

Distribution of *Bactrocera* Macquart (Diptera:Tephritidae) in Kerala with Special Reference to the Western Ghats

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ABSTRACT

Fruit flies (Tephritidae) are one among the major threat to Horticulture Industry. Among the several species, most pestiferous ones come under the genus *Bactrocera* Macquart, of which the majority are attracted to the lures. An attempt was made to understand the spatial distribution of the economically important fruit flies in Kerala using Global Positioning System (GPS). Fourteen species under the genus *Bactrocera* were encountered during the study and their distribution patterns are presented. Only four species show wide distribution, namely *Bactrocera dorsalis*, *B. caryeae*, *B. cucurbitae* and *B. tau*, which are known to infest an array of fruits and vegetables. Five species *B. caudata*, *B. nigrotibialis*, *B. scutellaria*, *B. trilineata* and *B. tau*, are new records for Kerala.

Key words: *Bactrocera*, Tephritidae, Diptera, Kerala, Western ghats.

INTRODUCTION

Understanding the spatial distribution of biological diversity is the foremost prerequisite for meaningful conservation of any natural ecosystem. The construction of biodiversity maps reflecting the spatial distribution would serve several purposes such as locating the hot spots of biodiversity, assigning conservation values for different areas, giving information on the structure and dynamics of the vegetation and eventually formulating strategies for sustainable utilisation of the resources. In India among insects, root grubs and ants were mapped for their diversity (Ali & Ganeshaiah, 1998). The Western Ghats, also known as the Sahyadri Hills, are well known for their rich and unique assemblage of flora and fauna. Myers *et al.* (2000) included the Western Ghats amongst the 25 biodiversity hot spots identified in the world. Concerted efforts

to understand the distribution of Tephritidae or any other subgroups thereof are lacking in general for the state as a whole. Quantitative mapping efforts for any group of insects is totally lacking in the country even for economically important groups. Members of the tribe Dacini of Tephritidae can be trapped using very efficient parapheromone (methyl eugenol and cue lure) based traps and trap catches allow for quantitative estimates of species abundances. Keeping this in mind the present study was undertaken to estimate the diversity of fruit flies of the Tribe Dacini, Kerala with special reference to Ghat sections. Twenty one species reported by Drew & Raghu (2002) and nine species reported from Eravikulam National Park by Radhakrishnan (2002) are all the definitive set of Tephritid species reported from Kerala and largely from Western Ghats.

MATERIAL AND METHODS

The locale selected for study was a segment of Western Ghats that is confined to Kerala covering latitudes ranging from 8°533' to 12°365' and longitudes of 75°116 to 77°153'. Three roving surveys for fruit flies were conducted in this segment of the Western Ghats from December 2005 to October 2006. Flies were trapped from 72 locations all over Kerala during the entire survey period. Methyl eugenol and cue lure were used for trapping the flies. Using a Global Positioning System, latitude, longitude and altitude of sampling site were recorded which helped in mapping the sites. All the collected specimens were sorted first into different morpho species. Samples were then drawn from each morpho species to make sure that the widest possible variability for various observable characters of taxonomic importance was obtained. Each such set of specimens was then keyed out individually using the keys and diagrams developed by White & Elson-Harris (1992), Ramani (1998) and Drew & Raghu (2002). Digital distribution maps were generated for each species obtained during the surveys using the latitude and longitude values recorded from each sampling site using the software, Map Info Professional®.

RESULTS AND DISCUSSION

The survey was undertaken during three seasons along the entire stretch of Kerala with special reference to the Western Ghats yielded 14 species of fruit flies. In all, seventy two locations covering the entire length and breadth of Kerala were visited in two different seasons and a total of 2078 specimens were collected. The results are discussed under three headings.

1. Species recovery pattern

All the species collected belonged to the genus *Bactrocera* Macquart under the tribe Dacini of subfamily Dacinae.

