	TM	HI	MD
$ 1 !" g)	0.36“0.12[a]	0.35“0.13[a]	0.35“0.01[a]
0)1 !" g)	0.42“0.02[a]	0.41“0.02[a]	0.47“0.02[a]
$1 " cm)	3.6“0.05[a]	3.5“0.06[a]	3.5“0.06[a]
0)1 " cm)	0.4“0.0[a]	0.5“0.0[a]	0.5“0.0[a]

3.4. Αύξηση βάρους (WG) και ειδικός ρυθμός ανάπτυξης (SGR %/ημέρα)

.!0'Œ/.23. 0 2. 121. ;+. 0' Œ #1.1.
12.2122/..!#29!10.20102'!0"
Œ1212. 0 2 121 70 . Œ#1.1. 12.212 2)20!
.!#“ .01 gr) (.
Œ.!0'Œ2.02. 0 2. 121. ;+. MD Œ#1.1.
12.212#%)20!#).2Œ" (ANOVA, P<0.05) 101$02'!0"
Œ1212.02 121 TM .

..." ù 1 !#" WG,g), ü /)'1#)".2#" SGR %/d 2"

./." *P.adspersus* 0#20 1#" TM, HI, MD ./12.

0!+

0120.'2#"			
	TM	**HI**	**MD**
ù1!#" WG, g)	0.04“0.01[a]	0.16“0.02[b]	0.15“0.02[b]
ü)#)'1" SGR %/d)	0.19“0.08[a]	0.65“0.09[b]	0.62“0.07[b]

3.5. Κατανάλωση τροφής και παράμετροι αξιοποίησης της

3.5.1. Συντελεστής μετατρεψιμότητας της τροφής

1#20012" 02.20%)22." FCR) 12" ./0" 0#

/.23. 0 2 o 121 70 0#1.1. 1#2 0.20!2 10

1$ 0 2"./0'0#1212. .212 $0 2. 121. þ I . 0' 0#

0!#1.1.)20! 1#20012 02.20%)22." FCR) &!" .

0#1 #12.2121.2'.3 !" ANOVA, P>0.05).

0# 01.)1% 2!3" DFI) /0 0#1.10

12.2121.2'.3 !'122'00#.20'02.$! 10" ANOVA,

P>0,05). " 1#20012'0#&12.'/0 0#1.10 12.212 1.2"

/.3 !'01.120#.20'02.$10" ANOVA, P>0.05)

..'#20012'02.20%)22.2'2!3" FCR), þ1.)1%

2!3" DFI)#20012#&12." CF2'./." *P.adspersus* 0#2

0# TM, HI, MD .212 $'120#.202!3

	TM	**HI**	**MD**
#20012'02.20%)22.22!3" FCR)	1.51“1.59[a]	1.24“0.22[a]	1.15“0.85[a]
þ1.)1%2!3" DFI!	2.52“2.65[a]	2.06“0.37[a]	1.78“1.23[a]
#20012#&12." CF)	0.82“0.01[a]	0.68“0.03[a]	0.68“0.03[a]

3.5.2. Κατανάλωση τροφής

þ2.&12'2!3" FC (g) 102.12 .. 7þ!. *P. adspersus* (g) 10 1 .2 0.?20!2. &12!3 *ς όταν τρέφονται με σ μ ηκτοþ* (“ . “ 1) 10 1$ 0 2 /. 2& .!& (g) 23 2. 0 2. 12 (g) MD (“) (g) (g) 1.1. .2.&12!3" 11“ 13 gþ20!2.&12!3' (g) 1120 12'!0" (g) 23 2.02 12 (g) 0$2 2 . 2. 0.13“ 01 g.

.." 7.2.&12!3" FC2'!." *P.adspersus* (g) 12 2.02. 12 (g) þ MD.212 $

		þ	MD
!" (g)	(g)	0.36“ 0.12[a]	0.35“ 0.13[a]	0.35“ 0.01[a]
.2.&12!3"	FC (g)	0.13“ .01[a]	0.12“ .01[b]	0.11“ .13[b]

.!0'2 #'0/ #" *P.adspersus* .2 (g) (g) 2 12 TM 10.20102'!0' (g) .2..#22!3 MD HI,)(g) (g) 1.1. 12.212 2!)20!2.&12!3" ANOVA, P<0,05).

