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SEASONAL ABUNDANCE AND HOST USE PATTERNS OF SEVEN *BACTROCERA* MACQUART SPECIES (DIPTERA: TEPHRITIDAE) IN THAILAND AND PENINSULAR MALAYSIA

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ABSTRACT. – Based on extensive male trapping, information is presented on the distribution and seasonal abundance of six *Bactrocera* species in Thailand and Peninsular Malaysia. *Bactrocera dorsalis* and *B. correcta* were trapped in northern and central Thailand, *B. papayae*, *B. carambolae* and *B. umbrosa* were restricted to southern Thailand and Malaysia, while *B. cucurbitae* was widespread, although more abundant in the north. *Bactrocera dorsalis*, *B. papayae* and *B. correcta* exhibited unimodal patterns of population abundance, with populations peaking between June and September depending on species and locality. *Bactrocera carambolae*, *B. cucurbitae* and *B. umbrosa* showed no clear patterns in their population modalities, varying between regions. Based on fruit rearing work undertaken in northern and southern Thailand, information on host use patterns is also provided for the above six species, plus *B. latifrons*. *Bactrocera umbrosa*, *B. latifrons* and *B. cucurbitae* are confirmed as oligophagous on *Artocarpus* spp., *Solanum* spp. and cucurbit spp., respectively. Species of the *B. dorsalis* complex (*B. dorsalis*, *B. carambolae*, *B. papayae*) and *B. correcta*, although with a very wide potential host range, were predominantly reared from a small number of hosts, including *Terminalia catappa*, *Psidium guajava*, *Syzygium samarangense* and *Averrhoa carambola*. The number of flies reared from such hosts were generally in excess of the proportion of that fruit in regional samples, implying that even though the flies are polyphagous species, not all hosts are used equally.

KEY WORDS. – *Bactrocera carambolae, Bactrocera cucurbitae, Bactrocera correcta, Bactrocera dorsalis, Bactrocera latifrons, Bactrocera papayae, Bactrocera umbrosa.*

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INTRODUCTION

Dacine fruit flies of the genus *Bactrocera* (Diptera: Tephritidae) are arguably the most serious pests of fruit and vegetables throughout Asia and the Pacific. The larvae of most *Bactrocera* species feed in fleshy fruits or vegetables, where they cause fruit rot and premature drop. While a large amount of published literature is available for the dacines (see for example reviews by Fletcher, 1987; Drew & Romig, 1999), most field ecological information is based on only a few pest species, commonly in regions outside their native range (e.g. *Bactrocera dorsalis* (Hendel) and *Bactrocera cucurbitae* (Coquillett) in Hawaii [Harris & Lee, 1989; Vargas et al., 1989; Liquido et al., 1990], *Bactrocera tryoni* (Froggatt) in southern NSW [Fletcher, 1973, 1974a, b]).

Of the serious *Bactrocera* pest species, several are indigenous to Thailand and Peninsular Malaysia. Species native to these countries include several of the *B. dorsalis* complex, including *B. dorsalis sensu stricto*, *B. papayae* Drew & Hancock and *B. carambolae* Drew & Hancock, and the cucurbit feeders *B. cucurbitae* and *Bactrocera tau* (Walker). Several workers have published on the field ecology and/or pest status of these species in South-east Asia, especially in Malaysia (Tan & Soo-Lam, 1982; Ooi, 1984; Tan, 1984; Vijaysegaran, 1984, 1991; Tan & Serit, 1988, 1994; Serit & Keng-Hong, 1990; Chua, 1991; Iwahashi et al., 1996; Tan & Nishida, 1998). Careful interpretation needs to be applied to most of these papers, however, as those published before Drew and Hancock's (1994a) revision were unaware of the sibling complex hidden within *B. dorsalis sensu lato*. Thus most of these papers refer to *B. dorsalis* in Malaysia, but it is now known not to occur in that country (Drew & Hancock, 1994a).

Between 1986 and 1994, extensive adult fruit fly trapping and larval host fruit rearing were undertaken in Malaysia and Thailand as part of joint projects between the Governments of Malaysia and Thailand and the Australian Centre for International Agricultural Research. From this work extensive fruit fly host plant and parasitoid lists were generated (Allwood et al., 1999; Chinajariyawong et al., 2000) and the taxonomy of several groups of dacine fruit flies were clarified (Drew & Hancock, 1994a, b; Drew et al., 1998).

From the same program, this paper presents information on the seasonal abundance (as determined by male lure trapping) and host use patterns of seven major pest fruit flies in Thailand and Peninsular Malaysia, viz. *B. carambolae* (carambola fruit fly), *Bactrocera correcta* (Bezzi) (guava fruit fly), *B. cucurbitae* (melon fly), *B. dorsalis* (Oriental fruit fly), *Bactrocera latifrons* (Hendel) (Solanum fruit fly) *B. papayae* (Asian papaya fruit fly) and *Bactrocera umbrosa* (Fabricius) (breadfruit fly). *Bactrocera dorsalis*, *B. papayae* and *B. carambolae* are all members of the *Bactrocera dorsalis* complex (Drew & Hancock, 1994a) and are considered highly polyphagous species, as is *B. correcta*. While claims for polyphagy are true based on the total number of hosts from which they have been reared (Allwood et al., 1999), host use patterns presented in this paper allow more definitive statements to be made about the nature of polyphagy in these species. Of the remaining species, *B. cucurbitae* is a major cucurbit pest, *B. latifrons* is a pest of *Solanum* species and *B. umbrosa* is a pest of breadfruit and jackfruit. General information and further references on each of these species are given in White & Elson-Harris (1994).

Information is not supplied for *B. tau*, even though data on this taxon were collected during the sampling programmes. *Bactrocera tau sensu lato* is considered to be a species complex, based on cytological evidence (Baimai et al., 2000) and morphological evidence (R.A.I. Drew, pers. obs.). We therefore refrain from publishing seasonal phenology or host-use information on this taxon until the species status of various geographic and host-associated populations is clarified.

MATERIALS AND METHODS

Adult fly trapping

Adult flies were sampled using Steiner traps (Queensland modification) (White & Elson-Harris, 1994), baited with a cotton wick soaked in either 3ml of cue-lure (4-(p-acetoxyphenyl)-2-butanone) or methyl-eugenol (ME) (3,3,dimethoxy (1) 2 propenyl benzene). A knock-down insecticide (malathion, 1ml) was added to the lure to kill insects attracted to the trap. At any one site, traps were hung in pairs at a distance of 10-20 m apart. Fifty-four sampling sites were established in Peninsular Malaysia and seventeen in Thailand. Flies were removed from traps on a 1-2 week basis and lures were recharged monthly. At any one site, traps were serviced for 12 to 36 months

Trap catches are pooled within a region and across years to give average monthly trap catches per region. Data were pooled for ten regions, identified in Thailand by three population centres (Chiang Rai [19°53'N 99°49'E][7 pairs of traps], Chiang Mai [18°44'N 98°37'E][5] and Bangkok [13°45'N 100°24'E][5]), and in Malaysia by the state in which traps were located (Kedah/Perlis [3], Kelantan [13], Perak [11], Terengganu [3], Pahang [12], Selangor [9] and Johor [3]).