Of the 59 species of genus *Bactrocera* reported from the Indian subcontinent (Hardy, 1977; White & Elson Harris, 1992; Kapoor, 1993; Agarwal & Seuyoshi, 2005), only fourteen species were recovered during the survey. All the flies collected belonged to a single genus *Bactrocera* Macquart and there were 14 species. Tribe Dacini are well known for their pestiferous nature and about 70 species have been reported from the Indian subcontinent (Agarwal & Sueyoshi, 2005). The 14 species collected belonged to four subgenera viz., *Bactrocera* Macquart, *Javadacus* Hardy, *Sinodacus* Zia and *Zeugodacus* Hendel. As many as 29 species belonging to the subgenus *Bactrocera* have been described from the Indian subcontinent. Nine of these species were collected during the survey. Among the fourteen species coming under the subgenus *Zeugodacus* reported from India (Kapoor, 1993; Agarwal & Sueyoshi, 2005), three were collected during the present survey. Similarly, two of the four species reported under *Javadacus* and one of the two species under *Sinodacus* was collected during this survey.

Table 1. Species recorded under the genus *Bactrocera* in the study.

Subgenus			
<i>Bactrocera</i>	<i>Javadacus</i>	<i>Sinodacus</i>	<i>Zeugodacus</i>
<i>caryae</i> (Kapoor)	<i>scutellaria</i> (Bezzi)	<i>binoyi</i> Drew	<i>caudata</i> (Fabricius)
<i>correcta</i> (Bezzi)	<i>trilineata</i> (Hardy)		<i>cucurbitae</i> (Coquillett)
<i>dorsalis</i> (Hendel)			<i>tau</i> (Walker)
<i>neonigrotibialis</i> Drew			
<i>nigrotibialis</i> *(Perkins)			
<i>verbascifoliae</i> Drew & Hancock			
<i>versicolor</i> (Bezzi)			
<i>zonata</i> (Saunders)			

*Tsuruta and White (2001) opine that the true *B. nigrotibialis* (Perkins) is not known from India and the records attributed to this species have been misidentified as “*nigrotibialis*” and all the records attribute to that species should be *B. nigrofemoralis* White and Tsuruta. The specimens of *B. nigrotibialis* collected during the study match the brief description of *B. nigrofemoralis* given by Drew and Reghu (2002) and it is likely that *B. nigrotibialis* is actually *B. nigrofemoralis* White and Tsuruta, described from Sri Lanka by White and Tsuruta (2001) and later reported by Drew and Raghu (2002) from Kerala. However, since it has not been possible to confirm this, the name *nigrotibialis* is used for the species in this paper.

2. Distribution of the species collected

The distribution patterns of the species obtained from the survey are compared with the known distribution for all the fourteen species. Distribution maps generated using GPS data is also provided for reference. In the map, the shaded region represents Western Ghats of south India.

***Bactrocera (Bactrocera) caryeae* (Kapoor)**

Known distribution: Karnataka, Kerala, Tamil Nadu (White & Elson-Harris, 1992; Drew & Hancock, 1994; Ramani, 1998; Agarwal & Sueyoshi, 2005; Kapoor, 2005/6).

Present survey: It is a member of *Bactrocera dorsalis* species complex and was present in fifty percent of the sampling sites. As many as 451 flies were collected across the length and breadth of Kerala. It was widely distributed but more abundant towards the Ghat sections especially south of Palakkad Gap and in higher altitudes (Fig. 1).

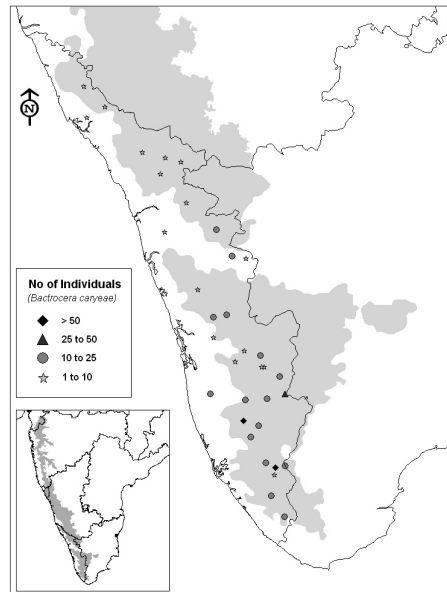


Fig. 1. Distribution of the *Bactrocera (Bactrocera) caryeae* (Kapoor).

