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EFFECT OF TEMPERATURE ON DEVELOPMENT AND REPRODUCTION OF *BRACON HEBETOR* SAY. (HYMENOPTERA: BRACONIDAE)

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ABSTRACT

The relationship between temperature and insect development time /rate has been investigated by various researchers. The phenology and synchrony of parasitoid Bracon hebetor and host Corcyra cephalonica has been affected by temperature. Temperature is one of the most important factors effecting population growth of insects. Development ceases below a low temperature threshold, above this the rate of development increases with temperature until the optimum is reached. Fecundity, sex ratio, incubation period, larval period, pupal period and total time taken to complete the lifecycle was significantly affected by low and high temperatures.

KEYWORDS: Parasitoid, temperature, development, *Bracon hebetor*, *Corcyra cephalonica*

INTRODUCTION

The philosophy of modern insect pest management is based on the management of entire pest population not just located one, where a single control technique is employed. In IPMs emphasis is placed on the use of combination of the methods aimed at providing cheap but long term reliability with the minimum harmful side effect**.** The philosophy and method of modern IPM programme is thus compatible with the philosophy and methodology of biological control. Indeed, biological control has been a control core around which IPM has been commonly developed**.** In recent past several aspect of biological control has been reviewed. Biological control, when it can satisfactorily employed, hold several distinct advantage over other pest control methods. Such as self-perpetuation lack of resistance and lack of adverse side effect**.**

The purpose of biological control can be achieved by judicious manipulation of environmental factors for increasing the activities of indigenous or exogenous (exotic) natural enemies or by the innundative release of biotic agent for the temporary alleviation. The merit of exotic form as a better bio control agents of pest have been discussed by De Bach (1974) and Hagstrum & Smittle (1977), but now it has been realized that the indigenous parasitoid can produce even better result provided their behaviour and the environment are carefully manipulated .

To solve the 'twin problem' i.e. the food problem and population explosion "Green revolution" and "Population control programs" were made to increase the quantity of important cereals and to minimize the human population respectively. Nearly 1000 species of insect have been found associated with stored products in various part of world. The majority of stored pest belong to order Coleoptera (60%) and Lepidoptera (8-9%).

Corcyra cephalonica **(Stainton)** (Lepidoptera: pyralidae) – a major pest of stored commodities is commonly known as – rice moth It is capable of damaging all kinds of food grain, particularly, Maize, wheat, rice etc. It is a pale greyish brown coloured moth. A single female lay about 100 – 200 eggs. The eggs are laid indiscriminately on loose gain mass. The larvae feed on food grain. When fully fed, the larvae spin a silken cocoon in which it pupates. The incubation period is about 4 – 5 days, the larvae period last for 3 – 4 weeks and pupae period 10 days. It damages the cereal quantitatively and deteriorates its quality.

An extensive study of literature suggest that although parasitoid *Bracon hebetor.* Say (**Hymenoptera: Braconidae)** works as potential Biocontrol agent against stored grain pest especially *Corcyra cephalonica.* (**Stainton**), very little work has been done to evaluate the effect of ecological factors especially temperature on development and reproduction of the parasitoid in India especially in Uttar Pradesh. The aim of the present work is an attempt to evaluate some factor which effect development and reproduction of *Bracon hebetor*, so it can be utilized successful biological control of stored grain pest especially *Corcyra cephalonica*.

MATERIALS AND METHODS

(a) Rearing of the pest: The rearing technique for the stored grain pest *Corcyra cephalonica* described herein is minor modification of the technique followed by **Deepak et al., (2006) and Antolin & Strand (1992),** respectively. To maintain the mass culture of stored grain pest. *Corcyra cephalonica*, the egg of rice moth were taken from control Integrated Pest Management Centre, Gorakhpur (CIPMC, GKP) and they were kept with coarsely ground rice (Oryza Sativa Linn) seed in large plastic containers (45x25x15 c.m.) at 25 ±2^{0}c and at 60%±0% RH. The containers were observed daily and nutrients were replenished after consumption and damage by the larvae. When adults were emerged then equal number of males and females were paired in a beaker (250ml) covered with a black muslin cloth. The eggs were collected from the beaker and were again placed with fresh nutrients. A mass culture of *Corcyra cephalonica* was thus maintained. After 3-4 generation, full grown larvae of rice moth were taken to feed and rear the parasitoid *Bracon hebetor.*

(b) Rearing of the parasitoid: For the culture of *Bracon hebetor* say (**Hymenoptera : Braconidae**), adult insects were collected from CIPMC, GKP. The insects were identified as males and females. One male and one female insects were paired in the beaker (250ml) having 10 full grown Vth instar larvae of *Corcyra cephalonica* covered with five muslin cloth. The adults were provided 30% honey solution as Food (**Kumar & Tripathi, 1985; Kumar et al., 1987, 1988a, 1988b**) through a thin glass tube having honey mixed with distilled water and plugged with cotton. After parasitisation, the parasitoids were withdrawn from the beaker and hosts and were kept separately for further development. After completing his/her development, the new generations of adult wasps were paired again in a similar manner for fresh laying. After third generation, adults were utilized in experiment.