Fruit rearing

To assess host use patterns, fruit were collected from the field and returned to the laboratory, where individual samples were placed in separate holding containers until pupation occurred and the flies isolated. Details of the techniques followed are given in White & Elson-Harris (1992: 16) and Allwood et al. (1999). Approximately 23,000 samples were collected, with the majority being collected in Thailand. Both cultivated and wild fruit were collected in Thailand, while in Malaysia predominantly commercial fruits were sampled. As an example of the level of collection undertaken in Thailand, the following are details of the collections made by the team lead by M. Jirasurat operating out of Bangkok. Collection period 1991-1992; 175 collecting trips totaling 420 days effort; 22 provinces covered; 600 known plant species or varieties sampled; 3,789 samples taken; 568,987 individual fruits collected. Teams operating out of other centers collected similar or even greater amounts of fruit.

In the Results section, only fruit samples from Thailand are included. This is because these samples are locally comprehensive, covering both commercial and non-commercial hosts. The inclusion of non-commercial host fruits allows more detailed statements to be made about host usage than is possible if only commercial hosts are sampled. Host fruit usage is summarised by the region from which fruit were sampled (Chiang Rai, Chiang Mai, Bangkok, Surat Thani [9°07'N 99°20'E] and Songhkla [7°13'N 100°33'E]). Because of the natural distribution of flies, not all fly species have host records from each centre. The full host-plant lists from these surveys (both Thailand and Malaysia), plus those hosts sampled that did not yield flies, are given in Allwood et al. (1999).

Fruit fly identification
All fruit flies caught in traps, or reared from fruit, were sent to Brisbane, Australia, where they were identified by either R.A.I. Drew or D.L. Hancock.

Data analysis and presentation
No statistical analysis has been undertaken on the data presented in this paper. Rather data are presented as summary tables or graphs, with only major trends discussed. The decision not to analyze data is based on the underlying assumptions of statistical analysis, many of which are violated by the available data. Most particularly the sampling programs, for both adult flies and fruit collections, were not performed with a particular experimental design, or hypothesis, in mind. Rather they were preliminary surveys, a fact that was necessitated by the lack of prior knowledge about fly species, fly distribution or host use. For example, wild fruit collections were haphazard and dependant on opportunistic collection. This meant that sample sizes varied, as did the collection localities and dates. Attempting formal statistical analysis of such data would therefore be inappropriate because of the unbalanced sample sizes and because background fly populations (and hence infestation rates) are variable with location and time. Similarly adult fly-traps came into or out of service in different years over the eight years that the projects ran, making statistical comparisons between sites inappropriate.

RESULTS

Seasonal abundance and distribution
Bactrocera dorsalis was only collected in Thailand and was most abundant at Chiang Rai in the far north of the country. For all regions where the fly was present (Chiang Rai, Chiang Mai, Bangkok) the population was unimodal, building up from the start of the monsoon season and peaking around June. A distinct period of low catches was evident from September through to January (Fig. 1). *Bactrocera papayae* and *B. carambolae* were only collected from Malaysian sites and southern Thailand (Figs. 2, 3, Table 1). *Bactrocera papayae* populations tended to be unimodal, with the peak late in the monsoon season (August/September) and dropping off during the dry season (Fig. 2). *Bactrocera carambolae* populations showed no repeatable pattern across regions (Fig. 3). For Perak and Kelantan populations were distinctly bimodal, with population peaks in Dec/Jan and June, while for other regions populations were unimodal, or without any obvious peak(s).

Bactrocera cucurbitae was found throughout Thailand and Peninsular Malaysia, but in general became more common towards the north (Fig. 4). No repeatable patterns in population modality were obvious in this cucurbit breeding fly, with relatively even population sizes throughout the year. This was particularly the case in regions where populations were low. For regions where the species occurred in higher numbers some population modality was observed (e.g. bimodal populations at Chiang Mai and Perak), but these were rarely repeated across regions and the generality of the patterns must be questioned.

Bactrocera correcta was only recovered in Thailand, particularly in the north at Chiang Mai and Chiang Rai (Fig. 5). This species exhibited a unimodal population pattern, peaking around June. At Chiang Mai the fly was present in relatively high numbers for most of the year except for the period September to December. However, at Chiang Rai and Bangkok the fly was only caught in the middle of the year and was otherwise rare or absent.

Bactrocera umbrosa was absent from northern and central Thailand, but was present in southern Thailand and throughout Peninsular Malaysia, becoming more common in the south (Fig. 6 and Table 1). As with *B. cucurbitae*, no clear modality was seen in the populations of *B. umbrosa* for most regions. However, at Johor, where fly numbers were highest, a distinct bimodality was obvious, with peaks in May/June and December/January.

Trap data for *Bactrocera latifrons* is not available, as this species does not respond to either cue-lure or methyl-eugenol (White & Elson-Harris, 1992: 211).

Host plant usage
As previously reported (Allwood et al., 1999), *B. dorsalis*, *B. papayae* and *B. carambolae* (all *B. dorsalis* complex species) were recorded from a wide range of host species across several plant families. *Bactrocera papayae* at Songkla was reared from the greatest number of different plant species, with 129 individual host records. However, despite the large number of host records for these three fly species, generally as few as 5 hosts accounted for 70-90% of all flies of a species reared (Table 1). While this is in part due to the fact that many rearing records are based on infrequently sampled fruits, certain host species reared disproportionately large numbers of flies. As an example, the two host plants rearing the greatest number of flies for any region accounted for 34-72% of all flies of a particular species reared in that region. At the same time, those host plants only accounted for 6-37% and 12-40% of the total number and total weight

