

PEST FREE AREAS (PFA) OF *Bactrocera caryeae* (Kapoor) IN MAJOR MANGO BELTS OF SOUTH INDIA

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ABSTRACT : Studies on pest free area (PFA) with respect to *Bactrocera caryeae* (Kapoor) was carried out for five years from 2001-2005 in South India, as part of trade prerequisite for export of mangoes from India to Japan. A CABI (UK) publication attributed the distribution of *B. caryeae* to South India. However systematic survey (which involved examining >82,000 fruit flies) clearly indicated that the *B. caryeae* was restricted to a narrow strip (corridor) along the west coast of South India. This zone clearly fitted into "tropical rain forest" climate of Koppen's climatic classification. Further, this corridor is major coconut and rice growing area. Major mango belts are not found in the *B. caryeae* corridor. Buffer areas to the east of the corridor were free of *B. caryeae* and no *B. caryeae* could be reared out of 5443 mangoes examined from major mango belts of South India, which showed that there was no breeding population of *B. caryeae* in the mango belts. The study clearly established the PFA of *B. caryeae* to be in a narrow strip on the west coast of South India from Goa to Kanyakumari and that it did not occur in the rest of South India, as well as rest of India.

Key Words : *Bactrocera caryeae*, Mango, Pest Free Areas (PFA), South India

INTRODUCTION

Fruit flies which belong to the family Tephritidae (Order: Diptera) are important quarantine pests. They infest several fruits and vegetables. Spread of fruit flies is facilitated through the movement of fresh fruits and vegetables. Several importing countries are wary of introduction of invasive alien species (IAS) into their countries. Historical records show that several invasive fruit flies have been introduced into countries other than their place of origin, mainly through infested commodities (fruits). For example, some *Bactrocera* spp. have established in Hawaii, French Guiana and Surinam; *Ceratitis capitata* has spread from Africa to many parts of the world (except Asia) through fruit

movements (White and Elson-Harris, 1994). Recently, Drew *et al.* (2005) reported introduction of *B. invadens* to Eastern Africa. Such invasions have prompted countries to be vigilant about importing commodities like fresh fruits and vegetables. As a precaution, countries importing fresh fruits may therefore, require one or more of the following specifications:

i) Fruits must have been treated post harvest with standardized heat (hot air, hot water, vapour heat, etc.), cold or insecticidal controlled atmosphere, that will disinfest fruit flies completely, and /or

ii) Data on pest free areas from where fruits can be imported, (as part of pest risk analysis).

These specifications are the prerogative of the importing countries. They specify the species and fruit commodity for which a post-harvest treatment, pest-risk or pest-free status data are sought. It then behooves on the exporting country to provide these through a NPPO (National Plant Protection Organization) as specified by FAO's guidelines as per the International Standards for Phytosanitary Measures (ISPM), Anon, (1999).

India's most important fruit, mango, is infested by the fruit fly, *Bactrocera dorsalis* (Hendel) (Verghese *et al.*, 2004). Indian mangoes are the best in the world and therefore has a wide international appeal. They are in high demand in Europe, Middle East and South-east Asia. To the USA and many other countries, mango is exported as processed fruit. However, fresh Indian mangoes are valued for their flavor, aroma, pleasing pulp colour, excellent taste, nutritional value, antioxidant properties, etc., and therefore are in demand.

One of the countries that had sought fresh mangoes from India is Japan. They, however, had expressed apprehension over a very innocuous species of tephritid viz., *B. caryeae*, which was described in 1970 by Kapoor (Kapoor, 1993). This species has been recorded in and around the hills of Coorg, West Karnataka, South India. However, the distribution of *B. caryeae* has been broadly given as South India (Drew and Hancock, 1994; White and Harris, 1994). This is misleading as geographically south of India encompasses the states of Andhra Pradesh, Tamil Nadu, Goa, Kerala and Karnataka, where several major mango belts are found.

