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Review Article

Rice moth, *Corcyra cephalonica* (Lepidoptera, Pyralidae) – A boon for biocontrol as a factitious host for mass production of parasitoids and predators

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ABSTRACT: The eggs, larvae and pupae of the rice moth, *Corcyra cephalonica* (Lepidoptera, Pyralidae), have been found to serve as factitious/alternative hosts for mass-production of at least 78 species of natural enemies – 60 parasitoids, 18 predators – belonging to 35 genera in 18 families under 8 orders that include Hymenoptera, Diptera, Arachnida and Nematoda for parasitoids while Coleoptera, Hemiptera, Hymenoptera and Neuroptera for predators. A list of these natural enemies is provided. Thus, though *C. cephalonica* is a serious pest of stored grains under natural conditions, it is a boon in laboratories as a factitious host for economic mass production of a variety of parasitoids and predators like *Trichogramma, Chrysoperla,* etc., which are extensively utilized in augmentative biological control.

KEYWORDS: Augmentative biocontrol, *Corcyra cephalonica*, factitious/alternative host, mass production, parasitoids, predators

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INTRODUCTION

The success of biological control by augmentation, more particularly by inundative releases of natural enemies, largely depends upon our ability to mass produce them for timely releases. Mass production of parasitoids and predators calls for elaborate arrangements to culture their host insects in the laboratory. In cases where the original host of the concerned biocontrol agent is either not amenable to mass production or its production is rather tedious and costly, a suitable alternative host will have to be employed. The rice moth or flour moth, *Corcyra cephalonica* Stainton (Lepidoptera, Pyralidae), has gained tremendous importance in this regard.

Corcyra cephalonica is a well-known storage pest of cereals (rice, jowar/sorghum, bajra/pearl millet, maize, etc.), oilseeds (groundnut, cottonseed, etc.) and several pulses with a wide distribution in sub-tropical and tropical countries. It also feeds on a variety of dried vegetable materials, dried fruits, chocolates, biscuits, oilcakes, etc., and is one of the most catholic feeders among the storage pests. Effective control measures are necessary from time to time to check this pest from causing serious losses in stored commodities. Strict quarantine measures are adopted in several countries to intercept its accidental entry along with imported foodstuffs. Though a pest of such serious concern under natural conditions, *C. cephalonica* has been found to be an extremely useful insect in altogether a different context as it serves a factitious host for the mass production of a large number of parasitoids and predators. This aspect is highlighted in this paper.

CORCYRA – A BOON FOR BIOCONTROL AS A FACTITIOUS HOST

The eggs and larvae as also pupae of *C. cephalonica* have been found to serve as perfect factitious hosts for mass-production of at least 78 species (these could be more) of natural enemies – 60 parasitoids, 18 predators – including a few that are highly host specific in nature. These belong to 35 genera in 18 families under 8 orders that include Hymenoptera, Diptera, Arachnida and Nematoda for parasitoids while Coleoptera, Hemiptera, Hymenoptera and Neuroptera for predators. These are listed in Table 1 (Manjunath, 1993).

One of the outstanding examples for mass-production of a biological control agent, using *C. cephalonica* as a laboratory host, is the egg-parasitoids, *Trichogramma* sp. (Hymenoptera, Trichogrammatidae), which are extensively utilised for the control of sugarcane borers, cotton bollworms and several other Lepidopteron pests of various crops in several countries including India. Other well-known examples of mass-production with *Corcyra* as an alternative

Table 1. List of (A) parasitoids and (B) predators reared on *Corcyra cephalonica* as a factitious host