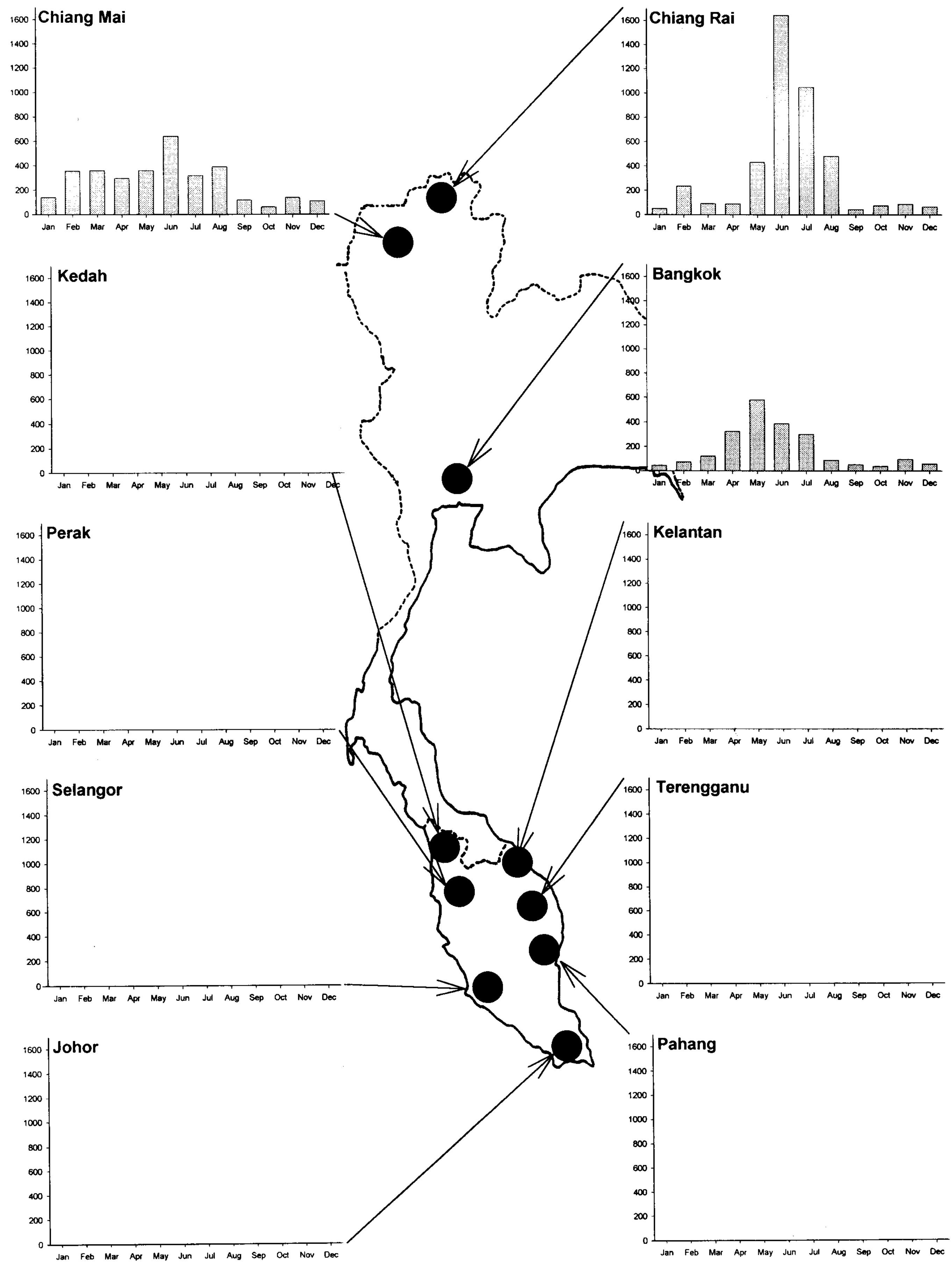

Fig. 1. Distribution and average monthly trap catch of *Bactrocera dorsalis* in Thailand and Peninsular Malaysia based on catches of male flies in methyl-eugenol baited Steiner traps.

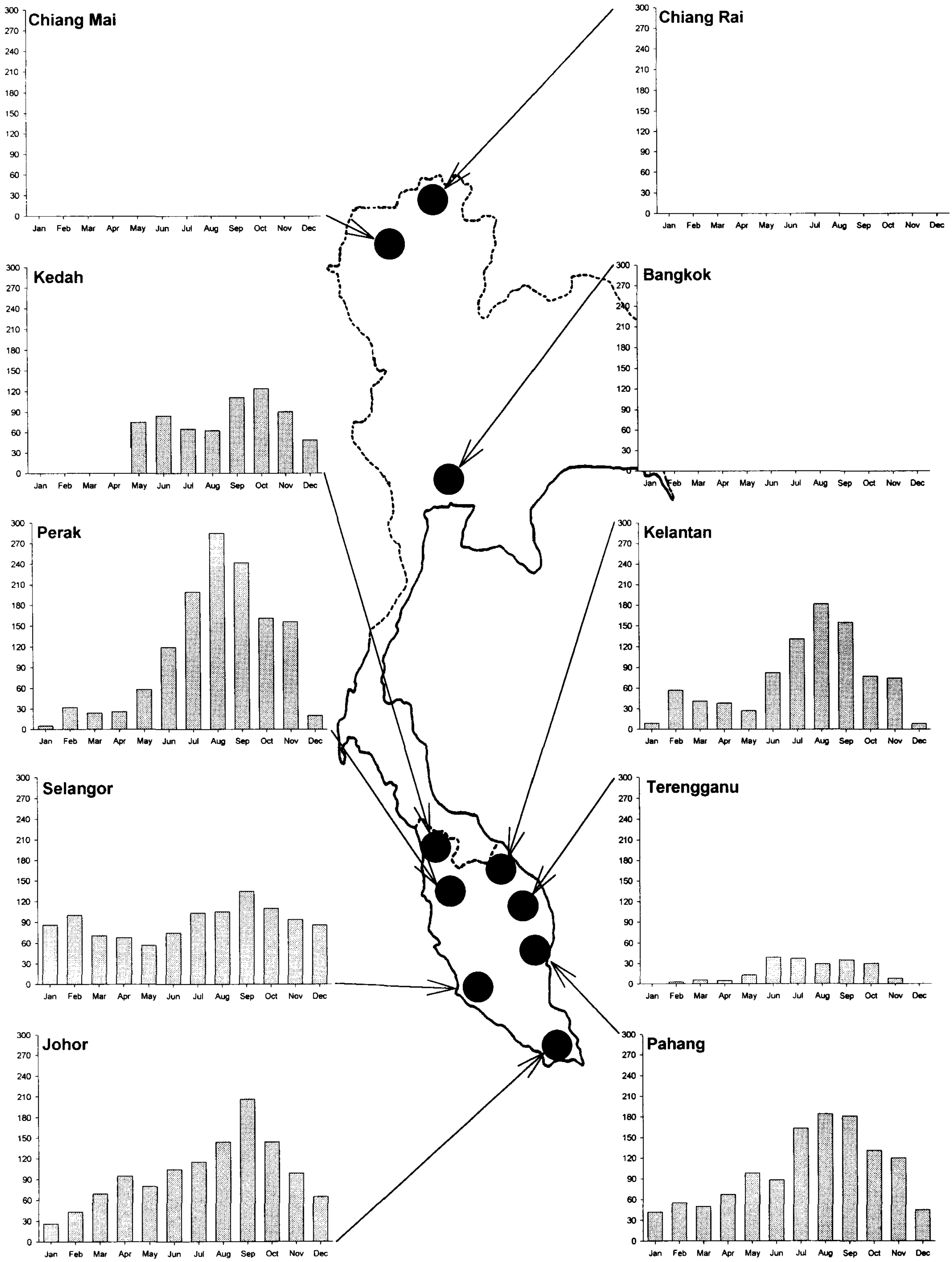

Fig. 2. Distribution and average monthly trap catch of *Bactrocera papayae* in Thailand and Peninsular Malaysia based on catches of male flies in methyl-eugenol baited Steiner traps.

