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Life-table of *Odoiporus longicollis* Oliver (Coleoptera: Dryophthoridae) under varying temperature ranges, an in-vitro study

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ABSTRACT: The age specific and stage specific life table of *Odoiporous longicollis* when exposed to various temperatures (ranging from 15-42ºC) reveals that there is a strong influence of temperature on the very existence of this weevil. The survivorship exhibit a parallel pattern over all the temperatures delivered and it tend to decline as the age proceeds with no indispensable mortality at any stage or age. The developmental stages such as egg, grub, pupa and the adult up to the age of two months showed highest survivor fraction and lowest apparent mortality, mortality ratio, survival ratio and K-values at lowest temperatures. The study displays its significance to determine the optimum temperature for the laboratory rearing of the pest and ensures zero mortality other than due to aging. A simulation model was also generated based on global temperature to predict the possible locations where the insect can be a major pest. © 2017 Association for Advancement of Entomology

KEY WORDS: Banana weevil, *Odoiporous longicollis,* thermal response distribution model

INTRODUCTION

Life is described by successive age intervals, the number of deaths, the survivors, the rate of mortality and the expectation of further life. Life table provides an important tool in understanding the aforesaid changes within a population. It is an especially useful approach in entomology, where developmental stages are discrete and mortality rates may vary widely from one life stage to another. It is very useful to analyse the mortality of insect population to determine key factors responsible for the highest mortality within population. The construction of life tables can be used to predict models which can be compared against natural population fluctuations. In pest management, life-table is a most important analytical tool, which provides detailed information on population dynamics and generates simple but informative statistics. Agriculturally important pests demand the knowledge of life table since this can significantly contribute over the pest management strategies. A high index in mortality of a pest is questioned in its life table and this is usually the time when it is most vulnerable due to various stress. By knowing such vulnerable stages from life table, one can make timely application of insecticides for the management of pest. It can also be utilised to conserve the natural parasites and predators and to reduce environmental pollution by adding interactions of the pest with its environment. It is a kind of hardback custody system that ecologists

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often used to keep track of stage specific mortality in the population they study.

The banana pseudostem weevil (*Odoiporus longicollis* Oliver) is the most noxious pest of banana (Visalakshi *et al.*, 1989) and is a major issue –'out of control'- for banana farmers. The pest enjoys a tropical distribution throughout the equatorial belt. It spreads either by flying or through infested planting material transport. The apodus, soft, fleshy, white cream coloured grub of this weevil was the infesting stage of the insect. Grubs are voracious feeders. It is estimated that *O. longicollis* causes 10-90% yield losses in banana fields were an active inoculum exist (Padmanaban and Sathiamoorthy, 2001). In the last decade several incidence of *O. longicollis* has been reported from different parts of the world (Mohammad *et al.*, 2010; Palanichamy, 2011; Azad *et al.*, 2012; Khairmode, 2015; Srinivasa *et al.*, 2015). The collection of life table data of insects reared at different temperatures give valuable information that can be used to propose a distribution model.

MATERIALS AND METHODS

Maintenance of insect: Pupae of *O. longicollis* collected from the banana fields of Thiruvananthapuram (8.5488 °N, 76.9173 °E), were maintained in the laboratory at 60 ± 10% RH, 12:12-L: D and 26 ± 1 ºC and they were allowed to moult into adults. On emergence, the adults (20 nos. irrespective of sex) were transferred into rearing bottles (one litre plastic container) and maintain such 10 containers (n = 200). Weevils were timely fed with fresh pieces of pseudostem (50g) in every alternate day. The rearing bottles were provisioned in such a way that the physical parameters set in the BOD incubator (LABLINE-4000 097; Bangalore-India) will have a parallel reflection and no other factors interfere. The optimum humidity range (60 ± 10% RH) and day length (L: D 12:12) was set constant throughout the experiment while varying temperature ranges as 15-18, 18-21, 21-24, 24-27, 27-30, 30-33, 33-36, 36-39 and 39-42 ºC were provided.