One of the specifications of Japan for import of fresh mango from India was therefore, to identify mango belts free of *B. caryeae* in South India. Importing countries can import fruits from pest-free areas, provided a detailed and systematic survey is done by an established entomologist of a NPPO. Indian tephritidologists knew that *B. caryeae* is not a widespread species,

as it was not detected in any major mango-growing areas. Therefore, the present study was undertaken to generate data systematically on the distribution and pest free areas (PFA) of *B. caryeae* in South India.

MATERIALS AND METHODS

The study was conducted in selected districts of South India which included districts or areas representing major mango belts and districts or areas representative of different parts of South India, where mango is only a minor crop or is found in the wild or backyards as seedling trees. These areas are as given in Table 1.

The monitoring of *B. caryeae* was done from 2001–2005 using the parapheromone lure, methyl eugenol in a plywood block (5x5x1.2cm) as dispenser (Stonehouse *et al.*, 2005), to attract the fruit flies. The plywood blocks were impregnated in ethanol, methyl eugenol and insecticide mixture in the ratio of 6:4:2 as prescribed by Stonehouse, J. (Personal Communication). These blocks were packed in airtight polythene sachet and mailed to all the above areas to selected representatives from either the state horticultural departments, state agricultural universities or progressive farmers. The representatives were instructed (by demonstration) how to dangle the wooden block in used mineral water bottles (with vents) which served as traps (see Verghese *et al.*, 2006, in this issue).

The representatives were instructed to collect the fruit flies, once in 20 days, dry them, and pack in plastic vials sandwiched with cotton wads and to mail to the senior author. These were sorted in the Fruit Entomology Laboratory of Indian Institute of Horticultural Research (IIHR), following the keys developed at IIHR (Madhura and Verghese, 2002). These were carefully processed, identified and partitioned species-wise as methyl eugenol attracts *B. dorsalis*, *B. correcta*, *B. zonata*, *B. caryeae*, *B. affinis*, *B. verbascifoliae* etc. The records of *B. caryeae*

Table 1. Trap catch (total number) data of *B. caryae* from South India in different years (2001-2005).

State	Trap stations/Districts*	2001		2002		2003		2004		2005	
		<i>B. caryae</i>	Others	<i>B. caryae</i>	Others	<i>B. caryae</i>	Others	<i>B. caryae</i>	Others	<i>B. caryae</i>	Others
Andhra Pradesh	Anantapur	0	6	0	30	-	-	-	-	-	-
	Chintalpudi (W.Godavari)	0	923	0	44	-	-	-	-	-	-
	Chittoor	0	356	0	216	0	90	0	367	0	685
	Cuddapah	0	8	-	-	-	-	-	-	-	-
	Krishna	0	985	0	1498	0	6	0	113	0	65
	Prakasam	-	-	0	4	-	-	-	-	-	-
	Ranga Reddy	0	2293	0	1039	0	588	0	516	0	876
	Medak (Sangareddi)	0	8	-	-	-	-	-	-	-	-
	Venkatagiri/Nellore	0	133	0	4	-	-	-	-	-	-
	Vizag	0	345	0	4079	0	311	-	-	-	-
	Bangalore (Airport)	0	303	0	195	0	170	0	16	-	-
	Bangalore (IIHR)	0	3898	0	4920	0	2670	0	12153	0	2940
Karnataka	Bellary	-	-	0	30	-	-	-	-	-	-
	Bijapur	-	-	0	156	0	26	-	-	-	-
	Brahmavar	-	-	3	140	21	31	-	-	-	-
	Chettalli (Kodagu)	81	212	217	461	407	1064	319	290	51	46
	Chitradurga/Hiriyur	0	12	-	-	-	-	-	-	-	-
	Dharwad	0	165	-	-	0	28	-	-	0	59
	Hassan	-	-	0	150	0	314	0	82	0	62
	Kolar	0	1225	0	321	0	76	0	1135	-	-
	Mandya	0	17	-	-	-	-	-	-	-	-
	Mysore/Periyapatnam/	-	-	-	-	-	-	-	-	-	-
	Hunsur	0	28	0	8	0	12	-	-	0	58
	Puttur	-	-	-	-	-	-	-	-	-	-
	Ramanagaram	-	-	-	-	-	-	-	-	0	7
	Raichur	-	-	-	-	-	-	-	-	0	587
	Shimoga	0	1	0	28	-	-	0	3	-	-