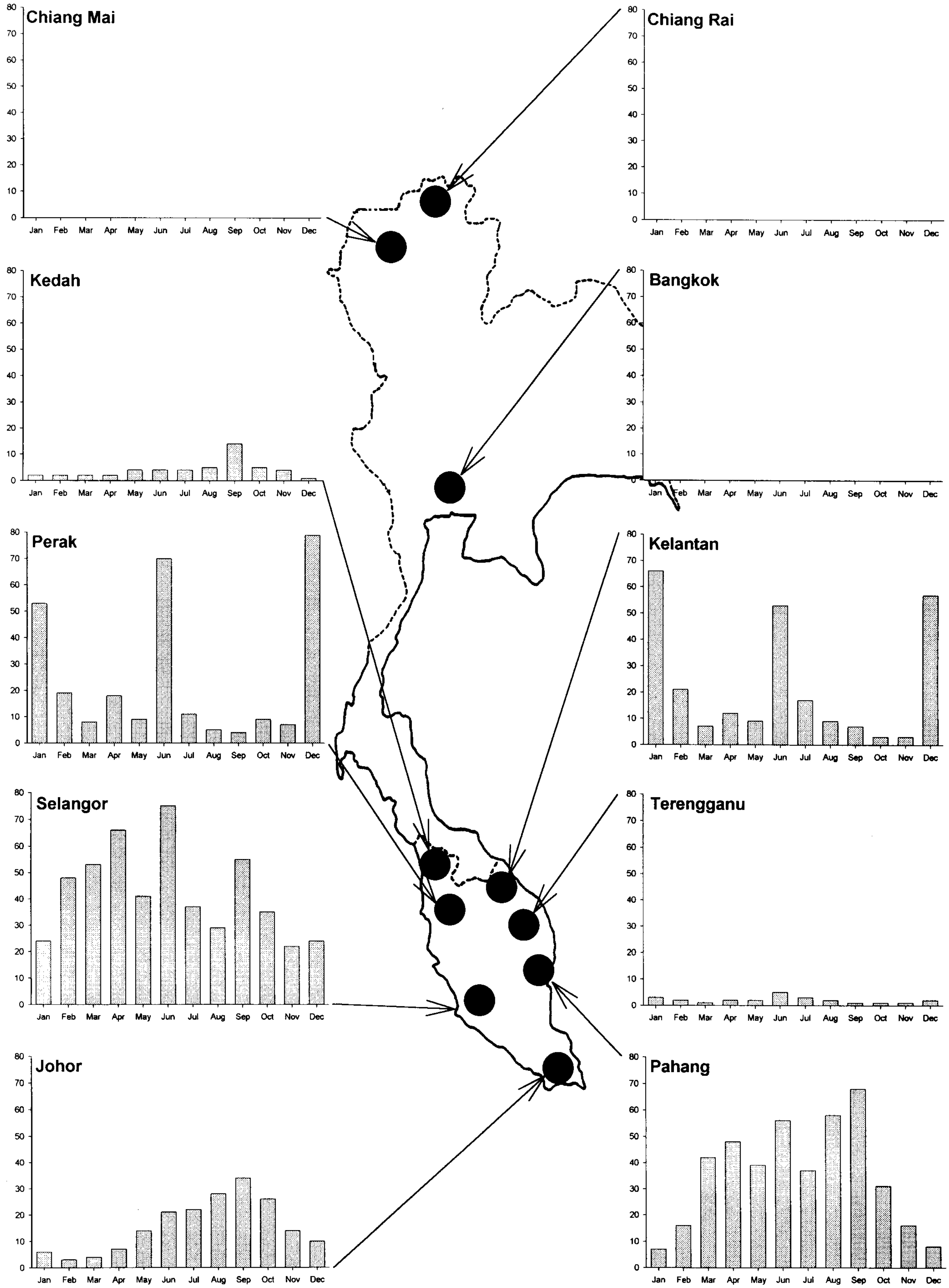

Fig. 3. Distribution and average monthly trap catch of *Bactrocera carambolae* in Thailand and Peninsular Malaysia based on catches of male flies in methyl-eugenol baited Steiner traps.

Table 1. Fruit rearing for *Bactrocera* species from different regions of Thailand. Each cell of the table contains three figures. The first is the number of flies of that species reared from the host, as a percentage of all flies of that species reared from the region. The second (round brackets) is the number of fruit from which flies of that species were reared, as a percentage fo the total number of all fruit from which flies of that species were reared for that region. The third number [square brackets] is the weight of fruit of that host-species from which flies of the species were reared, as a percentage of the total weight of all fruit from which flies of that species were reared for the region. "Other" is a pooled set of host-species which, individually, accounted for less than 2% of the total flies of that species reared for that region.

		B. dorsalis			***B. papayae***		***B. carambolae***	***B. correcta***		***B. umbrosa***
		Chiang Rai	Chiang Mai	Bangkok	Surat Thani	Songhkla	Songkhla	Chiang Mai	Bangkok	Songkhla
Total number of flies reared		8164	20129	24833	8479	118169	5893	13723	19233	1042
Total number of fruit yielding flies		6675	76480	53352	2708	116111	48272	67879	51957	165
Total weight of fruit yielding flies (kg)		195.43	1058.79	764.24	84.67	2815.23	1976.49	809.32	762.95	185.63
ANACARDIACEAE	*Anacardium occidentale*	24.4 (31.39) [33.92]			3.1 (5.02) [6.65]			2.4 (0.72) [2.38]		
	Mangifera indica	7.1 (2.79) [9.70]	4.4 (1.24) [5.59]	4.2 (2.90) [10.24]				8.7 (1.27) [11.24]		
ARECACEAE	*Areca catechu*		4.0 (0.53) [1.23]							
CAPPARACEAE	*Capparis sepiaria*							2.5 (5.72) [0.28]		
	Maerua siamensis								2.4 (0.47) [0.13]	
CARICACEAE	*Carica papaya*				3.3 (0.48) [7.33]					
COMBRETACEAE	*Terminalia catappa*	2.8 (2.37) [0.89]	15.0 (3.56) [2.67]	62 (16.90) [14.93]	27.2 (14.29) [5.83]	23.3 (12.79) [9.89]			31.3 (17.02) [14.85]	
CUCURBITACEAE	*Trichosanthes oxigera*	4.4 (0.73) [0.42]								
ELAEOCARPACEAE	*Muntingia calabura*							3.7 (3.68) [0.63]	3.2 (8.19) [0.82]	
FABACEAE	*Parkia speciosa*			3.0 (0.18) [0.54]						
LOGANIACEAE	*Fagraea ceilanica*						2.1 (0.12) [0.39]			
MELIACEAE	*Sandoricum koetjape*					4.1 (1.40) [5.57]				
MORACEAE	*Artocarpus altilis*									3.6 (49.09) [18.05]
	Artocarpus heterophyllus									84.5 (26.06) [58.76]
	Artocarpus integer									11.9 (24.84) [23.19]
MUSACEAE	*Musa acuminata*				2.3 (1.04) [0.67]					
	Musa paradisiaca				23 (3.57) [5.83]					
MYRTACEAE	*Psidium guajava*	30.1 (5.20) [13.91]	19.3 (2.61) [14.46]	8.2 (3.81) [25.59]	22.6 (12.28) [37.93]	25.5 (3.51) [16.19]	8.4 (8.40) [23.06]	17.8 (2.94) [18.91]	23.6 (3.84) [25.63]	
	Syzygium aqueum									
	Syzygium jambos		2.3 (2.15) [3.50]		3.6 (14.96) [6.89]			2.1 (2.43) [4.58]		
	Syzygium malaccensis						8 (1.27) [1.70]			
	Syzygium samarangense	4.6 (8.69) [6.41]	13.8 (4.95) [6.51]	7.1 (5.68) [9.21]		6.9 (9.03) [9.55]	26.4 (21.64) [13.61]	38.9 (5.57) [8.52]	18.4 (5.72) [9.23]	
OLEACEAE	*Myxopyrum smilacifolium*	2.8 (0.67) [0.96]								
OXALIDACEAE	*Averrhoa carambola*				5.2 (4.02) [4.58]	8.9 (6.69) [10.17]	45.2 (16.02) [14.49]			
POLYGALACEAE	*Xanthophyllum flavescens*	5.4 (3.21) [1.12]								
RHAMNACEAE	*Ziziphus jujuba*		6.5 (9.75) [5.37]	4.6 (34.45) [11.04]				7.4 (10.98) [7.03]	14.7 (34.72) [11.06]	
	Ziziphus oenoplia		2.4 (6.14) [2.80]							
	Ziziphus rotundifolia							6.7 (3.61) [1.74]		
	Zizyphus mauritiana					6.0 (10.80) [2.09]				
ROSACEAE	*Prunus persica*	8.1 (7.97) [5.71]								
SAPINDACEAE	*Lepisanthes tetraphylla*		2.3 (0.12) [1.01]							
SAPOTACEAE	*Manilkara zapota*					4.6 (2.51) [6.40]	3.4 (6.01) [9.11]			
	"OTHER"	10.4 (36.98) [26.96]	30 (68.95) [56.86]	11 (36.08) [28.45]	9.7 (44.34) [24.29]	20.8 (53.27) [40.14]	6.5 (46.54) [37.64]	9.8 (63.08) [44.69]	6.4 (30.04) [38.38]	0 (0) [0]