(c) Experimental Procedures

Although important attributes of potential natural enemies are many, thermal adaptions are one of the easiest to measure and are essential to successful biological control (**Frazer & McGregor, 1992**). The temperatures influence the biology of all trophic level and exert important limiting effect on the insect population and abundance. It affects the parasitoid in several ways directly and indirectly by reducing survival, retarding development or suppressing reproduction. (**Force & Messenger 1964, a,b**). The performance of the parasitoid was observed on different constant temperature 20^0c, 24^0c, 28^0c, 32^0c and 36^0c. A one day old mated and experienced female parasitoid satiated with 30% honey solution was released in the glass container for 24 hrs at 25 ±2^0c temperature, 60 ±10% RH and 12 hr. L:D period. The experiments were replicated five times and 12 hrs check was to record development time of different stages, fecundity and sex ratio. All the experiments were carried out in B.O.D. (Biological Oxygen Determination) incubator and data were utilized statistically.

RESULT AND DISCUSSION

The relationship between temperature and insect development time and developmental rate has been investigated by various research workers. This relationship was established very early and represents an important ecological variable for modeling population dynamics of Insects **(Gilbert & Raworth, 1996; Jarosik et. al, 2002).** Temperature is an important factor in the development of immature parasitoid. It is clear that parasitoid development is prolonged and mortality increases at relatively cool and hot temperature extremes **(Cheah, 1987; Cave & Gaylor, 1988).** Also, the phenology and synchrony of parasitoid-host relationship is affected by temperature **(Dowell 1979).**

The research on temperature-dependent development of immature stages of *Bracon hebetor* was carried out at six different constant temperatures (16^0C, 20^0C, 24^0C, 28^0C, 32^0C and 36^0C). The study of development time of different growth stages of *Bracon hebetor* showed that parasitoid was able to complete its life cycle at all temperature except for 16^0C, result similar to the work carried out by Forouzan *et al*., (2008). The incubation period was shortest on 32^0C (1.6 ± 0.21) when compared to other constant temperatures 36^0C (2.2 ± 0.29), 28^0C (3.2 ± 0.17), 24^0C (4.6 ± 0.3) and 20^0C (5.8 ± 0.4) (Fig. 1) with significant difference of 32.66, P<0.001. The development rate for incubation period was highest on 32^0C (0.6250) and lowest on 20^0C (0.1724) (Fig. 7). The larval period was shortest on two constant temperature 32^0C and 36^0C (4.4 ± 0.21) respectively in comparison to 20^0C (5.2 ± 0.17), 24^0C (6.0 ± 0.5) and 28^0C (5.2 ± 0.17) (Fig. 2). The rate of development again was highest on 32^0C and 36^0C respectively

(Fig. 8). The pupal period was longest on 20^0C (9.2 ± 0.43) and shortest on 32^0C (5.0 ± 0.39). (Fig. 3) therefore the fastest rate of development was obtained at 32^0C (0.2000) when compared to other constant temperature (0.1086), (0.1136), (0.1388) and (0.1923) respectively (Fig. 9). The total time taken to complete the development (egg to adult female) was shortest on 32^0C (11 ± 0.39) and longest on 20^0C (20.2 ± 0.52) (Fig. 4) with marked statistical significance F = 123.5 P<0.001. The rate of development was highest on 32^0C (0.0909) and shortest on 20^0C (0.0495) when compared to other (0.0515) on 24^0C (0.0641) on 28^0C and (0.0862) on 36^0C (Fig. 9).

A statistical difference was observed on the fecundity (F=32.27 P<0.001) when compared on different constant temperature. The fecundity was highest (Fig. 5) on 32^0C (88.60) and lowest on 20^0C (56.6). Thus the ability to produce female offspring was significantly affected by change in temperature. The development rate was also affected significantly (Fig. 10).The sex ratio was female biased at 20^0C (54.77%) and 24^0C (52.68%) but male biased at 28^0C (42.09%), 32^0C (33.86%) and 36^0C (27.75%). Thus there was an increase in the proportion of female with the decrease in temperature (Fig. 6).

Temperature is one of the most important factors affecting population growth of arthropods. The relationship between temperature and the development rate of insect is linear over most of the range of exposing temperature. Development ceases below a low temperature threshold; above this the rate of development increase with temperature until an optimum is reached **(Briere et al., 1999).** Since insects on poikilothermic, their temperature varies with ambient temperature. Ambient temperature is important because it affects enzyme activity through change in body temperature Body temperature represents a balance between the heat gained from metabolic activity and for the environment and heat lost by evaporation and convection. There is little physiological control of body temperature, but adaption tends to maintain the temperature as near to an overall optimum for metabolic activity as environmental condition allow. Insects develop with in a limited range of temperature which is characteristic of the species and they are killed by temperature outside this range **(Chapman, 1982).**

The temperature influences the biology of all trophic levels and exerts important limiting effect on insect population, distribution and abundance. It affects the parasitoid in several ways directly or indirectly by reducing survival, retarding development or suppressing reproduction **(Force & Messenger, 1964, b; Messenger, 1970)** and likely to influence the successful use of the parasitoid. Our study demonstrated the effect of temperature on the development, reproduction and development rate of *Bracon hebetor*. As expected and reported by **Forouzan et. al, 2008**, the total development time decreased with increase of temperature from 20^{0}C to 36^{0}C. The data suggest that temperature between 28^{0}C to 36^{0}C provide optimum condition for rearing the parasitoid in the shortest time. The control and management of temperature in the insectarium is an important factor in mass rearing and release of insects **(Naka mori et. al, 1975).** Our results were similar to that of **Barfield et al., (1977)** who studied the influence of temperature of development of immature stages of *Bracon mellitor* say, a braconid parasitoid of the boll weevil.