.....continued

State	Trap stations/Districts*	2001		2002		2003		2004		2005	
		<i>B. caryeae</i>	Others	<i>B. caryeae</i>	Others	<i>B. caryeae</i>	Others	<i>B. caryeae</i>	Others	<i>B. caryeae</i>	Others
Kerala	Kasaragod	167	238	113	279	-	-	6	36	-	-
	Kollam	-	-	-	-	2	71	-	-	-	-
	Thiruvananthapuram	315	360	0	11	62	456	18	179	18	185
	Thrissur	-	-	-	-	-	-	69	139	-	-
	Thalassery	-	-	-	-	-	-	4	27	-	-
Tamil Nadu	Chennai (Airport)	-	-	0	36	-	-	-	-	-	-
	Chemancheri	-	-	0	7	-	-	-	-	-	-
	Coonor	-	-	-	-	0	1232	-	-	-	-
	Coimbatore	-	-	-	-	0	31	-	-	-	-
	Kanyakumari	2	1	544	4059	7	5	-	-	-	-
	Nagercoil	323	339	99	1640	58	182	-	-	-	-
	Krishnagiri	0	98	0	94	0	29	0	836	0	296
	Kancheepuram	-	-	-	-	-	-	0	270	-	-
	Mahabalipuram	-	-	-	-	-	-	0	1	-	-
	Periyakulam	-	-	-	-	-	-	-	-	-	-
	Thiruvallur	0	493	0	290	0	11	-	-	-	-
Goa	Vellore/Latteri, Katpadi	0	263	0	547	0	4486	0	5913	-	4804
	Old Goa	-	-	-	-	-	-	19	382	44	526
	Kerri	-	-	-	-	-	-	56	254	34	155

*Certain districts and trap stations have had some incidental collections, so have been included, as they were useful as supplementary data.

*Others' mainly include total numbers of *B. dorsalis*, *B. zonata* and *B. correcta*

- indicates non-availability of trap catches

0 no occurrence of fruit flies.

Table 2. Absence of fruit infestation by the fruit fly *B. caryeae* (by actual examination of fruit samples) in major mango belts of South India.

Andhra Pradesh

Date	Location	Variety	Sample number	<i>B.caryeae</i> Present/Absent	<i>B. caryeae</i> infestation (%)
2.5.01	Chengalpet	Banganapalli	60	Absent	0
27.4.02	Chittoor	Totapuri	25	Absent	0
8.6.02	Chittoor	Banganapalli	52	Absent	0
24.6.02	Chittoor	Banganapalli	94	Absent	0
24.6.02	Chittoor	Banganapalli	10	Absent	0
24.6.02	Chittoor	Totapuri	42	Absent	0
5.7.02	Chittoor	Banganapalli	6	Absent	0
27.7.02	Chittoor	Neelam	27	Absent	0
26.6.03	Chittoor	Neelam	235	Absent	0
26.6.03	Chittoor	Totapuri	569	Absent	0
26.6.03	Chittoor	Banganapalli	30	Absent	0
12.4.04	Chittoor	Neelam	30	Absent	0
4.5.04	Chittoor	Totapuri	30	Absent	0
4.5.04	Chittoor	Neelam	33	Absent	0
4.5.04	Chittoor	Athimaduram	30	Absent	0
22.5.04	Chittoor	Alphonso	30	Absent	0
27.5.04	Chittoor	Banganapalli	30	Absent	0
27.5.04	Chittoor	Banganapalli	30	Absent	0
29.5.04	Chittoor	Neelam	30	Absent	0
29.5.04	Chittoor	Banganapalli	60	Absent	0
11.6.04	Chittoor	Banganapalli	18	Absent	0
15.5.05	Chittoor	Neelam	30	Absent	0
15.5.05	Chittoor	Alphonso	5	Absent	0
30.5.01	Cuddapah	Banganapalli	36	Absent	0
12.5.01	Krishna	Banganapalli	30	Absent	0
21.5.02	Krishna	Banganapalli	30	Absent	0
24.4.03	Krishna	Banganapalli	115	Absent	0
24.4.03	Krishna	Rasam	2	Absent	0
21.4.01	Mehbubnagar/Ranga Reddy	Banganapalli	66	Absent	0
3.4.02	Mehbubnagar/Ranga Reddy	Banganapalli	65	Absent	0
30.5.02	Mehbubnagar/ Ranga Reddy	Banganapalli	96	Absent	0

