Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 1036-1039

Received: 25-03-2017
Accepted: 26-04-2017

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Biometrical changes during post-embryonic development of *Apis mellifera* L. workers in subtropical India

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Abstract
The present research was conducted to study the biometrical changes during post-embryonic development of *Apis mellifera* L. workers in Subtropical India. Biometrical changes during post-embryonic development of *Apis mellifera* L. workers showed a considerable variation in different season of the year viz. Spring, summer, autumn and winter in Indian subtropics. Egg hatched in 2.90-3.31 days, larval stage ranged between 5.79 to 6.10 days and pupation completed 10.36 -12.44 days depending upon the season of the year. Biometrics like length and width of head capsule were 0.76 to 2.41 mm in Ist to Vth instars larvae during different seasons of the year. Body (trunk) length also ranged between 2.88 to 12.76 mm and width 1.09 to 1.15 mm for Ist to Vth instars larvae. Fresh weight of larva and pupa significantly differed in various larval instars and pupal age of different season. The growth index was higher in spring (18.33) followed by autumn (16.18) and the lowest in summer (14.19).

Keywords: Biometrics, post embryonic development, *Apis mellifera*, Subtropical India

1. Introduction
Post – embryonic period of insect development includes egg eclosion to the formation of adult insect which is characterized by conspicuous increase in size and more or less change in form [1]. *Apis mellifera*, an exotic species having wider foraging range and higher honey yield was introduced in India during 1960's in temperate region i.e. Kangra valley of Himachal Pradesh under the supervision of Punjab Agricultural University, Ludhiana[2]. The success of this temperate species encouraged the apiculturist to extend it to tropics and subtropical region of India. The North East India is located between 27˚57 N and 27 ˚25 N and 89˚46'E and 97˚ 25'E in subtropics of India. An attempt was made during 1990's to introduce this species in North East Himalayas, a subtropical region of Indian sub-continent. Initially the study was carried out at Assam Agricultural University, Jorhat, India during 2005-06 and again in 2015-16 to confirm the development of *Apis mellifera* in North East India [3]. Although, there are several reports on the post-embryonic developments of *Apis mellifera* by western counterparts [4] by applying Dyar's law [5] but information from tropics were particularly from Indian subcontinent is lacking. The only report availability are available on Asiatic species i.e. *Apis cerana* [6, 7]. Therefore, an attempt was made to study the developmental period of different stages viz. Eggs, larva, and pupal of *Apis mellifera*, the length and width of head capsule and larval body at different ages and determined the growth index of worker larvae during different seasons.

2. Materials and methods
The biometrical changes of *Apis mellifera* worker during different growth and development period *i.e.* egg, larva and pupa were initiated during 2005-06 and validate in 2013-14 to 2015-16 in the apiary and apiculture laboratory of Assam Agricultural University, Jorhat (26.75^0N and 94.22^0E).For this purpose, one colony of *Apis mellifera* was reared with freshly mated queen. Three combs from the colony were selected randomly. The empty cells of each comb were marked with white marker and the queen was then restricted for eight hours with the help of queen excluder. These marked empty cells were allowed to lay egg by the queen. Then the cells with freshly laid eggs were again marked with yellow marker. From the marked cells of each comb five numbers of egg, larvae and pupae were taken out and different observations

were taken for egg, larva and pupa. The measurement of head capsule and trunk (body) were recorded by using ocular and stage micrometer under microscope. The growth index was determined as the ratio of per cent matured larvae pupated and average larval period in days by following Dyar's law [5]. The observations were recorded in four different seasons of the year viz. Spring, summer, autumn and winter.

2. Statistical analysis

The experiments was carried out in completely randomized design (CRD) and the significant of the treatments was determined with the help of 'F' test and the critical difference (CD) value have been worked out at 5 per cent significance level.