Table 1 (continued).

		B. cucurbitae Chiang Rai	Chiang Mai	Bangkok	Surat Thani	Songkhla	***B. latifrons*** Chiang Rai	Chiang Mai	Bangkok	Songkhla
Total number of flies reared		1060	7446	16531	1071	12219	1579	5062	1964	7802
Total number of fruit yielding flies		1090	10640	9296	477	6660	3656	13722	15773	33771
Total weight of fruit yielding flies (kg)		109.77	148.5	258.37	14.2	359.61	16.08	50.99	33.07	121.32
CUCURBITACEAE	*Benincasa hispida*	4.7 (0.28) [2.83]		4.5 (1.03) [9.05]						
	Citrullus lanatus	5.3 (10.64) [49.26]								
	Coccinia grandis	33.8 (44.95) [4.73]	39.1 (17.53) [18.47]	32.7 (43.79) [16.71]	33.5 (23.06) [11.06]	42.2 (34.65) [8.70]				
	Cucumis melo	8.1 (3.67) [13.99]		3.4 (0.43) [6.25]						
	Cucumis sativus	17.1 (6.06) [13.47]	3.6 (0.98) [8.73]	8.2 (10.81) [25.80]	6.0 (4.40) [17.44]	21.3 (18.09) [34.11]				
	Cucurbita moscchata	10.4 (7.89) [8.19]								
	Luffa acutangula	6.2 (3.12) [1.97]		9.4 (2.68) [7.84]		6.5 (8.81) [7.97]				
	Luffa cylindrica	4.0 (2.02) [3.17]	2.2 (1.61) [9.24]			2.7 (1.50) [2.82]				
	Melothria wallichii		2.5 (2.18) [1.04]							
	Momordica charantia	7.3 (10.92) [0.77]	44.8 (31.72) [9.77]	5.9 (5.67) [5.17]	57.4 (53.67) [36.81]	22.6 (18.39) [13.20]				
	Trichosanthes anguina			21.5 (1.80) [4.84]						
	Trichosanthes oxigera		2.7 (0.52) [3.05]							
	Trichosanthes wawraei			2.2 (11.00) [3.44]						
MORACEAE	*Artocarpus altilis*									
	Artocarpus heterophyllus									
	Artocarpus integer									
SOLANACEAE	*Capsicum annuum*						9.4 (13.73) [18.83]	7.3 (6.93) [23.89]	4.6 (17.68) [1.73]	6.7 (10.62) [9.89]
	Solanum aculeatissimum								21.8 (3.32) [31.26]	59 (16.14) [46.39]
	Solanum incanum									16.2 (18.15) [2.93]
	Solanum indicum						12.8 (8.07) [2.10]		6.1 (2.73) [0.44]	
	Solanum macrolon						7.9 (8.75) [1.95]			
	Solanum melongena						27.5 (11.62) [47.56]	30.7 (10.12) [63.16]	4.6 (0.69) [37.47]	2.4 (0.86) [18.25]
	Solanum nigrum							3.8 (14.75) [0.98]		
	Solanum sanitwongsei						5.1 (13.79) [1.72]		27.8 (34.81) [8.96]	
	Solanum torvum						6.7 (12.96) [13.38]	10.9 (11.93) [2.69]	34.2 (36.76) [19.22]	12.7 (44.10) [11.05]
	Solanum trilobatum						29.6 (29.15) [11.29]	39.5 (48.28) [5.56]		
	"OTHER"	3.1 (10.45) [1.62]	5.1 (45.56) [49.70]	13.1 (22.79) [20.90]	3.1 (18.87) [34.69]	4.7 (18.56) [33.20]	0.9 (1.93) [3.17]	7.8 (7.99) [3.72]	0.9 (13.58) [0.92]	2.7 (10.13) [11.49]