Life-table: Instar specific and age specific life table of *O. longicollis* for varying temperature was constructed following Arshad and Parvez (2009) and Kakde *et al.* (2014). After stage based classification of grub, since the longevity of adult is higher, it was categorised into four age groups (1, 2, 3 and 4 month old) to study the life table.

Apparent mortality (q): It is the percentage of death of grub while moulting from one instar to other, and the adult at different ages.

$$q = d / l$$

where -

d = mortality of either the grub or the adult at the particular stage or period

l = number surviving of either the grub or the adult at the beginning of each interval

Survival fraction (Sx): It is the no. of individuals alive in each stage. Data obtained on apparent mortality was used for the calculation of the stage specific survival fraction (Sx) of each stage by using the equation:

Sx of a particular stage = LS/LP (It is always ≤ 1)

where -

L = average survivorship at each class

S = of subsequent stage

P = of particular stage

Mortality Survivor Ratio (MSR): It is the increase in population that would have occurred if the mortality in the stage of interest had not occurred and was calculated as follows:

MSR of particular stage =
[d* in particular stage] / [l of subsequent stage],

where -

d= death in each class

d*= cumulative death in each class

Indispensable mortality (IM): This type of mortality would not be there in case the factor(s) causing it is not allowed to operate. The equation is:

IM = Total individuals observed × MSR of particular stage

RESULTS AND DISCUSSION

Life table for *O. longicollis* was constructed and the following results were achieved for the various temperature ranges trialled. Extreme temperature responses and the median are listed in Table 1. In general, the apparent mortality curve shows that mortality is due to aging (Fig. 1). The 'J' curve warrants low mortality of *O. longicollis* in its active young stages. A noteworthy difference in the life span of *O. longicollis* with varying temperatures was observed. Lowest survival at both high (42ºC) and low (15ºC) extremes of temperature studied were with cent per cent mortality within 2-3 month after emergence (MAE). The Survival fraction curve (Fig. 2) shows the breadth of adaptation that *O. longicollis* could survive under varying ranges of temperatures trialled. Survival was found to decrease through aging. Mortality to Survivor Ratio was maximum in adult insects at 3rd and 4th month and minimum at pupa and adult stage in 1st and 2nd month of growth (Fig. 3). In the indispensable mortality curve the maximum mortality was on the adults on 3rd and 4th month respectively. Apart from the apparent mortality curve, indispensable mortality curve shows that there is indispensable death that occurs during the egg, pupae and in the 3rd MAE adults, that was due to unaffordable temperature ranges (Fig. 4). From the simulation study it was observed that, plantations with a temperature range of 24-30ºC is ideal for the optimum growth and spread of this noxious weevil.

Lu *et al.* (2002) first constructed a life table of *O. longicollis* population in artificial conditions,in his study only the survivorship and mortality was estimated in regular format and all other parameters were done in an exclusion index format for easiness. Current study by regular indexing gives clear idea on all the life table parameters including

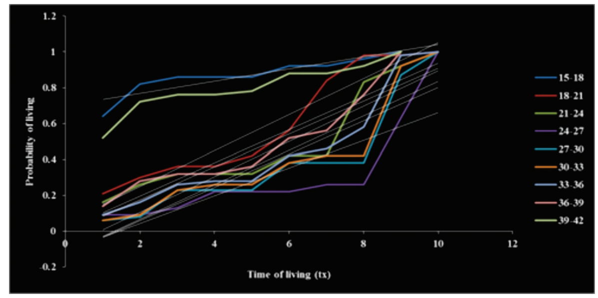

Fig. 1. Apparent mortality (qx) curve of *Odoiporus longicollis* to varying ranges of temperature