A decrease in proportion of female was observed with increase in temperature. The increase in temperature shifted the sex ratio towards more male production. More production of higher temperature is a result of more unfertilized haploid eggs **(Holloway et. al., 1999).** The fecundity was affected in the same manner as fecundity of *A. incarnatus* was affected. At moderate temperature more progeny was produce than those at extremely low or high temperature 20^{0}C (56.6 ± 3.92) and 32^{0}C (88.60 ± 5.60). At 16^{0}C the parasitoid failed to produce any progeny.

In over all experiment it was observed that the speed of development was higher on high temperature when compared to low temperature the incubation period, larval period, pupal period and the total time taken for the cycle was shortest on 32^{0}C and 36^{0}C (1.6 ± 0.21, 2.2 ± 0.29), (4.4 ± 0.21, 4.4 ± 0.2), (5.0 ± 0.39, 5.2 ± 0.29), (11.0 ± 0.39, 11.6 ± 0.21) respectively in comparison to 20^{0}C and 24^{0}C (5.8 ± 0.4, 4.6 ± 0.3), (5.2 ± 0.17, 6.0 ± 0.5), (9.2 ± 0.43, 8.8 ± 0.25), (20.2 ± 0.52, 19.4 ± 0.46). It is a general phenomenon reported in parasitoid **(Mackauer, 1986; Riggin et al., 1992)** and may occur due to increased metabolic activities with increasing temperature. The result in this study revealed that temperature between 28^{0}C to 32^{0}C provides a favourable condition for rearing *Bracon hebetor*.

CONCLUSION

Fecundity of *Bracon hebetor* was affected by all rearing temperature. At moderate temperature the parasitoid produced significantly more progeny than those at extremely high on low temperatures. Fecundity of *Bracon hebetor* reached maximum at 32^{0}c but did not differ greatly than that at 28^{0}c with a stabilizing trend at 36^{0}c. Over the range of temperature tested, the lowest reproduction rate was found at lower temperature (20^{0}c and 24^{0}c) and this implies that in cooler environment the reproductive rate of the parasitoid decreases. Sex ratio was female biased at lower temperature 20^{0}c & 24^{0}c with a linear decrease at 28^{0}c, 32^{0}c and 36^{0}c which is due to characteristic of haplodiploid group (arrhenotokous sps), superparasitism etc, at higher temperatures. The development time of immature stages was shortest at moderate temperatures viz 32^0c, 36^0c and 28^0c in comparison to 20^0c and 24^0c.

The result obtained from the experiments showed the suitability of moderate temperatures 32^0c and 28^0c in comparison to low temperatures in development of *Bracon hebetor*. Say and can be utilized accordingly in mass rearing programmes.

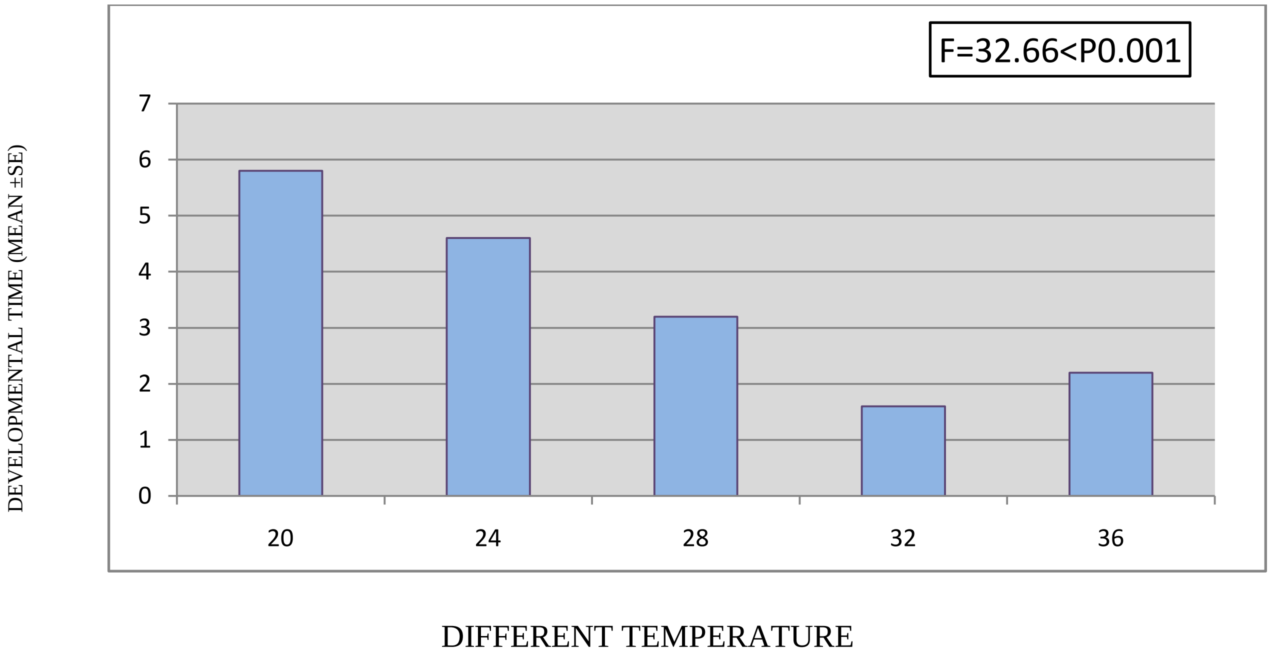


Fig-1 - Effect of different temperature on mean development time (in days) of egg of *Bracon hebetor*

