Production attributes of *Trichogramma* reared on Eri silkworm eggs vis-à-vis *Corcyra* eggs and economics of rearing system

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Attended International Training Course on the "Theory and Technology of Plant Protection for Sustainable Agriculture in 21st Century" from 2nd to 21st September, 2004 in the Shenyang Agricultural University, Shenyang, China

As a consequent of the International training is the study of production attributes of *Trichogramma* reared on Eri silkworm eggs vis-à-vis *Corcyra* eggs and economics of rearing system

- Egg parasitoid – *Trichogramma* spp. mass produced on eggs of *Corcyra cephalonica*, *Sitotroga cerealella*, *Anagasta kuehniella* in major laboratories of the world
- Oak silk worm – *Antheraea pernyi* and Eri silkworm – *Samia cynthia ricini* eggs used for production of seven species of widely released *Trichogramma* spp. in China

- In India, *Trichogramma* spp. mass produced on *Corcyra cephalonica* eggs in many laboratories and commercial insectaries
- Recent emphasis laid on mass production at cheaper costs, large scale adoption of production system by commercial insectaries, quality of mass produced parasitoids vis-à-vis changing climatic condition & pesticide usage

Use of *Trichogramma*

- ***Trichogramma chilonis*** **a most dominant native egg parasitoid of south-east Asia and Pacific region & most widely released in different ecosystems in India**
- ***T. chilonis*** **released in 17 crops including cereals, vegetables, commercial crops and fruit trees**
- ***T. japonicum*** **released in sugarcane, paddy & brinjal**
- ***T. pretiosum*** **(Thelytokous & Arrhenotokous) released in tomato**
- ***T. embryophagum*** **field released in apple orchard for control of codling moth**

Advantages of Eri silkworm

- **Eri silkworm is an alternative host**
- **Feeds on castor (*Ricinus communis* Linn.)**
- **Requirement of minimum infrastructure man power & cost**
- **Mostly disease free, production on large scale & supply of parasitoids with better biotic attributes**

- **Eri silkworm culture - Department of Sericulture, Bangalore University, Bangalore, Karnataka, India**
- ***Trichogramma chilonis*** **indigenously collected, taxonomically confirmed with voucher specimens available in the insect collections of National Bureau of Agriculturally Important Insects, Bangalore, Karnataka, India**
- **Host and parasitoid cultures reared continuously in the laboratory**

Parameters studied

Acceptability
Adaptability
Evaluation
Mass production
Cost Economics

Initial testing

- ✓Fresh eggs exposed to *T. chilonis*
- ✓50-75% hatching
- ✓Few eggs blackened
- ✓Very few eggs with incomplete cutting of chorion
- ✓Eleven days developmental period
- ✓Only ten adults emerged & 70% were females
- ✓Adult longevity 8 days
- ✓On *Corcyra* eggs - 95.14% parasitism

Sterilization of eggs

i) UV treatment - 30 min, 1h, 1.30h, 2h, 2.30h - 58-78% hatching

ii) Influence of distance (30cm from UV source) - 30 min, 1h, 1.30 h - 62-90% hatching

iii) Storage at 4°C for 5 different time durations – 1, 6, 12, 18, 24 h - 6h storage resulted in no hatching

Treatment of eggs and its influence on parasitism

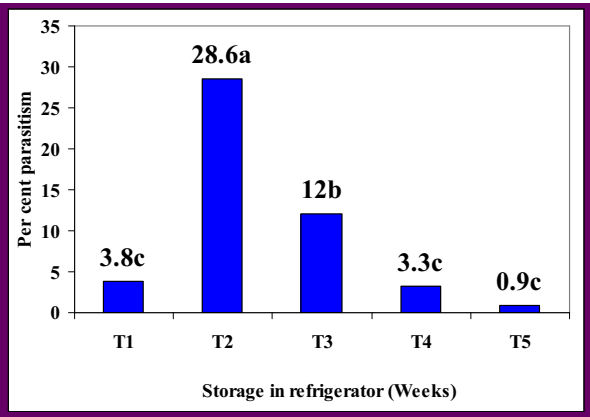
Formalin (2%)	Hatching 38-98%	38.8 % parasitism with very less adult emergence
KOH (1%)		Completely dissolved chorion
NaHCl (0.05%)		No parasitism
Water		No parasitism

KOH (0.5%)	1, 5, 10, 15, 20, 25, and 30 min	No hatching & parasitism
KOH (0.1%)		18-44 % hatching 58.4% & 10.4% parasitism in 1 and 30 minute treatments respectively
KOH (0.1%)	% Hatching	% Parasitism
1female : 5 eggs	47.7	52.3
1female : 2 eggs	31.2	58.4