Table 2 continued

30.5.02	Mehbubnagar/ Ranga Reddy	Kesar + Dasher	19	Absent	0
Mar, 02	Prakasam District	Totapuri	30	Absent	0
24.4.02	Reddipalli	Suvarnakha	31	Absent	0
24.4.02	Reddipalli	Banganapalli	34	Absent	0
24.4.02	Reddipalli	Kolangora	18	Absent	0
24.4.02	Reddipalli	Totapuri	31	Absent	0
13.5.01	Vizag	Suvarnakha	23	Absent	0
25.4.02	Vizag	Banganapalli	33	Absent	0
25.4.02	Vizag	Suvarnakha	30	Absent	0
25.4.02	Vizag	Panukulu	21	Absent	0
TOTAL =			2216		

Tamil Nadu

Date	Location	Variety	Sample number	<i>B. caryae</i> Present/Absent	<i>B. caryae</i> infestation (%)
4.6.03	Krishnagiri/Paiyur	Totapuri	63	Absent	0
14.6.03	Krishnagiri/Paiyur	Neelam	116	Absent	0
10.6.01	Thiruvallur (Arambakkam)	Jawari	36	Absent	0
11.7.02	Thiruvallur (Arambakkam)	Jawari	34	Absent	0
		Totapuri	40	Absent	0
		Neelam	45	Absent	0
		Rumani	60	Absent	0
24.6.02	Thiruvallur	Banganapalli	30	Absent	0
26.7.02	Thiruvallur	Neelam	37	Absent	0
26.7.02	Thiruvallur	Rumani	81	Absent	0
26.7.02	Thiruvallur	Panjarum	36	Absent	0
7.7.03	Thiruvallur	Rumani	132	Absent	0
7.7.03	Thiruvallur	Totapuri	76	Absent	0
7.7.03	Thiruvallur	Banganapalli	30	Absent	0
4.6.02	Vellore	Neelam	67	Absent	0
4.6.02	Vellore	Totapuri	43	Absent	0
4.6.02	Vellore	Neelam	30	Absent	0
4.6.02	Vellore	Kalepad	5	Absent	0
14.7.02	Vellore	Neelam	42	Absent	0
11.6.04	Vellore	Neelam	66	Absent	0