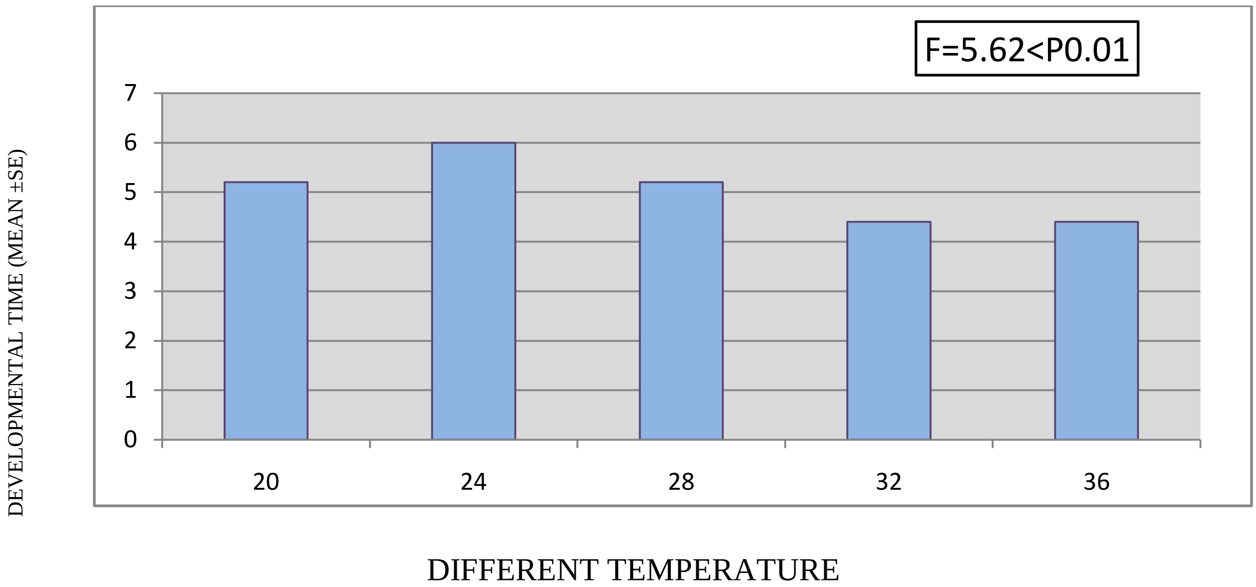


Fig-2- Effect of different temperature on mean development time (in days) of larvae of *Bracon hebetor*

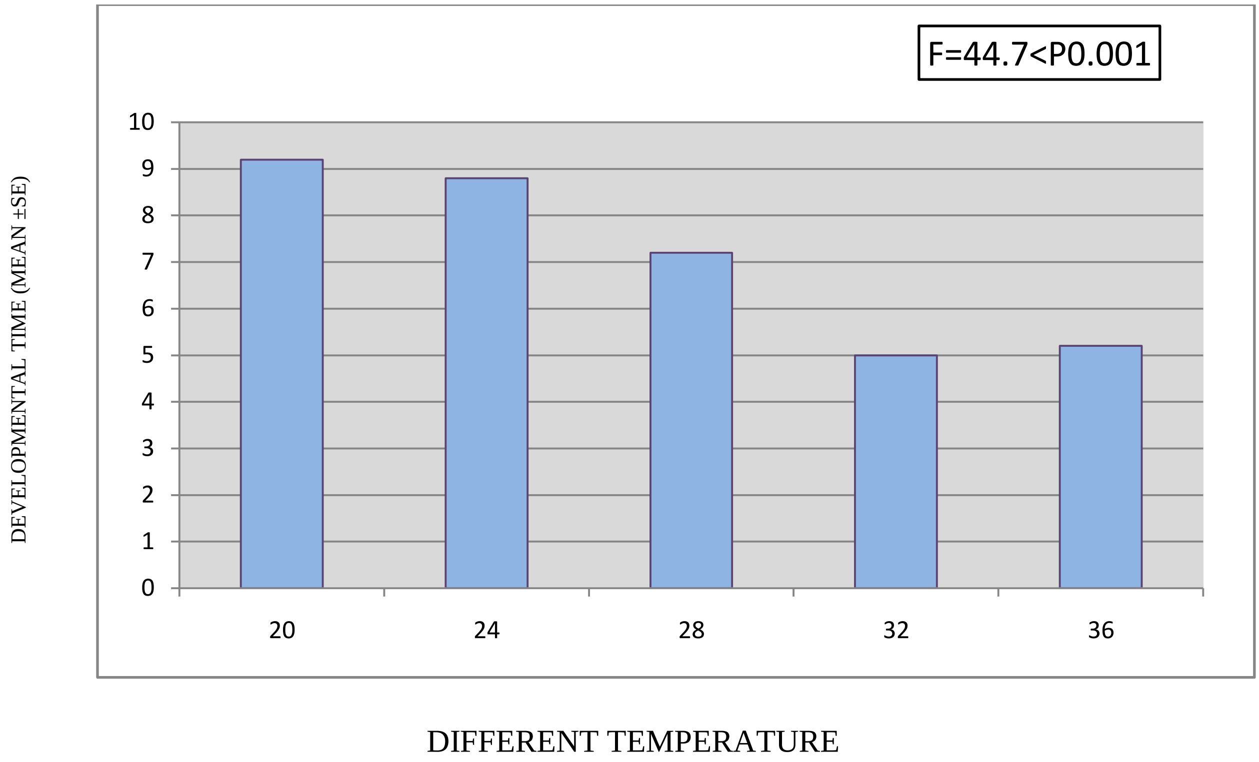


Fig-3- Effect of different temperature on mean development time (in days) of pupae of *Bracon hebetor*