1. Order/ Family	S.No.	**2.** *Corcyra* as a Factitious Host For A. Parasitoids : B. Predators	**3.** References
A. Parasitoids Reared on *Corcyra* as Factitious Host			
Hymenoptera:		Parasitoitds	Refs.
- Bethylidae	1	*Goniozus nephantidis* (Muesebeck)	RAE*:1970, 58, 1190
	2	*Goniozus pulveriae* Chandy Kurian	RAE:1975, 63(4), 1272
	3	*Goryphus* (*Melcha*) *orantipennis* Cam.	RAE:1961, 49, 669
	4	*Holepyris hawaiiensis* Ashm.	Thompson, 1945
- Braconidae	5	*Apanteles angaleti* Muesebeck	RAE:1974, 62(10), 4164
	6	*Apanteles tachardiae* Cameron	RAE:1967, 55, 233
	7	*Bracon brevicornis* Wesmael	RAE:1970, 58, 1190
	8	*Bracon chinensis* Szepligeti	Hertings, 1975
	9	*Bracon gelechiae* Ashmead	RAE:1976, 64(4), 1902
	10	*Bracon hebetor* Say	RAE:1974, 62(10), 4164
	11	*Bracon kirkpatricki* (Wlkn.)	RAE:1986, 74(7), 2708
	12	*Chelonus blackburni* Cameron	RAE:1979, 67(8), 3376
	13	*Chelonis narayani* Subba Rao	Hertings, 1975
	14	*Cotesia (*earlier *Apanteles*) *plutellae* (Kurdj.)	RAE:1975, 63(5), 1615
	15	*Stenobracon deesae* Cameron	RAE:1975, 63(12), 5052
- Chalcididae	16	*Anthrocephalus aethiopicus* Masi	Thompson, 1945
	17	*Anthrocephalus crassipes* Masi	Hertings, 1975
	18	*Anthrocephalus mahensis* Masi	Thompson, 1945
	19	*Brachymeria tachardiae* Cameron	RAE:1975, 63(4), 1272
	20	*Hockeria atra* Masi	Hertings, 1975
- Eulophidae	21	*Tetrastichus ayyari* Rohwer	RAE:1961, 49, 12
	22	*Tetrastichus Israeli* Mani and Kurian	1976, 64(11), 6640
	23	*Trichospilus pupivora* Ferr.	Hertings, 1975
- Ichneumonidae	24	*Eriborus trochanteratus* Morley	RAE:1978, 66(4), 2034
	25	*Isotima javensis* Rohwer	Hertings, 1975
- Scelionidae	26	*Telenomus dignoides* Nixon	RAE:1980, 68(12), 6308
	27	*Telenomus remus* Nixon	RAE:1988, 76(7), 3969
- Trichogrammatidae	28	*Trichogramma achaeae* Nagaraja and Nagarkatti	RAE:1982, 70(10), 5193
	29	*Trichogramma australicum* Girault	RAE:1963, 51, 514
	30	*Trichogramma brasiliensis* Ashmead	RAE:1977, 65(7), 3773
	31	*Trichogramma chilonis* Ishii	RAE:1983, 71(5), 3225
	32	*Trichogramma chilotreae* Nagaraja and Nagarkatti	RAE:1982, 70(6), 3214
	33	*Trichogramma confusum* Viggiani	RAE:1979, 67(3), 1025
	34	*Trichogramma dendrolimi* Mats.	RAE:1975, 63(11), 4649
	35	*Trichogramma erosicornis* Westwood	Thompson, 1975

Table 1 to be continued...

	36	*Trichogramma evanescens* Westwood	Thompson, 1975
	37	*Trichogramma evanescens minutum* Riley	RAE:1972, 60 ( ), 880
	38	*Trichogramma exigua* Nees	Hertings, 1975
	39	*Trichogramma exiguum* Perkins	RAE:1982, 70(2), 792
	40	*Trichogramma fasciatum* Perkins	RAE:1966, 54,630
	41	*Trichogramma japonicum* Ashmead	RAE:1970, 58, 3083
	42	*Trichogramma minutum* Riley	RAE:1966, 54, 144
	43	*Trichogramma oatmani*	RAE:1986, 72(10), 6337
	44	*Trichogramma ostriniae* (Pang and Chen)	RAE:1988, 76(3), 1009
	45	*Trichogramma perkinsi* Gir.	RAE:1981, 69(8), 4421
	46	*Trichogramma semifumatum* Perkins	RAE:1970, 58, 3083
	47	*Trichogrammatoidea armigera* Nagaraja	RAE:1974, 62(7), 2663
	48	*Trichogrammatoidea bactrae* Nagaraja	RAE:1989, 77(5), 3084
	49	*Trichogrammatoidea fumuta* Nagarja	RAE:1983, 71(11), 7374
	50	*Trichogrammatoidea fulva* Nagaraja	RAE:1989, 77(5), 3084
	51	*Trichogrammatoidea nr. guamensis* Nagaraja	RAE:1982, 70(7), 4111
	52	*Trichogrammatoidea lutea* Gir.	RAE:1989, 77(5), 3084
	53	*Trichogrammatoidea nana* (Zehnt.)	RAE:1976, 64(1), 252
	54	*Trichogrammatoidea prabhakeri* Nagaraja	RAE:1989, 77(5), 3084
Diptera:			
- Tachinidae	55	*Plagiprospherysa trinitatis* Thompson	RAE:1976, 64(3), 1304
	56	*Sturmiopsis inferens* Tns.	RAE:1982, 70(4), 2036
Acarina:			
- Ascidae	57	*Blattisocius tinevorus* Oudemans	Hertings, 1975
- Cheyletidae	58	*Acarapis docta* Berl.	RAE:1974, 62(7), 2660
- Pymotidae	59	*Pyemotus ventricosus* Newport	Hertings, 1975
Nematoda: Rhabditidae			
- Steirnernematidae	60	*Steinernema (Neoaplectena) carpocapsae* (Weiser) (DD-136)	
B. Predators Reared on *Corcyra* as Factitious Host			
1. Order/ Family		2. Predators	3. Refs.
Coleoptera:			
- Cicindelidae	61	*Cicindela cancellata* DeJean	RAE:1988, 76(4), 1606
Hemiptera:			
- Anthocoridae	62	*Amphibolus venator* Klug	Hertings, 1975
	63	*Cardiastethus* sp.	RAE:1983, 71(1), 322
	64	*Cardiastethus* sp. nr. *nazaremus* Reut.	RAE:1988, 76(2), 615
	65	*Dufouriella ater* Duf.	RAE:1988, 76(11), 8047
	66	*Orius* sp.	
	67	*Xylocoris flavipes* (Reuter)	RAE:1987, 75(11), 415
	68	*Xylocoris sordidus* (Reuter)	RAE:1988, 76(11), 7546