Table 2 continued

11.6.04	Vellore	Alphonso	44	Absent	0
21.6.04	Vellore	Malgoa	8	Absent	0
26.7.04	Vellore	Neelam	24	Absent	0

TOTAL = 1145

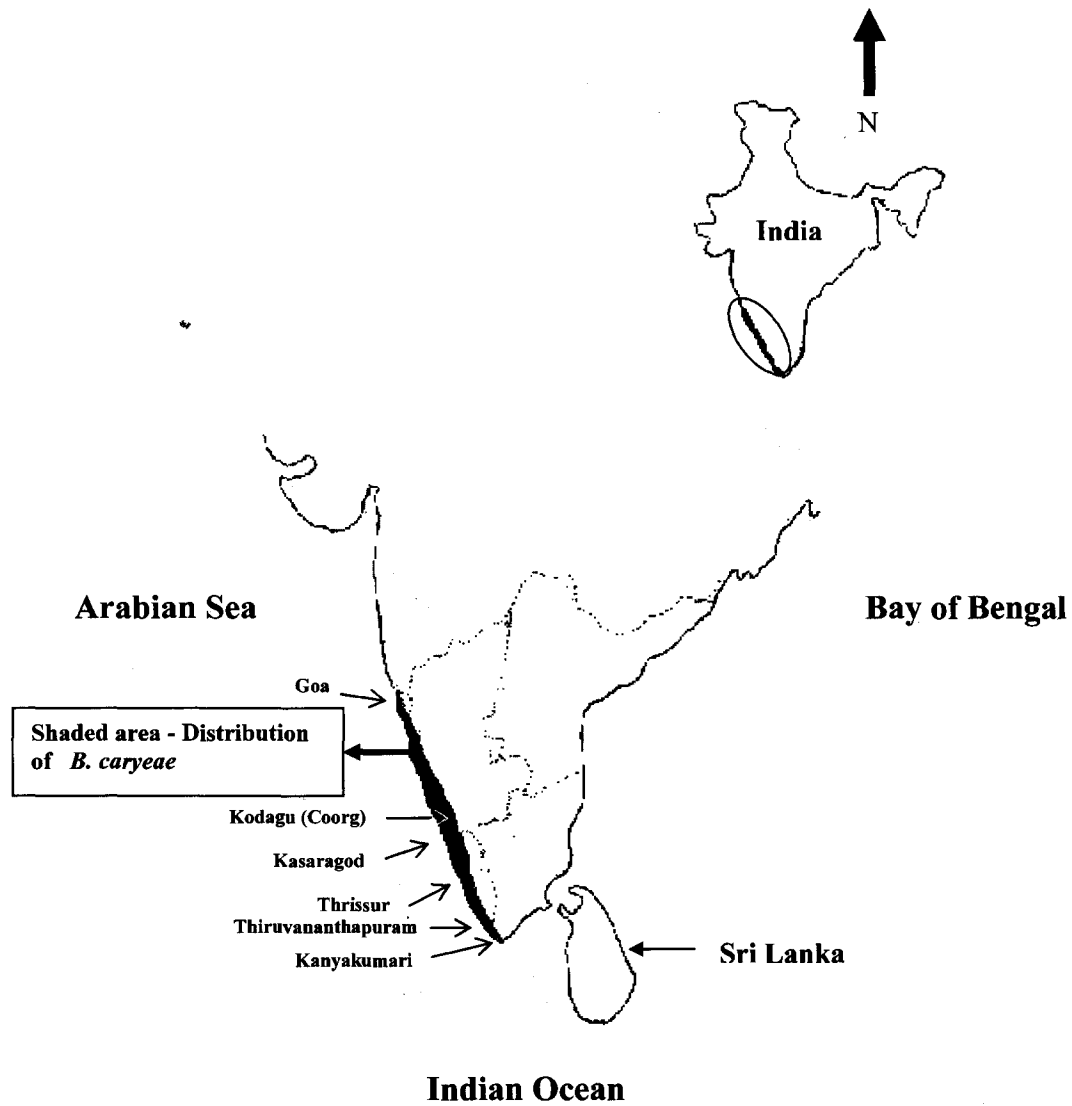
Karnataka

Date	Location	Variety	Sample number	<i>B. caryeae</i> Present/Absent	<i>B. caryeae</i> infestation (%)
June 02	Bangalore (IIHR)	Banganapalli	90	Absent	0
June 02	Bangalore (IIHR)	Alphonso	90	Absent	0
June 02	Bangalore (IIHR)	Totapuri	90	Absent	0
June 02	Bangalore (IIHR)	Others	180	Absent	0
June 03	Bangalore (IIHR)	Banganapalli	90	Absent	0
June 03	Bangalore (IIHR)	Alphonso	90	Absent	0
June 03	Bangalore (IIHR)	Totapuri	90	Absent	0
June 03	Bangalore (IIHR)	Others	180	Absent	0
June 04	Bangalore (IIHR)	Banganapalli	90	Absent	0
June 04	Bangalore (IIHR)	Alphonso	90	Absent	0
June 04	Bangalore (IIHR)	Totapuri	90	Absent	0
June 04	Bangalore (IIHR)	Others	180	Absent	0
27.6.02	Dharwad	Alphonso	36	Absent	0
May 02	Hassan	Alphonso	13	Absent	0
20.6.02	Hassan	Alphonso	60	Absent	0
6.7.02	Hassan	Alphonso	35	Absent	0
10.4.02	Hassan	Alphonso	29	Absent	0
17.6.02	Hassan	Alphonso	105	Absent	0
May 04	Hassan	Alphonso	160	Absent	0
24.6.02	Kolar (Srinivasapura)	Banganapalli	42	Absent	0
17.6.02	Kolar (Srinivasapura)	Neelam	36	Absent	0
17.6.02	Kolar (Srinivasapura)	Local	10	Absent	0
24.6.02	Kolar	Alphonso	37	Absent	0
28.6.02	Kolar	Banganapalli	30	Absent	0
25.6.04	Kolar (Srinivasapura)	Banganapalli	64	Absent	0
25.6.04	Kolar (Srinivasapura)	Totapuri	38	Absent	0
25.6.04	Kolar (Srinivasapura)	Neelam	39	Absent	0