***Bactrocera (Bactrocera) correcta* (Bezzi)**

Known distribution: Bihar, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab and Tamil Nadu (Kapoor, 1993; Ramani, 1998; Agarwal & Sueyoshi, 2005).

Present survey: The species showed a limited distribution among the sites where collections were made (Fig. 2). Around fifty flies were trapped during the three seasons of survey from 15 sampling sites out of 72 spread along Kerala. It was more frequently captured during the months December-January months of the year.

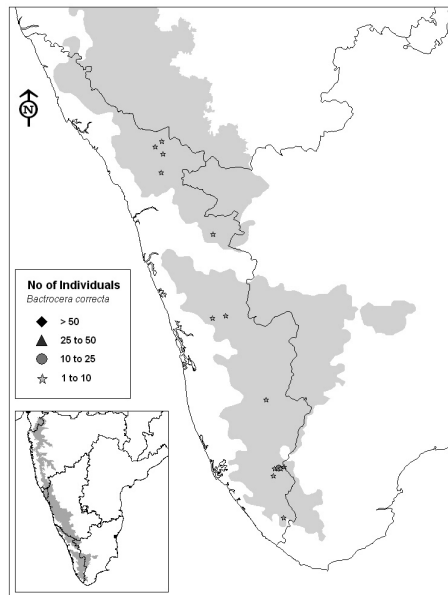


Fig. 2. Distribution of the *Bactrocera* (*Bactrocera*) *correcta* (Bezzi).

***Bactrocera* (*Bactrocera*) *dorsalis* (Hendel)**

Known distribution: Assam, Bihar, Delhi, Himachal Pradesh, Jammu & Kashmir, Kerala, Karnataka, Maharashtra, Manipur, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, W.Bengal. (Drew & Hancock, 1994; Ramani, 1998; Agarwal & Sueyoshi, 2005; Kapoor, 2005/6).

Present survey: It is quite evident from the map (Fig. 3) that this species has a ubiquitous distribution in the surveyed areas. It was the most abundant, among all encountered species and contributed to fifty percent of the total fruit flies collected. Its activity was apparent across seventy percent of the sampling sites.

***Bactrocera* (*Bactrocera*) *neonigrotibialis* Drew**

Known distribution: Kerala (Drew & Raghu, 2002).

Present survey: It is a member of the *nigrotibialis* complex. It was collected from a single location namely Kallar region coming under Thiruvananthapuram district (Fig. 4). It has been so far recorded only from Kerala, New Amarambalam in Malapuram being the first record (Drew & Raghu, 2002).

***Bactrocera* (*Bactrocera*) *nigrotibialis* (Perkins)**

Known distribution: Karnataka (Ramani, 1998).

Present survey: This species showed a fairly uniform distribution (Fig. 5) across the study area except Malampuzha region of Palakkad district, wherein 72 flies were trapped. Though a long series of specimens were collected from Karnataka, it is a first record for Kerala state. This species is an economically important species whose known host plants include *Coffea canephora*, *Malphigia glabra*, *Syzygium jambos* (White & Elson-Harris, 1992; Ramani, 1998).