Table 1 to be continued...

- Miridae	69	*Cyrtorhinus lividipennis* (Reuter)	RAE:1987, 75(2), 578
- Reduviidae	70	*Alloecranum biannulipes* (Montr.)	RAE:1984, 72(8), 5609
	71	*Rhinocoris fuscipes* (Fabr.)	RAE:1981, 69(1), 238
	72	*Sycanus affinis* Reuter	RAE:1976, 64(11), 6642
Hymenoptera:			
- Eumenidae	73	*Discoileus zonalis* Panzer	RAE:1989, 77(4), 2324
Neuroptera:			
- Chrysopidae			
	74	*Chrysopa kulingensis* Navas	RAE:1989, 77(8), 5771
	75	*Chrysopa scelestes* Banks	RAE:1983, 71(9), 6152
	76	*Chrysoperla boninensis* Okamoto	RAE:1983, 71(9), 6160
	77	*Chrysoperla carnea* (Stephens)	RAE:1984, 72(4), 1736
	78	*Chrysoperla zastrowi sillemi* (Esben-Petersen)	
Summary: **78** species (60 parasitoids, 18 predators), **35** genera (24 parasitoids, 11 predators), **18** families (12 parasitoids, 6 predators), **8** orders (4 parasitoids, 4 predators)			

**RAE = Review of Applied Entomology: Year, Volume No. (Issue No.), Abstract No.*

host include the egg-larval parasitoid, *Chelonus blackburni* Cameron (Hymenoptera, Braconidae); the larval parasitoids, *Bracon brevicornis* Wesmael (Hymenoptera, Braconidae) and *Goniozus nephantidis* Muesbeck (Hymenoptera, Bethylidae); the pupal parasitoids, *Tetrastichus ayyari* Rohwer and *Trichospilus pupivora* Ferr. (both Hymenoptera, Eulophidae); and the predators, *Chrysoperla* sp. (Neuroptera, Chrysopidae) and *Orius* sp. (Hemiptera, Anthocoridae). Thus, *C. cephalonica* is undoubtedly a boon for the mass production of biological control agents.

ATTRIBUTES OF *CORCYRA* AS A LABORATORY HOST

- *Corcyra cephalonica* is amenable to mass-production under normal conditions of temperature and humidity.
- Facilities required are simple.
- Production is economical.
- Acceptable as a factitious host to a variety of parasitoids and predators (Table 1).
- Its food media, like sorghum, bajra, etc., are dry, readily available at reasonable price and can be easily stored.
- Larvae are not cannibalistic, so suitable for mass-rearing.
- Eggs are loosely laid and are very convenient to collect, measure and handle.
- Eggs, larvae and pupae are sufficiently large and nutritious enough for the normal development of various parasitoids and predators.
- Serious incidence of diseases in the mass-culture is rare.

Corcyra cephalonica has been successfully mass-produced in several laboratories since decades using different kinds of wooden boxes or metal trays, but these methods which relied on manual collection of moths faced several challenges, the most common being that the manual collection of thousands of moths daily is labour intensive and neck-breaking and the scales shed by a large number of moths that escaped during collection contaminated the laboratory, causing serious health hazards including respiratory problems. The semi-automatic production device developed by the author largely helps in overcoming these as well as other problems, leading to effective and economic mass production of *Corcyra,* thereby paving the way for mass production of parasitoids and predators for practical applications in biological control (Manjunath, 1993; 2014).

CONCLUSION

Corcyra cephalonica is amazing in the sense that a wide range of parasitoids and predators, cutting across 8 orders, 18 families and 35 genera, have accepted it as an alternative host. The ease with which it can be mass produced in the laboratory and its various attributes have made it possible to undertake commercial production and utilization of

biocontrol agents, especially *Trichogramma*, *Chrysoperla*, etc. Thus, *C. cephalonica,* though a serious pest of stored grains under natural conditions, is a boon for augmentative biological control as it serves as an excellent factitious host for commercial production of a large number of parasitoids and predators.

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