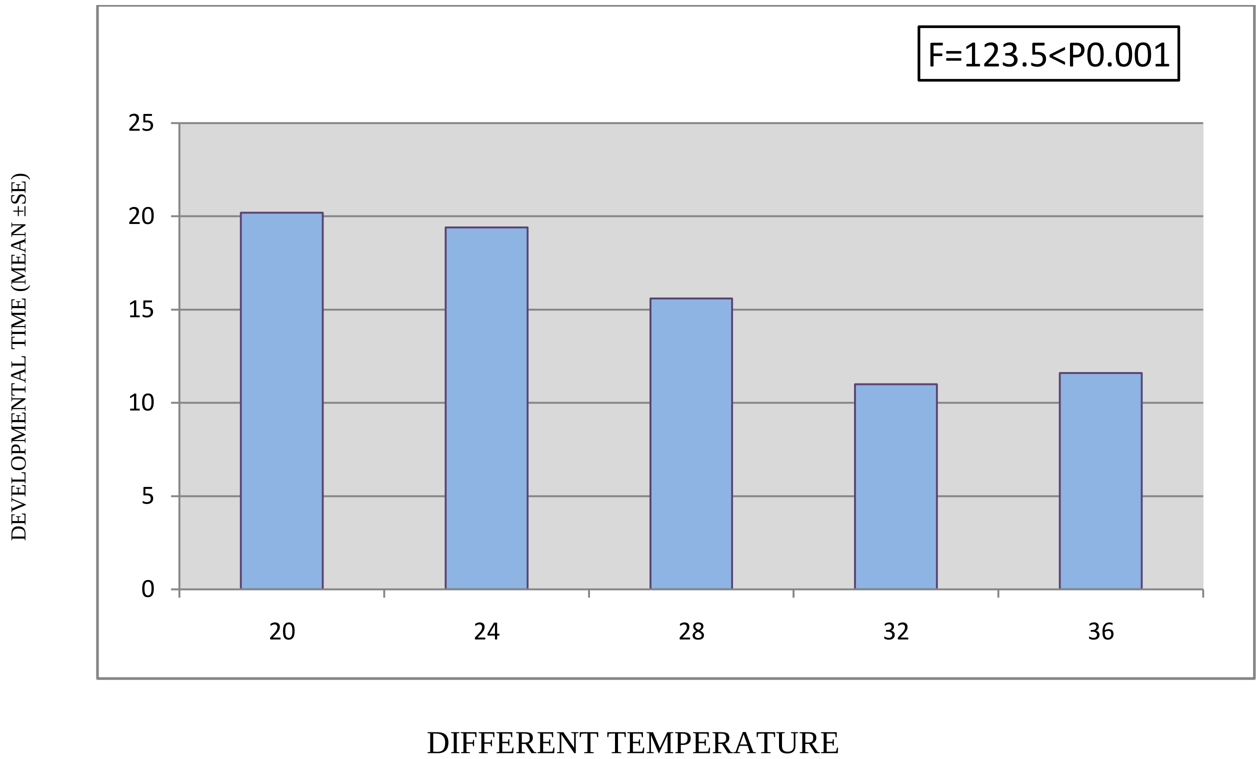
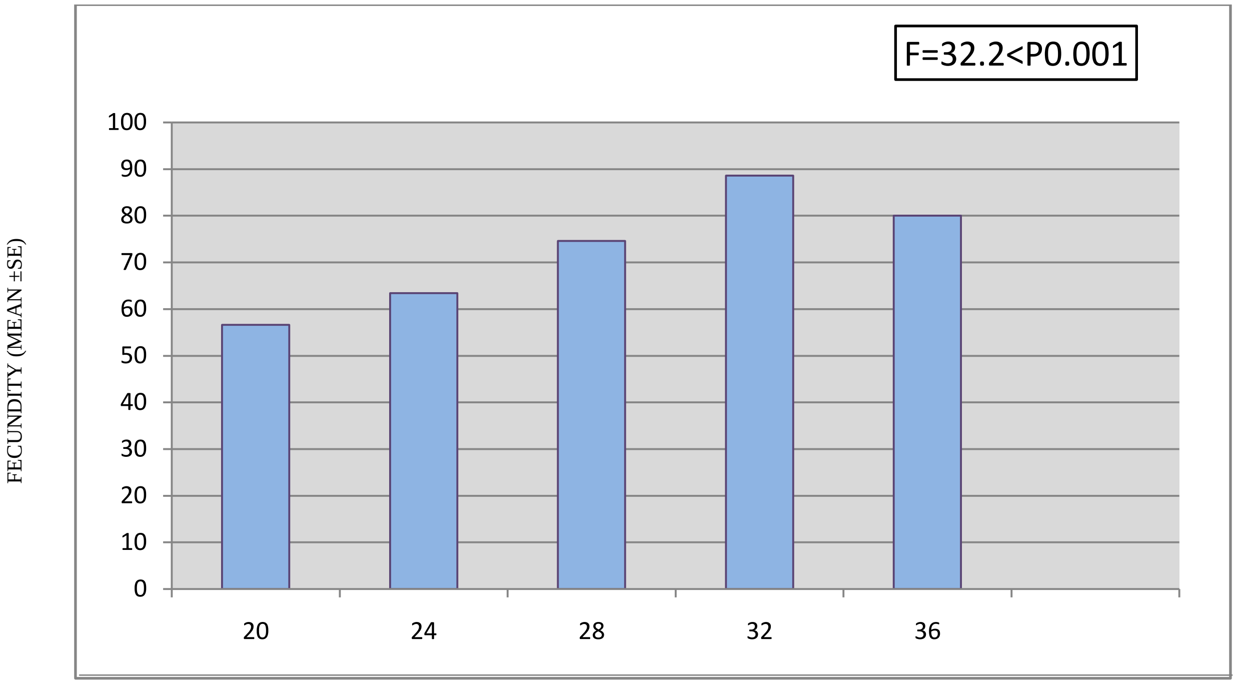
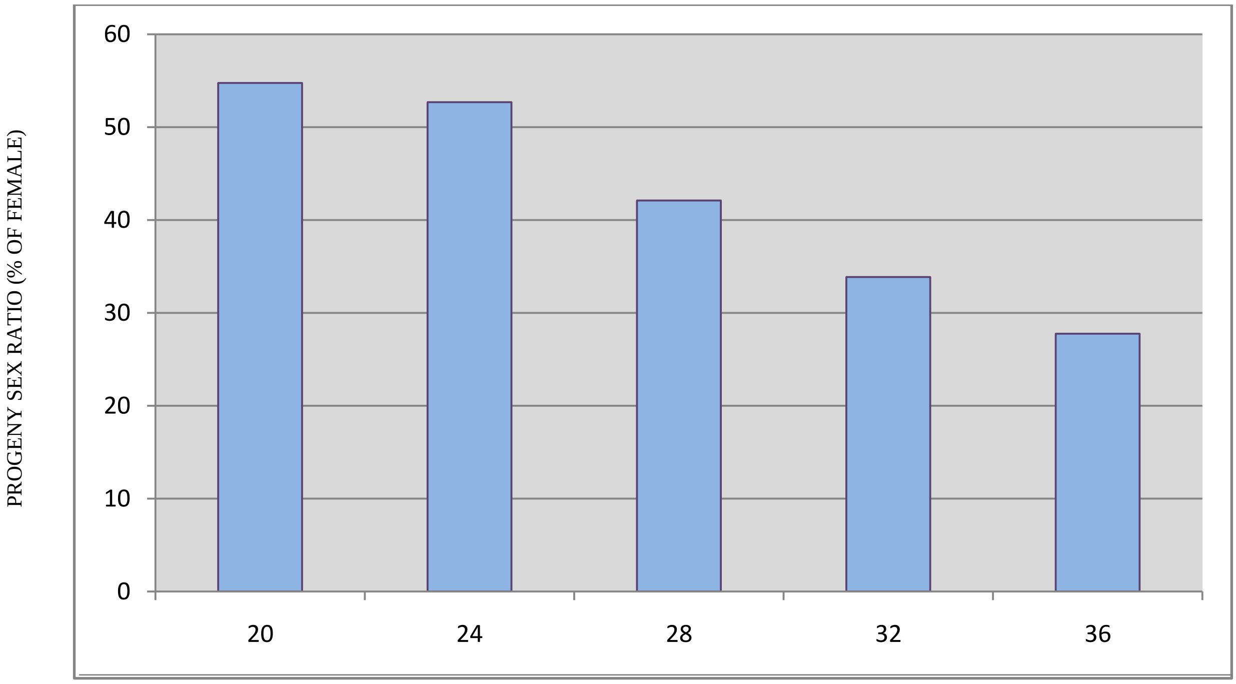