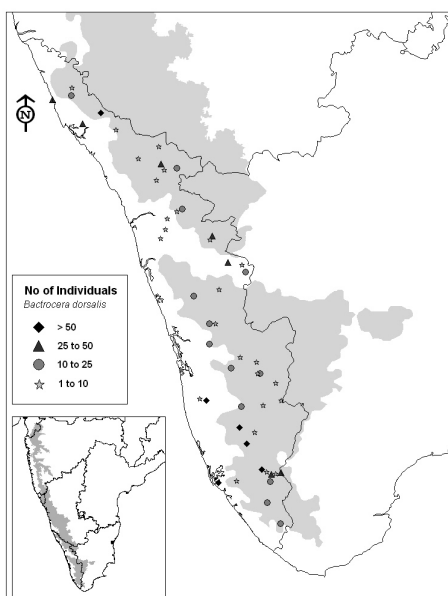


Fig. 3. Distribution of the *Bactrocera* (*Bactrocera*) *dorsalis* (Hendel).

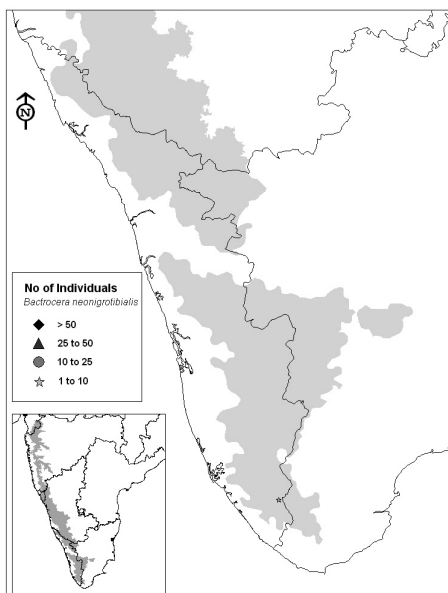


Fig. 4. Distribution of the *Bactrocera* (*Bactrocera*) *neonigrotibialis* Drew.

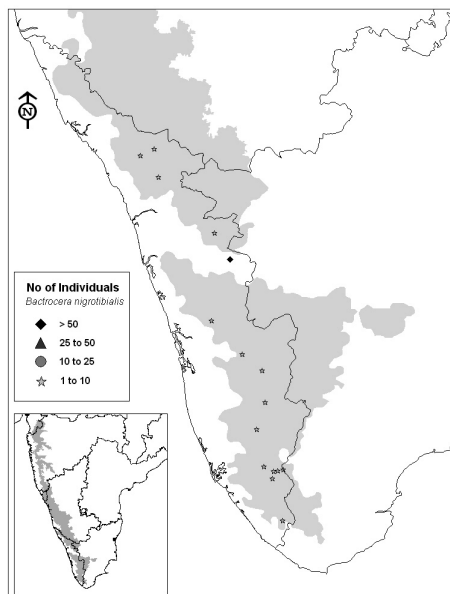


Fig. 5. Distribution of the *Bactrocera (Bactrocera) nigrotibialis* (Perkins).

***Bactrocera (Bactrocera) verbascifoliae* Drew & Hancock**

Known distribution: Karnataka (Drew & Hancock, 1994; Ramani, 1998; Drew & Raghu, 2002).

Present survey: It was recorded from a single sampling site during first survey at Tenmalai, Kollam district. It is highly restricted in its distribution (Fig. 6) in Kerala.

***Bactrocera (Bactrocera) versicolor* (Bezzi)**

Known distribution: Bihar, Karnataka, Kerala, Tamil Nadu (Ramani, 1998; Drew & Raghu, 2002).

Present survey: It was also distributed only in three namely, Palode (Thiruvananthapuram), Tenmalai (Kollam), Poringal (Thrissur) out of seventy two sites during the survey (Fig. 7).

***Bactrocera (Bactrocera) zonata* (Saunders)**

Known distribution: Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana Himachal Pradesh, Jammu & Kashmir, Kerala, Karnataka, Maharashtra, Manipur, Orissa, Punjab, Tamil Nadu, Uttaranchal, Uttar Pradesh, W. Bengal (Kapoor, 1993; Ramani, 1998; Drew & Raghu, 2002; Agarwal & Sueyoshi, 2005).