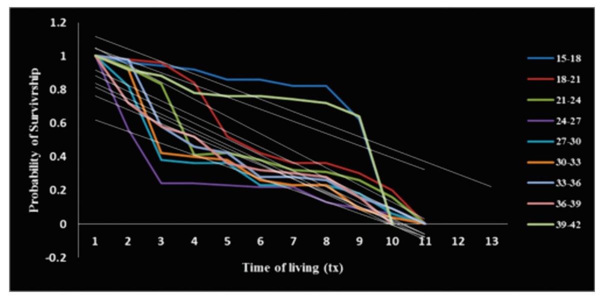

Fig. 2. Survival fraction (Sx) curve of *Odoiporus longicollis*to varying ranges of temperature.

the indispensible mortality which was not addressed by Lu *et al.* (2002). Apparent mortality of *O. longicollis* was on par with the observation documented by Christa and Shelby (2006) in *Acalymma vittatum* (Coleoptera: Chrysomelidae). Dixon and Houseweart (1982); Wittmeyer and Coudron (2001); Christa and Shelby (2006); Ali and Parvez (2009) claim the apparent mortality for a coleopteran pest will be less in the initial instar stages and pupa and this pattern was similarly followed by *O. longicollis*. Life table of *Coccinella transversalis* (Coleoptera: Coccinellidae) by Ali and Parvez (2009) also reported that in the egg stage, the apparent mortality was minimum, and in 4th instar it was high. It was clearly observed that temperature has influence the life span and cycle of *O. longicollis* with difference to apparent mortality over higher and lower ranges.

In this study a survival fraction curve for *O. longicollis* was plotted and observed maximum values for survival at stage 1 (egg) to 7th (Adult, 1 month old). The studies of Dixon and Houseweart (1982); Christa and Shelby (2006) and Ali and

Table 1. Life table of *Odoiporus longicollis*at varying temperature

Stage or age group (x)	Pro. survivorship (lx)			Pro. death (dx)			Pro. Mortality rate (qx)			Pro. Survival fraction (sx)			MSR		
	15-18 ℃	24-27 ℃	39-42 ℃	15-18 ℃	24-27 ℃	39-42 ℃	15-18 ℃	24-27 ℃	39-42 ℃	15-18 ℃	24-27 ℃	39-42 ℃	15-18 ℃	24-27 ℃	39-42 ℃
Egg	1.00	1.00	1.00	0.00	0.00	0.00	0.17	0.09	0.23	1.00	1.00	1.00	0.00	0.00	0.00
1st instar	0.74	0.90	0.65	0.12	0.09	0.17	0.32	0.00	0.32	0.96	0.94	0.93	0.01	0.11	0.01
2nd instar	0.61	0.90	0.52	0.22	0.19	0.36	0.12	0.10	0.14	0.84	0.94	0.82	0.03	0.11	0.02
3rd instar	0.61	0.81	0.48	0.38	0.22	0.42	0.08	0.04	0.34	0.62	0.92	0.54	0.08	0.24	0.06
4th instar	0.51	0.77	0.37	0.36	0.22	0.48	0.02	0.00	0.12	0.56	0.97	0.48	0.18	0.29	0.11
Pupa	0.51	0.77	0.37	0.42	0.29	0.48	0.17	0.08	0.62	0.56	0.95	0.42	0.52	0.30	0.31
Adult 0-1 MAE	0.34	0.71	0.32	0.61	0.00	0.52	0.42	0.00	0.82	0.42	0.95	0.39	1.20	0.40	0.98
1-2 MAE	0.26	0.71	0.22	0.74	0.18	0.63	0.57	0.18	0.98	0.42	0.90	0.27	1.31	0.45	1.24
2-3 MAE	0.17	0.58	0.09	1.00	0.63	1.00	1.00	0.63	1.00	0.31	0.61	0.08	2.21	1.06	2.72
3-4 MAE	0.0	0.21	0.0	NS.	1.00	NS.	NS.	1.00	NS.	NS.	0.26	NS.	NS.	3.12	NS.
4-5 MAE	0.0	0.00	0.0	NS.	NS.	NS.	NS.	NS.	NS.	NS.	NS.	NS.	NS.	NS.	NS.