Fig-4- Effect of different temperature on egg to adult (female) development time (in days) of *Bracon hebetor*



DIFFERENT TEMPERATURE

Fig-5- Effect of different temperature on fecundity of *Bracon hebetor*



DIFFERENT TEMPERATURE

Fig-6 - Effect of different temperature on progeny sex ratio (% of female) of *Bracon hebetor*

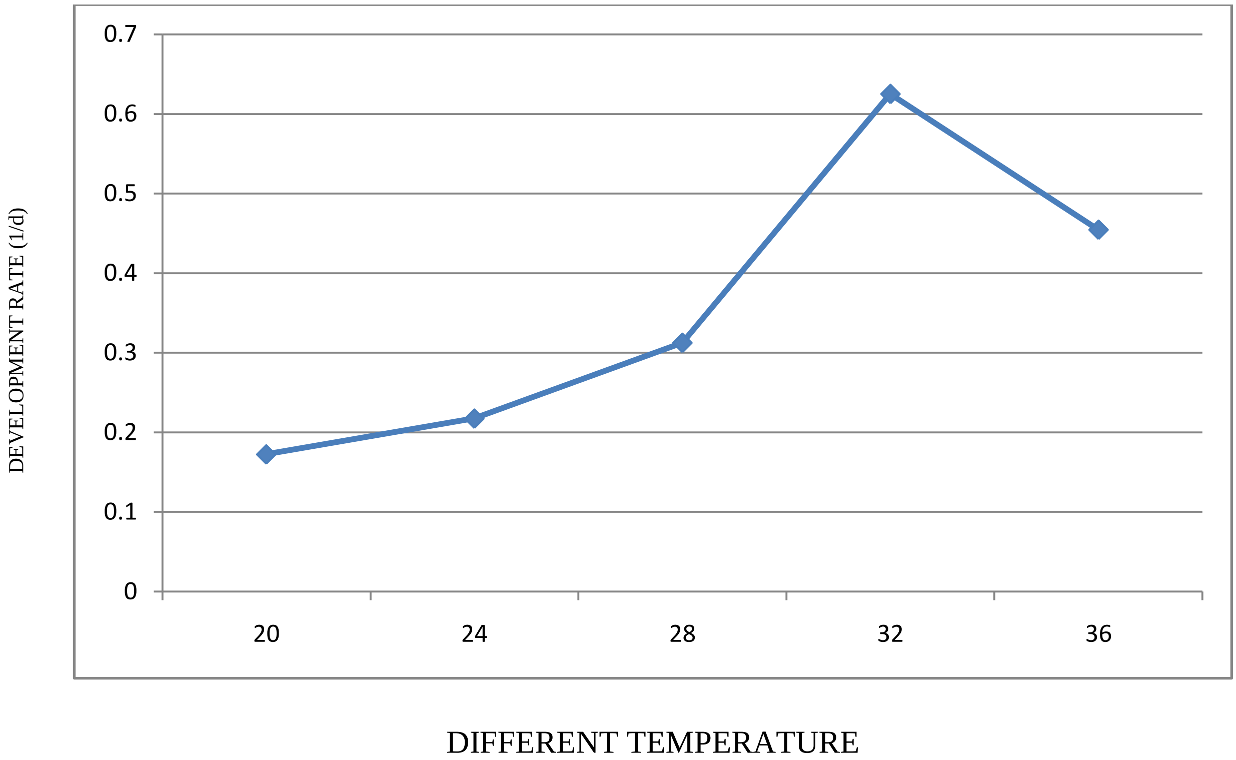


Fig- 7 – Graph showing development rate (1/d) for egg of *Bracon hebetor plotted against temperature* (*^{O}C*)