Present Survey: It was trapped only during the second season of survey. Though it is a widely distributed species in India, the present survey did not record it in large numbers (Fig. 8).

***Bactrocera (Javadacus) scutellaria* (Bezzi)**

Known distribution: Karnataka (Kapoor, 1993; Ramani, 1998; Drew & Raghu, 2002; Agarwal & Sueyoshi, 2005).

Present survey: It was collected from two sites in Wayanad district during the third season of the survey. Though its type locality is Mysore, it is reported for the first time from Kerala. Though it was more abundant than *B. trilineata*, it was confined to two sampling sites towards the north of the state (Fig. 9).

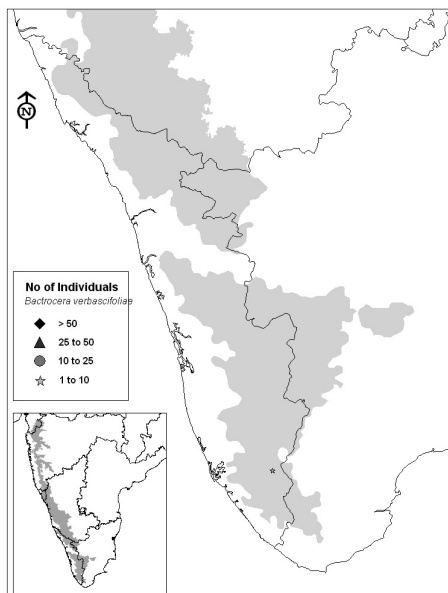


Fig. 6. Distribution of the *Bactrocera* (*Bactrocera*) *verbascifoliae* Drew & Hancock.

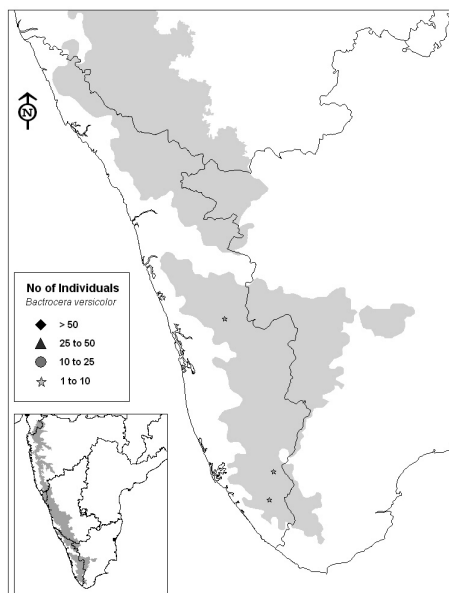


Fig. 7. Distribution of the *Bactrocera* (*Bactrocera*) *versicolor* (Bezzi).

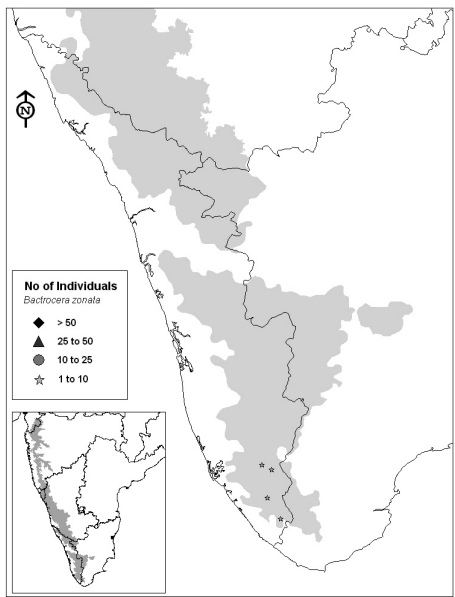


Fig. 8. Distribution of the *Bactrocera* (*Bactrocera*) *zonata* (Saunders).