Effect of storage methods and duration on parasitism

i) Vacuum packing:
Vacuum 20, 40, 60, 80, and 100%
N_2 20, 40, 60, 80 and 100%
Vacuum & N_2 60, 80 and 100%;
N_2 & vacuum 60, 80 and 100%
Storage at 3 different temperatures
Laboratory (27 ± 0.5°C)
BOD (16°C)
Refrigerator (9°C)
Duration 5, 10, 15 and 20 days

ii) Refrigerator (9°C)
Duration (weeks) – 1, 2, 3, 4 and 5



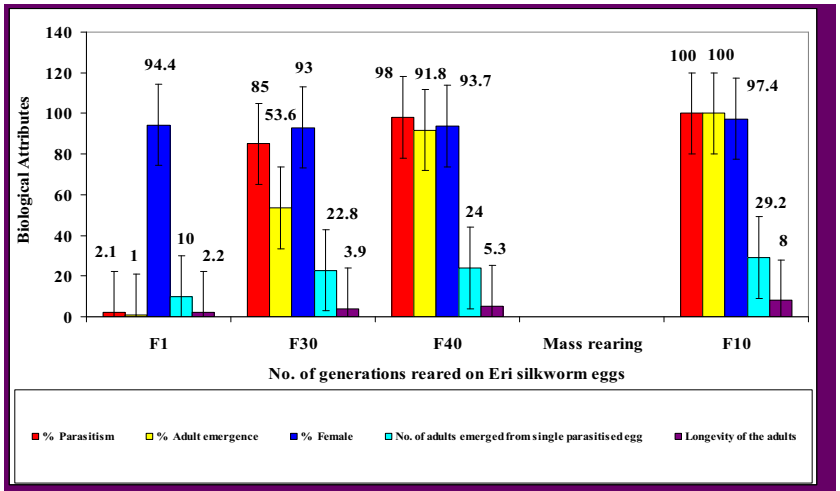
Means with different alphabets are significantly different from each other at LSD = 0.05 SED = 5.90; LSD (0.05) = 13.61

Mean per cent parasitism of Eri silkworm eggs stored at 9°C for different periods

- Vacuum packing and storage
  Lab 25 -98% hatching
  Refrigerator (10 days storage) 0-20% hatching
  15 and 20 days storage in refrigerator and BOD resulted in 0 % hatching
- Storage in Refrigerator (9°C)
  1 week storage 14 to 24% hatching
  2 to 5 weeks no hatching
- Laing and Eden (1990) reported viability of *Sitotroga cerealella* eggs for one month at 9°C

- Average developmental period: 9 -11 days
- Adult longevity: 1-8 days
- Per cent female progeny: 28.6 to 100
- Number of adults emerged from single parasitized egg: 7-34
- Per cent parasitism progressive: 2.1 to 98

- Nagarkatti *et al*. (1991) - frozen eggs of *Manduca sexta*, recorded 1- 20 eggs of *T. nubilale* from single parasitized egg
- Greenberg *et al*. (1996) - use of Eri silkworm eggs for rearing *T. chilonis*, *T. dendrolimi*, *T. cacoeciae*, *T. evanescens* and *T. pretiosum* & number of adults emerged from single parasitized egg ranged from 27- 60 with an average of 25



Biological attributes of *T. chilonis* reared on Eri silkworm eggs at different generations

- Speed of travel (Distance 40cm)
  - Towards light (n = 17)
    - Time 2 to 4 min (Mean 3.2 min)
    - No. of adults 2 to 5 (Mean 3.4)
    - Per cent parasitism 41.0 to 79.7% (Mean 55.7%)
  - Opposite to light (n = 1)
    - Time 20 minutes
    - Parasitism 54.0%

❖Host searching ability studied in 1 square foot cloth sleeved acrylic cage

❖Influence of changing host (from Eri silkworm to *Corcyra*) on biological parameters of *T. chilonis*

Host searching ability of *T. chilonis* reared on Eri silkworm eggs

Treatments (No. of Parasitoids/cage)	Per cent parasitism of the single female on *Corcyra* eggs		Mean (B)
	T. chilonis reared on Eri silkworm eggs	*T. chilonis* reared on *Corcyra* eggs	
One female	59.8[a]	29.6[b]	44.7[a]
Two females	36.4[b]	25.4[b]	30.9[a]
Five adults	42.9[a]	22.8[b]	32.9[a]
Ten adults	29.8[b]*	34.3[b]	32.1[a]
Mean (A)	42.2 [a]	28.0 [b]	35.1

A Factor SED = 4.84 & LSD (0.05) = 9.86
B Factor SED = 6.84 & LSD (0.05) = 13.94
A x B Factor SED = 9.68 & LSD (0.05) = 19.71
Means with different alphabets are significantly different from each other at LSD = 0.05; *- super parasitism was observed

Influence of changing host on per cent parasitism of single female and per cent females emerged from parasitized eggs

Generations	% parasitism of single female	% females emerged
Parent	37.9[b]	49.4[b]
F_5	90.5[a]	74.0[a]
F_{10}	83.5[a]	74.6[a]
SED	5.21	4.44
CD (0.05)	14.45	12.32

Means with different alphabets are significantly different from each other at LSD = 0.05