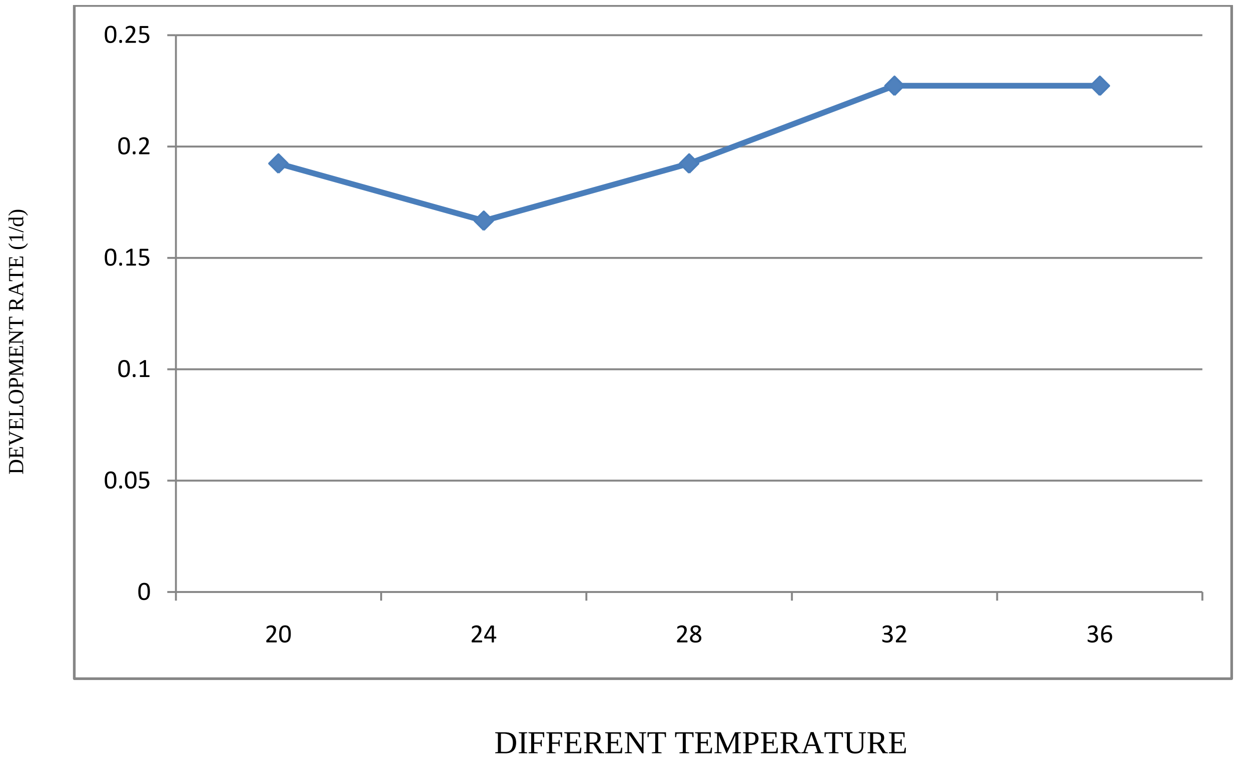
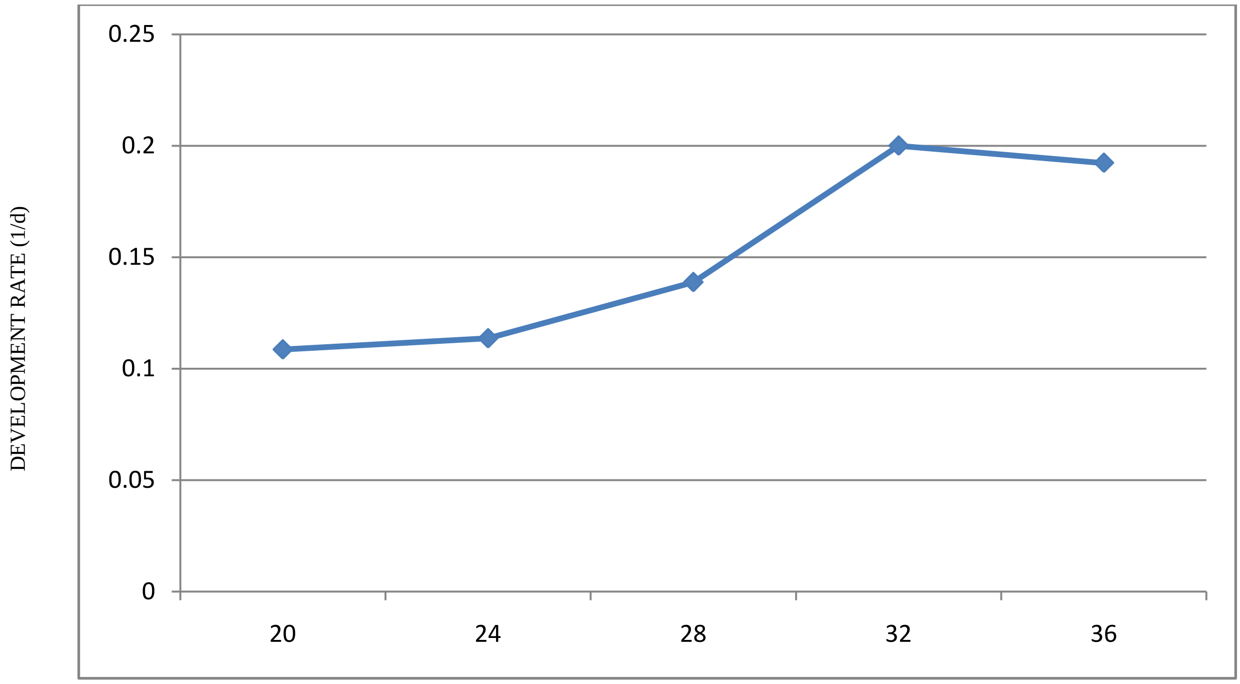
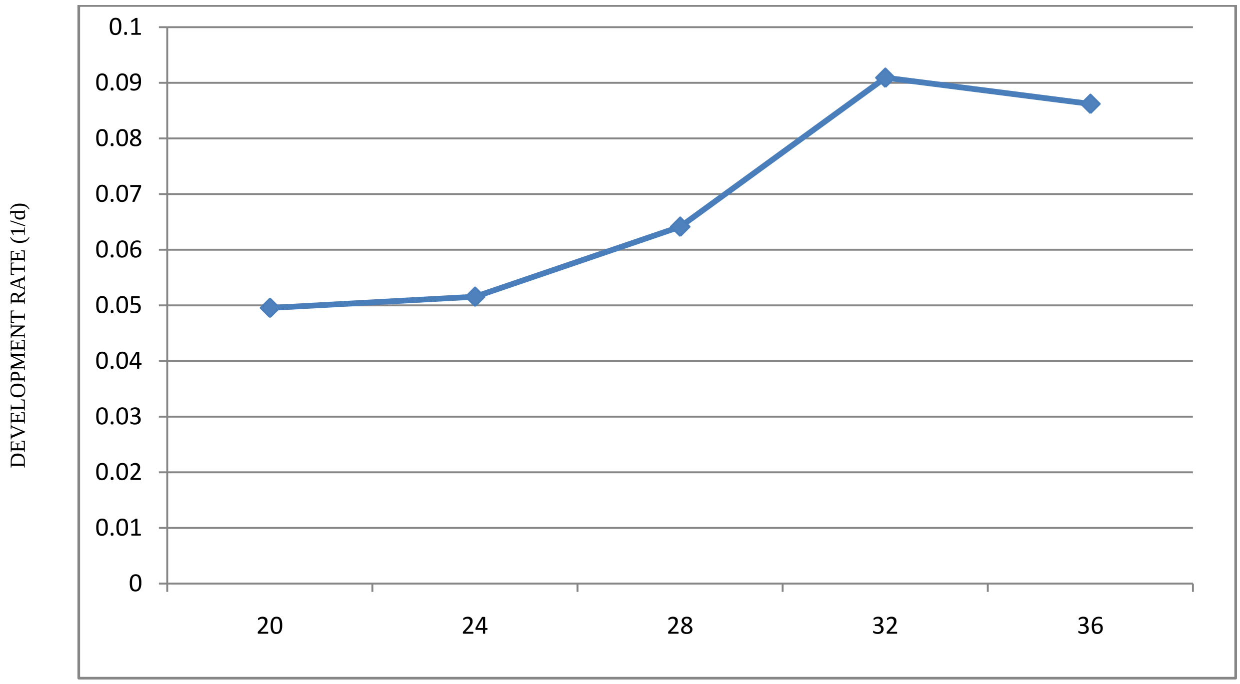


Fig- 8 – Graph showing development rate (1/d) for larvae of *Bracon hebetor plotted against temperature* (*^{O}C*)



DIFFERENT TEMPERATURE

Fig- 9 – Graph showing development rate (1/d) for pupae of *Bracon hebetor plotted against temperature* (*^{O}C*)



DIFFERENT TEMPERATURE

Fig- 10 – Graph showing development rate (1/d) for egg to adult (female) of *Bracon hebetor plotted against temperature* (*^{O}C*)

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