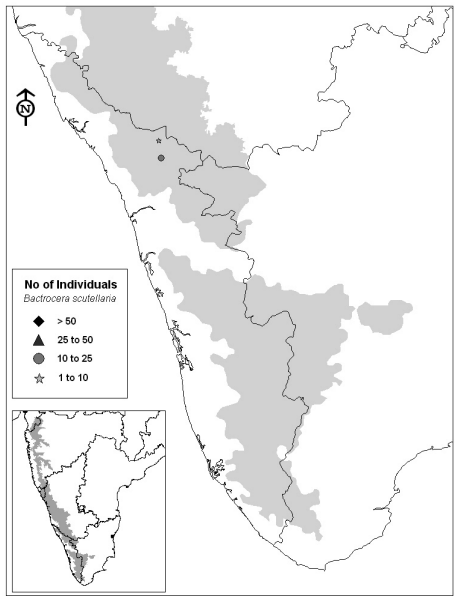


Fig. 9. Distribution of the *Bactrocera* (*Javadacus*) *scutellaria* (Bezzi).

***Bactrocera (Javadacus) trilineata* (Hardy)**

Known distribution: Karnataka, Tamil Nadu (Ramani, 1998; Drew & Raghu, 2002; Agarwal & Sueyoshi, 2005).

Present survey: It was collected from four locations from north to south across the study area, hence can be considered more evenly distributed compared to *B. scutellaria*. It is also a new record for Kerala. It was collected only from the Ghat sections, in areas of high altitude (Fig.10).

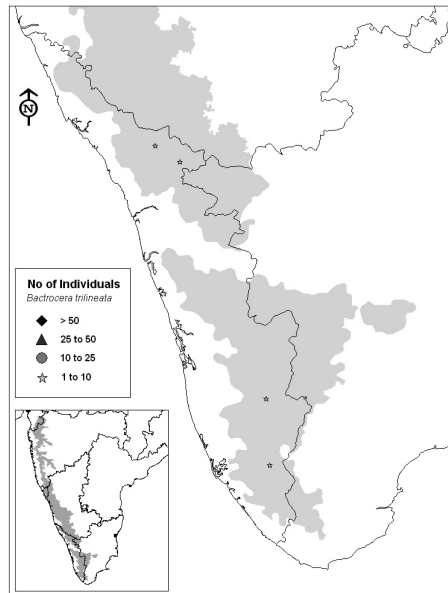


Fig. 10. Distribution of the *Bactrocera (Javadacus) trilineata* (Hardy).

***Bactrocera (Sinodacus) binoyi* Drew**

Known distribution: Kerala (Drew & Raghu, 2002)

Present survey: It was collected from a single location along the Ghat section, Nelliampathi of Palakkad district. It was reported from New Amarambalam reserve forest of Malappuram district (Drew & Raghu, 2002) and may be restricted in distribution (Fig. 11).

***Bactrocera (Zeugodacus) caudata* (Fabricius)**

Known distribution: Assam, Bihar, Meghalaya, Sikkim, Uttaranchal, West Bengal (Ramani, 1998; Drew & Raghu, 2002; Agarwal & Sueyoshi, 2005).

Present survey: This species had a restricted distribution during both the seasons (Fig. 12). Though it was recovered from north and south of the state, most of the sampling sites did not yield this particular species. It was collected from three sampling sites during the survey. It was distributed in a limited range of altitude (27 m to 35 m) but covered a wider range of latitudes, 8° 53.486' to 11° 12.893'.