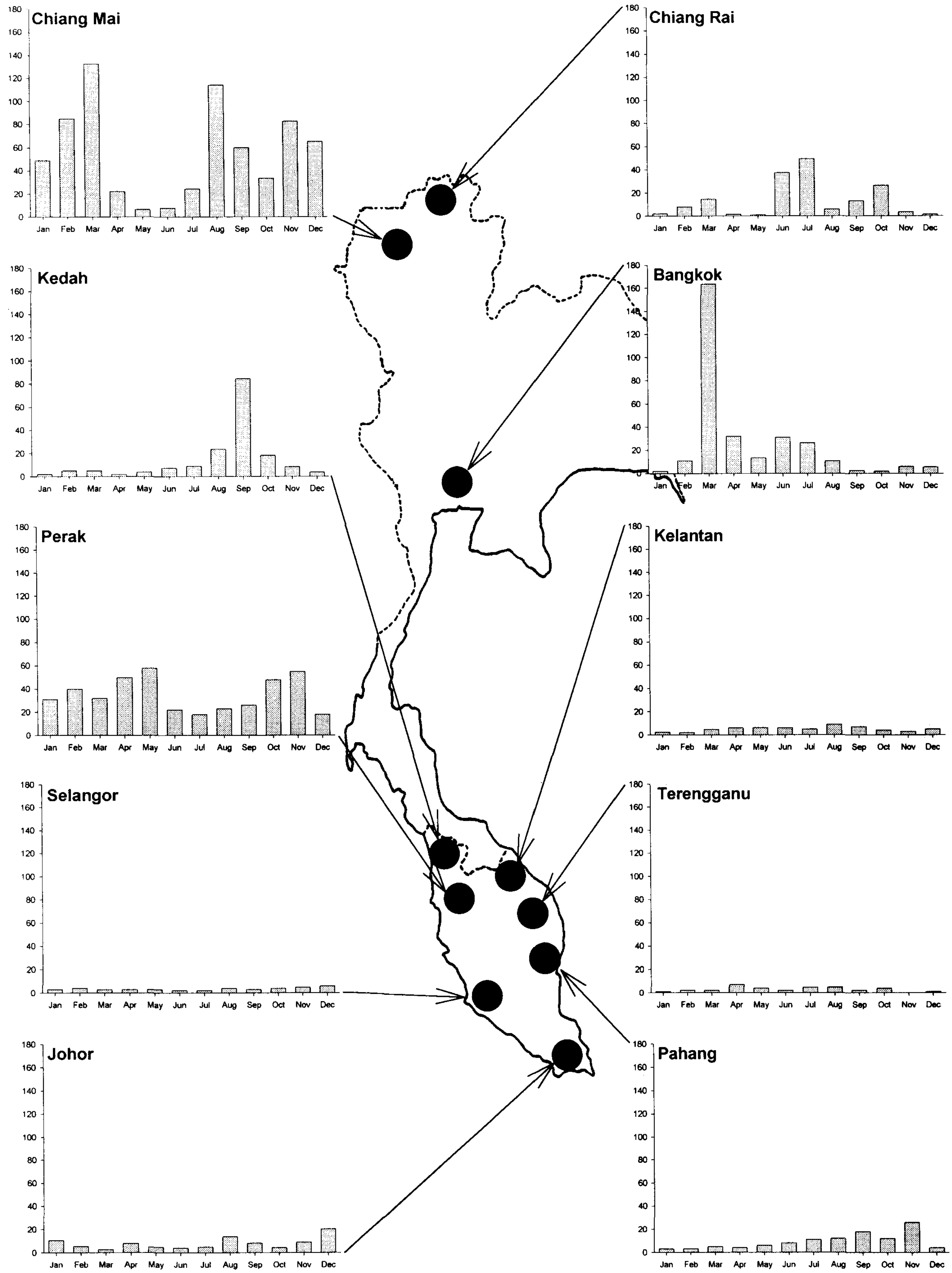

Fig. 4. Distribution and average monthly trap catch of *Bactrocera cucurbitae* in Thailand and Peninsular Malaysia based on catches of male flies in cue-lure baited Steiner traps.

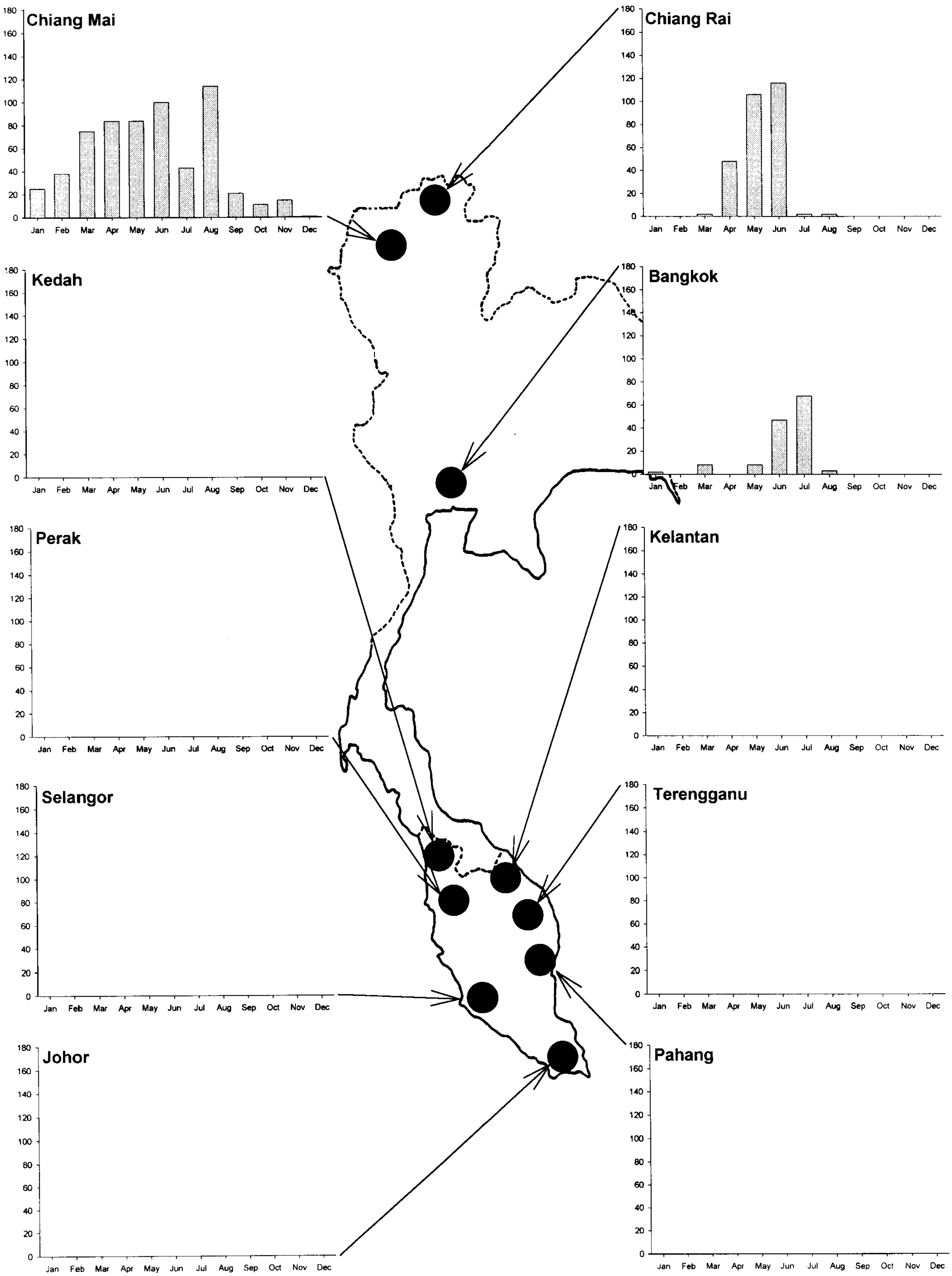

Fig. 5. Distribution and average monthly trap catch of *Bactrocera correcta* in Thailand and Peninsular Malaysia based on catches of male flies in methyl-eugenol baited Steiner traps.