Ave.= Average, Pro.= Probable or Probability, NS. = Non Significant value, MSR= Mortality to Survivor ratio

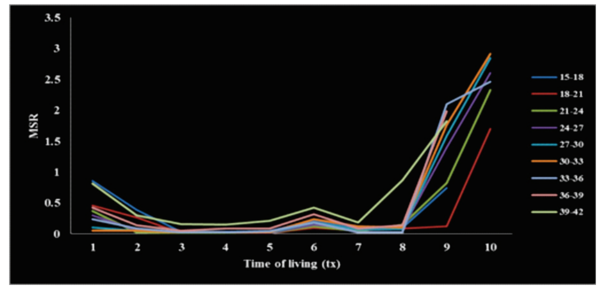

Fig. 3. Mortality to survivorship ratio of *Odoiporus longicollis*to varying ranges of temperature.

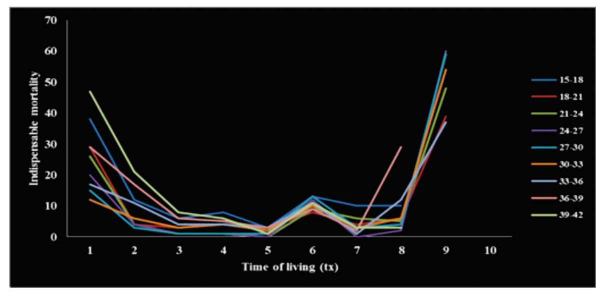

Fig. 4. Indispensable mortality curve of *Odoiporus longicollis*to varying ranges of temperature.

Parvez (2009) revealed most of the coleopteran weevils exhibit similar inverted 'J' shaped survival fraction curve, representing significant level of mortality that happens only by aging. For different temperature range the mortality exhibited a steady increase both to higher and lower ranges.

Mortality survivorship ratio (MSR) was high in adults of the age 3rd and 4th months and this support the survival fraction curve as it is exactly inverse. A similar observation was made by Dixon and Houseweart (1982) in white pine weevil, *Pissodes strobe*, and relates the MSR with survival fraction curve. MSR ratio clearly depicts the major decline in population happens by aging even in the case of higher or lower temperature stress.

By sketching an indispensible mortality curve it is clear that irrespective of sex there was no indispensable mortality for *O. longicollis* at an optimum temperature ranges such as 24-27 ℃ and for 27-30 ℃. Aging was the only indispensability as far as *O. longicollis*is concerned in its optimal conditions. According to Ives (1964) "indispensible mortality only due to aging- is a status shown by a pest, if the insect is from agricultural background". In most of the coleopteran life table significant indispensible mortality can be noticed at the egg stage due to egg viability (Ives, 1964; Dixon and Houseweart, 1982; Wittmeyer and Coudron, 2001; Christa and Shelby, 2006; Ali and Parvez, 2009), microbial infections (Lu *et al.,* 2002), and by many other abiotic futility issues (Kakde *et al.*, 2014), but in *O. longicollis* as the eggs are well protected in the pseudostem, there is no futility and no significant indispensible mortality in its egg stage.

In the current study the temperature ranges that are optimum for the survival and multiplicity of *O. longicollis* was revealed. By analysing the survivorship cure, mortality curve and indispensible mortality curve present study marks *O. longicollis* the status of a major pest. By relating the survivorship possibilities with the temperature ranges the study portraits tropical planes with an average year round temperature of 24-30 ºC with an average high humidity as the best platform for *O. longicollis* to thrive in its pest status. A detailed study regarding the biology of *O. longicollis* with varying physical parameters will be helpful for making simulation models to forecast pest incidence and for its management.

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