3.5.3. Δείκτες εκμετάλλευσης των συστατικών της τροφής (PER)

.!0'(g) /.23. 0 2. 121. ,+. 0' (g) 1.1. 12.212 2 / 1#20012 .(g))22.'2'(g) 20þ (ANOVA, P>0.05), 10 . 201 0 2'!0'(g) 1212. 0 2 121 70 . (g) 1.1. 12.212 2)20! 1#20012 .(g))22."2'(g) 20þ (8). þ #%)20?2 2 #1#20012.(g))22.?2'(g) 20þ PER) (g) 1020 12'!0'(g) 1212.0 22!3 MD (0.25“ 0.03) 10.20102'!0" (g) /.23.022!3 TM (g) 0.)20!" .08“ 0.03).

.." 8 #20012" .Œ2)22." 2" 8 20 (PER) 2" .." *P.adspersus* TM, HI, MD .) 2 /12. 2" 02!3" .

	TM	HI	MD
1 !" g)	0.36“ 0.12[a]	0.35“ 0.13[a]	0.35“ 0.01[a]
#20012".Œ2)22."2" 20 (PER)	0.08“ 0.03[a]	0.22“ 0.03[b]	0.25“ 0.03[b]

ΚΕΦΑΛΑΙΟ ΤΕΤΑΡΤΟ

ΣΥΖΗΤΗΣΗ

2 .Œ*1. 2$ 0!1. 0020 .2.)22. 2!+ /.3 0 02+1201 *Tenebrio molitor (TM), Hermetia illucens* (HI), *Musca domestica* (MD) 12.2#.2.&12!3" .0&12"./." *Palaemon adspersus* 101#0".$&1. þ1 ..Œ& 2 #0/ #"12.3#1 1#12.2.$0020.)Œ* 00#2" Berglund 1985, Bilgin *et al.* 20090+ Vlahos *et al.* (2016) 021. 2 .2# 0&1 . .2.&1 2!3"2"./." *P.adspersus* 10 /.3 0 20!!1002!3"

þŒ*. 02 0. Œ02 Œ../00 2".Œ20" Œ 0". 2 0 2 02!3 2 # 0/ #" 10 012 #.2. 02!3" $ Œ.'&'12!1.1Œ12. Œ0 .2.212.1 2& &200 0#!02)&

. .Œ01.2. 02 .)Œ 0"02!3"/0.)2 ./. *P.adspersus*,)2. 2302. 0 2 . 2 # 0/ #" *Hermetia illucens* Œ#10 12.212 P<0.05) .20!.2# 0.20!0&1 . .2.&1 2!3 ". þ/.)2. 2302. 0 2 . 2& 0/+ *Tenebrio molitor* . *Musca domestica* Œ#2 P<0.05) 2)20!.2.&1 2!3" .2#.0&1

..Œ01.2.2Œ*0!1.1#3& 000.2& Burtle *et al.* (2012))Œ# $ .2)%.!# (*Ictalurus puntacus*) Œ#1.10 .#. Œ 12 0&1". .20!.2#)2. 23 2. 0 2 . 2 # 0/ #" *Hermetia illucens*.

þ!3. 0. Œ!1 1$2 0 2 0Œ1 2& 02)& 12 .2# . 0&1 2& ./& 0 Œ2. /.2!3"Œ $# /0.$.)2 #" Stanner *et al.* (2014) 12!#1.Œ2!3...2.2121. 2 $0#!00#!02)&2 #0/ #" *Hermetia illucens* Œ2. 75% Œ#1.10 .#. Œ 12 1)22.'0 2. %! Œ/.23. .Œ120$0#!

2 2 # 0 # 0)2 $ 2 # 02) # *Locusta migratoria* 10 .2.212.12 # $0#!# -# 1.10 02& 1 12 .2# 2&%.!2

Makkar *et al*. (2014) . Henry *et al*. (2015) 12. 2. /0.. ..3!#)2 2 0/ " *Oncorhynchus mykiss* #10 1.2 .20!2#)2.23 02.012 1.# 12 1 12.12 #2 2 *H. illucens* 10 12) 12 $10 022& St-Hilaire *et al*. (2007 . Kroeckel *et al*. ..302.)2 0.20! 12 1#02 $2 # 2 -0#!# *H. illucens* .) / *.02#$ .01.2 ..2#".2)22.22!3" #%/.2!3..# 1 #2.2 ..00..02 #$0 2. $ 2. 2 1#12.2 02!32&%.!!0/10)1 0 1#0!12. /0.!0/.2 02..02.2 2& 0#.)1& 2& .00 12& . 20#2. . . .*2. 0 2 2 02!3 ..& . 0 12"!." *P.adspersus* 2 2