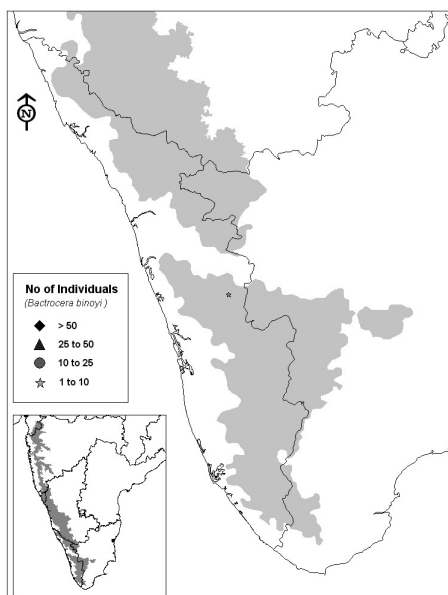


Fig. 11. Distribution of the *Bactrocera* (*Sinodacus*) *binoyi* Drew.

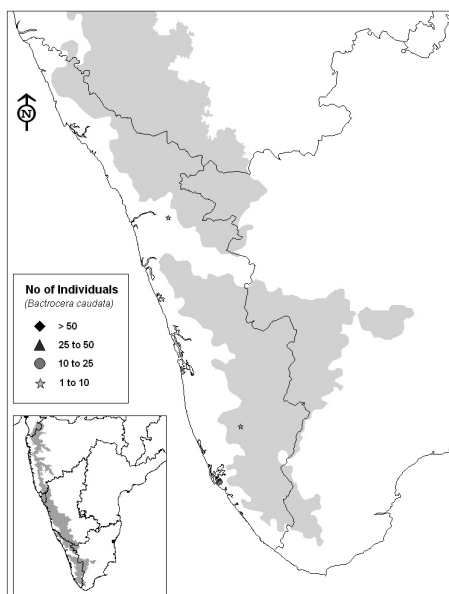


Fig. 12. Distribution of the *Bactrocera* (*Zeugodacus*) *caudata* (Fabricius).

***Bactrocera (Zeugodacus) cucurbitae* (Coquillett)**

Known distribution: Widespread (Kapoor, 1993; Ramani, 1998; Drew & Raghu, 2002; Agarwal & Sueyoshi, 2005).

Present survey: It is widely distributed along the sampling sites and was encountered in 41 locations out of 72. In all the three surveys it was evenly loaded in all the 30 sampling sites with numbers less than five except one or two sites where it exceeded 10 (Fig. 13). It showed a wide altitudinal and latitudinal range. It was represented in high ranges, midlands and coastal areas. Though it was less abundant compared to *B.dorsalis* it was widely distributed across the state.

***Bactrocera (Zeugodacus) tau* (Walker)**

Known distribution: Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Bihar, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Maharashtra, Orissa, Punjab, Sikkim, Tamil Nadu, Uttaranchal, Uttar Pradesh, W. Bengal (Kapoor, 1993; Ramani, 1998; Drew & Raghu, 2002; Agarwal & Sueyoshi, 2005).

Present survey: It showed a wide distribution pattern with 354 flies trapped from 38 locations. Compared to *B. cucurbitae* it was more abundant in Kerala during all the three seasons. There was a uniform distribution of the species with two sites revealing exceptionally higher numbers and had a better altitudinal and latitudinal coverage (Fig. 14).

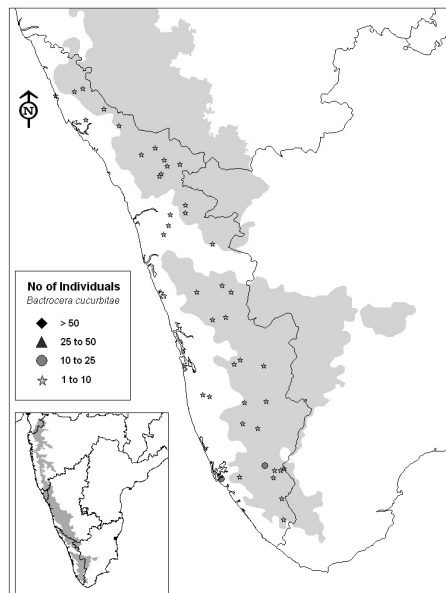


Fig. 13. Distribution of the *Bactrocera (Zeugodacus) cucurbitae* (Coquillett).