TOTAL = 2084

GRAND TOTAL = 5445

Map of South India showing the distribution of the fruit fly, *Bactrocera caryeae* (shaded area)*



*Map is indicative and not to scale

were carefully tabulated (Table 1) and the final records were mapped, for submission through the Institute to APEDA for further needful action.

In addition, harvested mango fruits from major mango belts (Table 2) were brought to IIHR, quarantined, and examined for maggots, post ripening. Maggots were reared to adults in individual jars and adults identified.

RESULTS AND DISCUSSION

In the five years between 2001 and 2005, both years inclusive, 70,808 fruit flies were examined. It was found that *B. caryeae* was found only in Kanyakumari, Trivandrum, Trichur, Kasargod, Coorg and Goa in South India. This narrow strip along the west coast of South India, where mango is not a major crop, is the corridor where *B. caryeae* occurs (Map). The rest of south India, where the major mango belts are found, is free of *B. caryeae* as not a single *B. caryeae* was recorded. The results clearly showed that in South India *B. caryeae* was restricted to the west coast along a narrow corridor, between Goa and Kanyakumari. Reports of its occurrence from Coorg (Kodagu) made us to make an intensive collection in Conoor as well (a hill station in Tamil Nadu), where oranges and tea gardens are common. No *B. caryeae* was recorded here. Collections from 'buffer zones', such as Dharwar, Hassan, Mysore, Hunsur (very close to the east of the corridor) showed the clear absence of *B. caryeae* confirming its non-occurrence beyond east of *B. caryeae* corridor (Table 1.).

Thus, *B. caryeae* is restricted to a small strip of South India and the earlier report of South India (by implication the whole of south India) is misleading. *Bactrocera caryeae* is confined only to non-mango areas and therefore is not a threat to Indian mango cultivation or exports. This area clearly falls under "tropical rainforest climate" by Koppen's climatic classification; further the predominant crops here are coconut and rice (Anon, 2006). The major mango belts like

Mehbubnagar, Ranga Reddy, Chittoor, Visakhapatnam, Krishna of Andhra Pradesh are free of *B. caryeae*. In fact the entire Andhra Pradesh is free of *B. caryeae*. Like wise major mango belts of Tamil Nadu (Krishnagiri, Vellore, Thiruvallur) and Karnataka (Kolar, Bangalore, and Dharwad) are also free of *B. caryeae* (Table 1).

The absence of *B. caryeae* in the mango belt was further confirmed from ripe mango fruit examination. In all 5445 fruits were cut and examined. It was found that *B. caryeae* was absent in all the fruits from the major mango belts as listed in Table 2. Thus it was confirmed that breeding population of *B. caryeae* is present only in the west coast of south India (map). So, it can be inferred that even if stray *B. caryeae* drift into non-*B. caryeae* areas it is not likely to breed, multiply, or establish.

Mango samples from Dharwad has showed that mango fruits were free from *B. caryeae* (Table 2) thus, *B. caryeae* even if drifted to buffer zones are not likely to breed and hence establish. Mysore and Hunsur are not mango belts but fall under 'buffer' zone, so, trap catches were examined, but no fruits were available for checking the occurrence of infestation by *B. caryeae*.

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