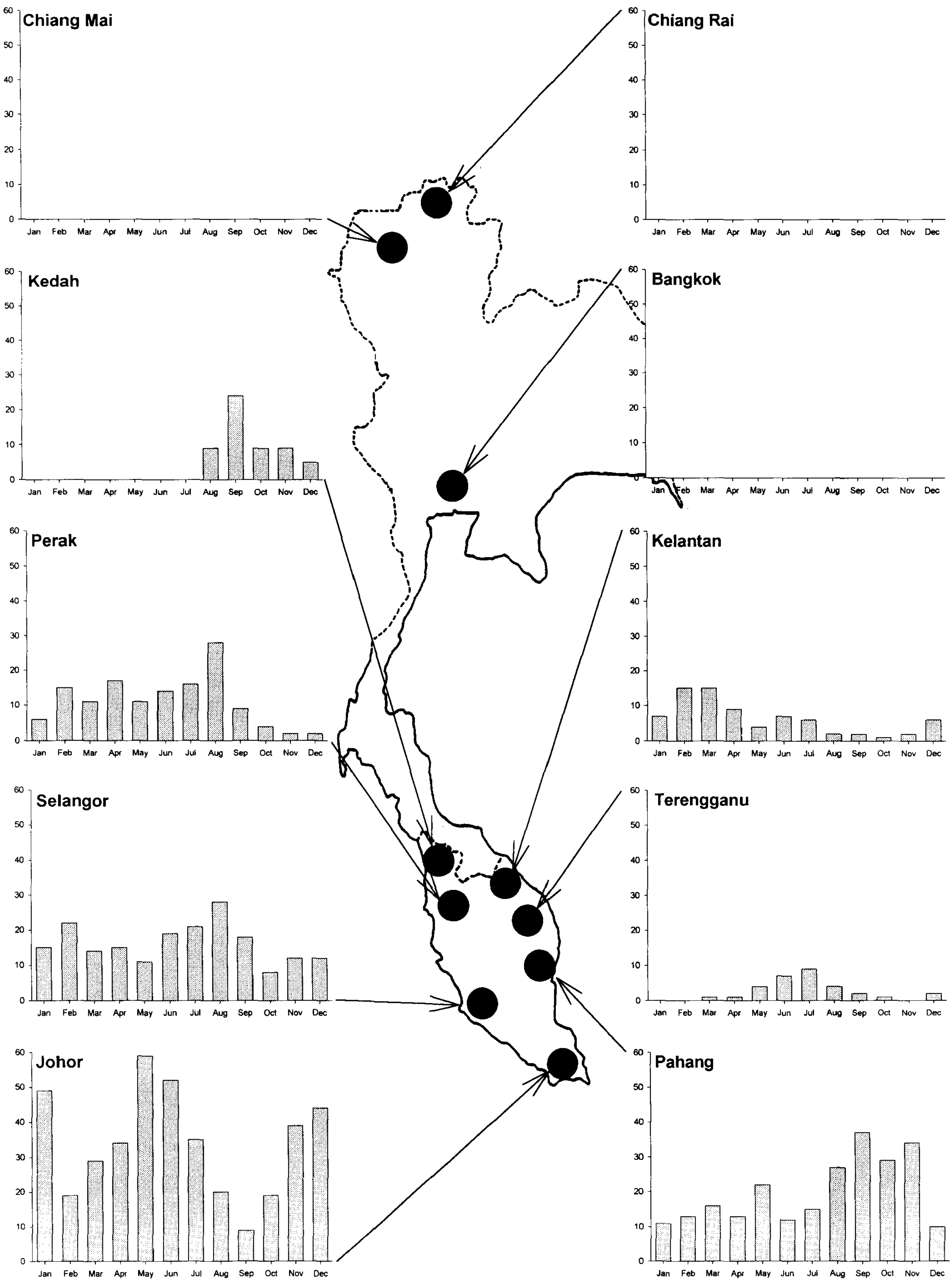

Fig. 6. Distribution and average monthly trap catch of *Bactrocera umbrosa* in Thailand and Peninsular Malaysia based on catches of male flies in methyl-eugenol baited Steiner traps.