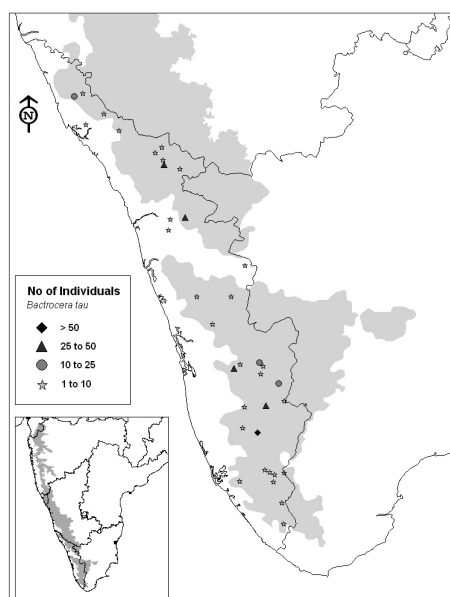


Fig. 14. Distribution of the *Bactrocera (Zeugodacus) tau* (Walker).

3. Patterns of distribution

Species distribution maps were generated for all the 14 species collected during the course of the survey. Among the species collected *B. dorsalis* (Fig. 3) was most widely distributed followed by *B. caryeae* (Fig. 1), *B. cucurbitae* (Fig. 13) *B. tau* (Fig.14) and *B. correcta* (Fig. 2). It was observed that there was a relation between the generally known distribution of these species and the recovery nature. For example, *B. dorsalis* is known to be distributed widely throughout most of Asian and South East Asian countries and most Northern Pacific islands (Drew & Hooper, 1981, White & Elson-Harris, 1992). Other species, which had a restricted distribution during the course of study, were largely reported to have narrow domains compared to the above listed five species but for *B. zonata* and *B. caudata*. Thus, largely the nature of distribution on a wider scale fitted the present relatively micro-scale distribution. Similar studies had been undertaken for other insect taxa namely ants (Hymenoptera: Formicidae) and root grubs (Coleoptera: Scarabaeidae) across India (Ali & Ganeshaiiah, 1998) but using only qualitative data of species distributions collected over decades for mapping the distribution of these two taxa while this study used quantitative data.

CONCLUSION

Nine out of fourteen species collected were all previously reported by Drew & Raghu (2002) to occur in New Amarambalam Forest in the Western Ghats of Kerala. However, Drew & Raghu (2002) reported an additional 7 species from the Amarambalam Forest area. This disparity in the number of species encountered between the two species is surprising. The first survey covered only a small part of Kerala while the second survey covered a substantially wider area of Kerala, concentrating largely along the Western Ghats. Both the surveys were based on use of the two lures but the important difference was that while their survey was over a duration of three months of study, in this study at each location the traps were placed only for two hours and all surveys were conducted during the day time. This important difference may affect the trapping pattern of flies due to activity timings of the flies, and abundance *etc.* Further, at each location only one trap was used for each lure. That might have also had an impact on the number of species trapped. Nevertheless, unlike the study conducted by Drew & Raghu (2002), the present work did not yield a good diversity of the species of Dacinae by the same standards, as expected of one locality within Kerala.

Hence more intensive methods where, long term deployment of parapheromones at every location (Drew & Raghu, 2002) and sampling of plant parts would be ideal for such purposes (Ramani, 1998). Such a method would also be of use in obtaining species of fruit flies that are not normally attracted to the two parapheromones. The present survey has however served its primary purpose of testing a methodology for more intensive surveys in the first place and has helped making gross quantitative estimates of the diversity of fruit flies across the length and breadth of the Kerala part of the Western Ghats.

ACKNOWLEDGEMENT

We thank Mrs. Narayani Barve, School of Ecology and Conservation (SEC), University of Agricultural Sciences, Bangalore for the distribution maps presented in this paper.

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Received: January 14, 2008

Accepted: June 08, 2008