ΚΕΦΑΛΑΙΟ ΠΕΜΠΤΟ

ΣΥΜΠΕΡΑΣΜΑΤΑ

þ Œ. [illegible] 0!1.0210 2.[illegible] 2.2.&1 2" 2!3". 2 0[illegible]1 2"./." *Palaemon adspersus*)2. 1202. 0 12!1.12. Œ 0 0!2.212.12 #$0#!#0 02 0#! 2&0/+ *T. molitor, H. illucens,* . *M. domestica.*

..Œ01.2./0.)2

- þ[illegible] 2" .Œ220"Œ 0". 0 2 02!3 2 # 0/ #"10 1#0".$&1.'0 12!1. Œ0 0!2.212.1 2 # $0#!# $ Œ.'&'0..2'[illegible]20þ 2.2 . *T. molitor, H. illucens,* . *M. domestica* ..[illegible] [illegible]
- þ Œ#10 .20!.[illegible] SGR))2. 2302. 0 1[illegible] Œ 2. 2 . 2& 0/+ *H. illucens,* . *M. domestica* Œ#1 2.'12.2121.2/'.3 !' .
- [illegible] *T. Molitor* 0[illegible]0 12.212 2)20! .[illegible].0[illegible]1
- [illegible] Œ# /.23 2. 1[illegible]#2 2 *H. illucens.*
- þ [illegible] [illegible] [illegible] *T. Molitor* 10.2010 2.1[illegible]$2.2 . *H. illucens* . *M. domestica* Œ# Œ#1.1.2)20!2.&1
- [illegible] [illegible] [illegible] [illegible] *H. illucens* . *M. Domestica* 10.20102. 1[illegible]$ &'0..2[illegible]202 2 *T. Molitor.*
- þ Œ#10 12.212 0.20! 1#20012 .)Œ1" 2'[illegible]20)2.1202.02'2!3'[illegible] [illegible]$2 .2&

0/+ *H. illucens* . *M. Domestica* .2)201)2.23 2.

02 .2 . *T. Molitor.*

- [illegible]

ΚΕΦΑΛΑΙΟ ΕΚΤΟ

ΒΙΒΛΙΟΓΡΑΦΙΚΕΣ ΑΝΑΦΟΡΕΣ

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B. Ελληνόγλωσση Βιβλιογραφία

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Γ. Διαδικτυακή Βιβλιογραφία

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ABSTRACT

Palaemon adspersus is a decapods crustacean which lives in the Messolonghi lagoon and has increased commercial interest in the local community. The aim of this study was the effect of the replacement the fish meal with insect meal on growth, consumption and survival of *Palaemon adspersus* shrimp in captivity using as food the insects *Tenebrio molitor*, *Hermetia illucens* and *Musca domestica*.

90 shrimps were used for the experiments with a average mean weight “ 0.01 g and average PHDQOHQJWK ‘FP , was divided into individual cages. Ten shrimps per cages were put individually to avoid cannibalism. The experiments was carry out in three closed systems with total volume of 250 L which were supported by a sump filters. Each system consisted of three aquariums of a beneficial volume of 50 L with its replicates.

For the purposes of the experiment, the shrimps were divided into three trials (30 individuals / trial) and were fed 5% of the body weight. The protein was replaced at different levels by insects of *Tenebrio molitor, Hermetia illucens, Musca domestica*, respectively. The total duration of the experiment was 60 days. 7HPSHUDWXUHDQGVDOLQLW\ZHUHNHSWFRQVWDQWWKURXJKRXWWKHH[SHULPHQ 30 ppt, respectively.

The results showed that *Palaemon adspersus* shrimps showed statistically higher specific growth rate (SGR) and food consumption when fed the insect *Hermetia illucens* and the insect *Musca domestica* foods in contrary to those fed the insect *Tenebrio molitor*. The survival was higher on *Palaemon adspersus* trial fed the *Hermetia illucens* insect meal and was 73% in contrary to shrimps fed the *Musca domestica* and *Tenebrio molitor* meals.