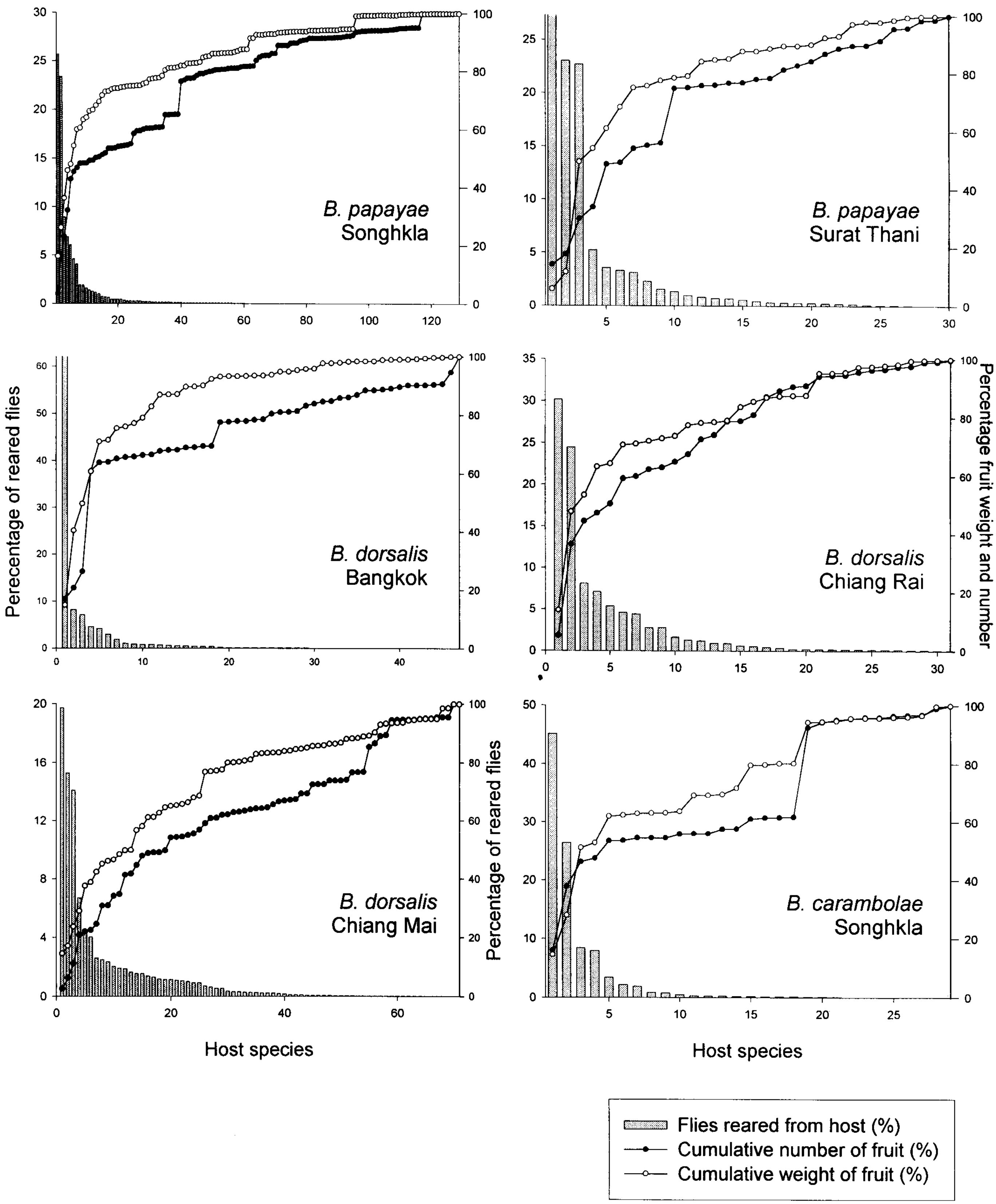

Fig. 7. Ranked plots of the percentage of three *Bactrocera dorsalis* complex species (*B. dorsalis*, *B. papayae* & *B. carambolae*) reared from host fruits in five regions of Thailand. Each column is the number of flies reared from a particular host fruit species, presented as a percentage of the total number of flies of that species reared for that region. Also plotted are the number of each host fruit sampled, and the weight of that host fruit, presented as a cumulative percentage of the total number and weight of fruit sampled for that region. Only fruit samples that yielded at least one specimen of the particular fly species are included in these totals. The total numbers of flies reared and total fruit numbers and weights are presented in Table 1.

of fruit sampled, respectively, in those regions (Fig. 7, Table 1).

Terminalia catappa and *Psidium guajava* were the major hosts of *B. dorsalis* and *B. papayae*, although *Anacardium occidentale* (*B. dorsalis*, Chiang Rai) and *Musa paradisiaca* (*B. papayae*, Surat Thani) also reared large numbers of flies in particular localities. *Terminalia catappa* consistently reared a greater proportion of flies than might be expected from the proportion of fruit (by number or weight) sampled (Table 1) and should probably be regarded as a primary native host of these species. Nearly 50% of *B. carambolae* reared came from *Averrhoa carambola*, despite this host constituting only approximately 15% of fruit sampled.

That many host plants yielded only a few flies is not directly related to low sample sizes of those fruits. Host fruits that individually contributed less than 2% of flies reared in a region are grouped in Table 1 as "Other". It can be seen that fruits in this category generally contributed only around 12% of the regional total of flies, while the respective fruit samples constituted 36-68% and 24-56% of the total number and total weight of fruit sampled, respectively. Few host fruit species rearing many flies, and many host fruits rearing few flies, accounts for the negative exponential curves seen in the ranked plots of fly numbers against the fruit they were reared from in Figure 7.

Although Allwood et al. (1999) listed *B. cucurbitae* as being reared from plants in families other than Cucurbitaceae, such records are relatively isolated and most flies were reared from a few cucurbit genera. *Bactrocera cucurbitae* was reared predominantly from three hosts, *Coccinia grandis*, *Cucumis sativus* and *Momordica charantia*, with these three hosts supplying 47–97 % of all flies reared for a region (Table 1).

Bactrocera correcta had a very similar host use pattern to *B. dorsalis* and *B. papayae*, although the total list of host plants recorded was smaller (Allwood et al., 1999). Like the two *B. dorsalis* complex species, *B. correcta* was recorded from over 25 families of plants, but key host species tended to be restricted to only a few families, particularly the Anacardiaceae, Combretaceae, Myrtaceae and Rhamnaceae (Table 1). *Terminalia catappa* and *P. guajava* were again major host plants, as was *Syzygium samarangense*.

Key hosts of *B. latifrons* were entirely restricted to the Family Solanaceae and with the exception of *Capsicum annuum*, to species of *Solanum*. *Bactrocera umbrosa* was similarly narrowly oligophagous, being collected from only three *Artocarpus* species (F. Moraceae) (Table 1).

DISCUSSION

Trapping data

Although summarised at a relatively course scale, several species (e.g. *B. papayae, B. correcta*) show distinct temporal patterns of abundance. That some species show these patterns gives confidence that those that do not are accurately reflecting a real lack of pattern, rather than a loss of pattern due to an inappropriate sampling or presentation technique. Changes in total population abundance and temporal patterns with trapping region may reflect regional differences in climate, particularly at the limits of a species' ranges. Alternatively, different host abundances or host fruiting patterns may influence population phenology. We do not have sufficient data to suggest what is driving the patterns that the data shows.

Host use patterns

Four of the seven species dealt with here, viz. *B. papayae, B. dorsalis*, *B. carambolae* and *B. correcta*, are regarded as highly polyphagous fruit flies, capable of utilising a wide range of host plants from up to 50 plant families (White & Elson-Harris, 1992; Allwood et al., 1999). Such generalisation, however, makes no comment about how individual plant species may be used in preference over others, or which species may be the most important in supplying new flies to a local population. If a species is truly polyphagous then a host should be utilised in proportion to its presence in the environment (or in a sample from that environment). Occasional use of an abundant host, or disproportionately large use of a rarer fruit, is evidence for host preference, despite apparent polyphagy.

All four of these "polyphagous" insects showed evidence for non-uniform host use, with one host species commonly supplying a disproportionately large number of flies for the amount of fruit sampled. Thus *Syzygium samarangense* supplied 2 - 4 times more *B. correcta* than might be predicted by the weight or number of that fruit sampled, *Terminalia catappa* supplied 2 – 5 times the number of *B. papayae* and *B. dorsalis*, while *Averrhoa carambolae* supplied 3 times the number of *B. carambolae*. Other hosts, particularly *Psidium guajava*, produced large numbers of flies in the samples, but this was generally in proportion with, or slightly less than, the proportional weight of that fruit in samples.

Understanding the nature of polyphagy in insect pests is critical in understanding to which host plants a species is primarily adapted, which in itself is a precurser for understanding and researching host selection and host acceptance mechanisms (Walter & Benfield, 1994). Although pertinent to the fly species above, this statement is perhaps best demonstrated by the host data for *B. latifrons*. The full host records presented in Allwood et al. (1999) show that *B. latifrons* was reared from 14 species across 10 plant families, which by definition is suggestive of polyphagy (Bernays & Chapman, 1994). However, 90 to 95% of all *B. latifrons* were reared only from species of *Solanum* (Table 1), a result more in line with a narrowly oligophagous insect. Should more detailed research on host use in *B. latifrons* occur, it could immediately target literature dealing with *Solanum* specific insects, such as the well known Colorado potato beetle (*Leptinotarsa decemlineata* Say), rather than be distracted by research complexities inherent in fully understanding polyphagy (Bernays & Chapman, 1994).

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