Morphological parameters of *T. chilonis* reared on Eri silkworm and *Corcyra*

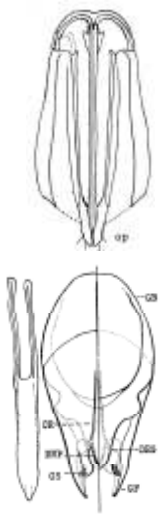
❖ Measured total body length, width, size of ovipositor / aedeagus at 50x magnification

❖ Data subjected to paired t - test & correlation between per cent parasitism and per cent females

Morphological characters of *T. chilonis* reared on Eri silkworm and *Corcyra* eggs

Character	Female reared on Eri	Female reared on *Corcyra*	Male reared on Eri	Male reared on *Corcyra*
Length mean	99.5	94.2	95.6	97.8
t- test	2.34*		-0.89	
Width mean	39.2	31.8	37.5	32.4
t-test	7.65***		3.86**	
Ovipositor /Aedeagus mean	44.3	38.9	43	39.3
t-test	5.24***		2.34*	

* significant at 0.05; ** significant at 0.01& *** significant at 0.001



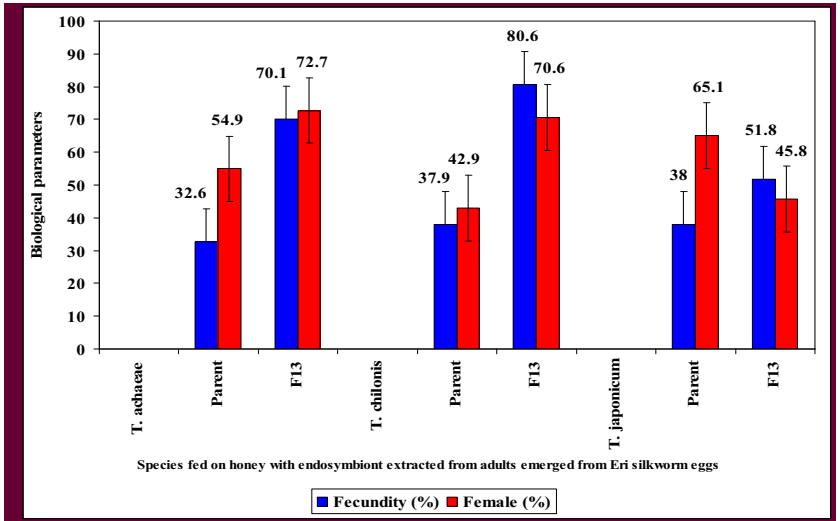
Orange and white colonies of yeast isolated from *T. chilonis* reared on Eri silkworm eggs

- **Association of endo-symbiont in the adults of *T. chilonis* reared on Eri silkworm eggs**

  Adults killed, surface sterilized, processed, homogenized, spread on YEPD agar plates and incubated, Yeast colonies identified belonged to *Candida* group, single colony isolation

- **Influence of endo-symbiont on biological attributes of other species reared on *Corcyra* eggs**

  Endo-symbiont yeast isolated grown on YEPD broth, pelleted colonies, mixed with honey and water at 1:1:2 (v/v/v) ratio, fed to laboratory reared *T. achaeae*, *T. chilonis* and *T. japonicum* for 13 generations, recorded fecundity and per cent females compared with parent



Influence of endo-symbiont isolated from *T. chilonis* reared on Eri silkworm eggs on biological attributes on different species of *Trichogramma*

Mass production
&
Cost Economics

Mass production

After 10 generations of Mass rearing
- Per cent parasitism: 100
- Per cent females: 97.4
- Number of adults from single parasitized egg: 29.2
- Longevity of adults: 8 days

Cost Economics

- Cost of production of Tricho cards required for release in one hectare @ 3 cards (ca. 18000 adults per card) US $ 0.81

Cost of production reduced by 47.6% in comparison to the production using *Corcyra*

Salient findings

- Storage of ES eggs at 9ºC for 2 weeks completely prevented hatching, whereas UV sterilization required to prevent hatching in *Corcyra* eggs
- Initial per cent parasitism 2.1%, increased progressively to 100% after 10 generations of mass rearing
- 7-34 adults emerged from single parasitized ES egg, with 93 – 98% females, whereas on *Corcyra* generally only 1 adult emerges, with 40-50% females among progeny produced
- 83.5 to 90.5% parasitism and 74 to 74.6% females after shifting from rearing on ES to *Corcyra* eggs
- Endo-symbiont enhanced mean fecundity by 54%, 53% and 27% in *T. achaeae*, *T. chilonis* and *T. japonicum,* respectively, and mean female percentage by 25% and 39% in *T. achaeae* and *T. chilonis,* respectively
- Cost of production of Tricho card (utilizing ES eggs) required for release in one hectare @ 50,000/ha = US $ 0.81; production cost reduced by 47.6% in comparison to that using *Corcyra* eggs

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