3. Results and discussion

The post embryonic developments of *Apis mellifera* worker involved egg eclosion to the formation of the adult and was studied four seasons of the year viz. Spring, summer, autumn and winter. The results were presented for developmental period of various stages of *Apis mellifera* in Table 1 and measurements of larval head capsule, trunk in Table 2 and 3 and pupal weight in Table 4. The growth index of *Apis mellifera* is presented in Table 5.

3.1 Egg: The of egg of *Apis mellifera* is a tiny white, sub-cylindrical with slightly enlarged anterior end measuring length and width 1.65±0.04 mm and 0.40±0.005 mm in spring; 1.63±0.038 mm and 0.4±0.004 mm in summer, 1.65±0.059 mm and 0.4±0.005 mm in autumn and 1.63±0.036 mm and 0.4±0 0.005 mm in winter respectively (Table 1). The variation in the length and width of egg showed no significant differences in different seasons of the year. The average egg stage of *Apis mellifera* worker was 3.10±0.026 days in spring, 2.90±0.024 days in summer, 3.31±0.102 days in autumn and 3.44±0.140 days in winter respectively (Table 1). Woyke reported such type of variation in egg of *Apis mellifera* during incubation period [8].

3.2 Larva: The larva of *Apis mellifera* worker is a creamy white, worm like grub. The larval characteristics such as head capsule and body was studied at I,II,III,IV and V larval instars in different seasons. The Table 2 revealed that the measurements of length of head capsule of *Apis mellifera* larva increased from 0.81±0.070 to 2.41±0.017 mm in spring, 0.77±0.048 to 2.23±0.123 mm in summer, 0.76±0.095 to 2.36 ±0.187 mm in autumn and 0.76±0.017 to2.33±0.0135 mm in winter respectively between I to V larval instars. Similarly, the width of head capsule measured to be 0.73±0.037 to 1.94±0.059 mm in spring, 0.70±0.027 to 1.90±0.077 mm in summer, 0.71±0.033 to 1.91±0.081 mm in autumn and 0.70 ±0.044 to 1.93±0.012 mm in winter respectively. The Table 2 indicated that there was no significant variation in length of instars but significant difference was observed at III, IV and V instars.

The fresh weight of larva at Ist instars was recorded to be 0.19±0.02 mg in spring, 0.19±0.003 mg in summer, 0.024±0.004 mg in autumn and 0.19±0.004 mg in winter which was increased to 72.13±1.275 mg in spring, 62.51±0.193 mg in summer, 69.93±0.756 mg in autumn and 65.94±0.756 mg in winter at Vth larval instars. The average larval duration of *Apis mellifera* worker was recorded to be 5.9±0.245 days in spring, 6.04±0.019 days in summer, 5.79±0.091days in autumn and 6.10±0.196 days in winter respectively. Similar trend of growth was observed in *Apis mellifera* [9]. The fresh weight of *Apis mellifera* worker larva was significantly higher during spring in comparison to other seasons which might be due to sufficient pollen and nectar supply and favourite climatic conditions for foraging activities of bees.

3.3 Pupa: After sealing of the larva, the pupa underwent developmental changes before it became a fully formed adult. On the fourth day of pupation, the pupa was white with non pigmented white eyes, which became pink with white body on the sixth day. The characteristics pale yellow pigmentation of the exoskeleton was observed after seventh day of pupation having brown eyes. The pupal weight was taken upto eleventh day of pupation at one day interval and is presented in Table 4. The table revealed that the initial weight of pupa at one day was recorded to be 90.83±2.49 mg in spring, 79.94±2.50 mg in summer, 84.93±2.50mg in autumn and 83.10±1.52 mg in winter. At 11th day of pupation, the weight of pupa recorded to be 70.07±1.62 mg in spring, 63.04±1.83 mg in summer, 67.80±2.21 mg in autumn and 65.23±2.80 mg in winter. It was observed that pupal weight decreased from the day of pupation till the emergence of the adult as they were not fed during this period. Similar observations were made by in *Apis cerana* [10, 11]

3.4 Growth index: The growth index indicated the performance of the insect and suitability of the seasonal to a phenological adaptation to ensure maximum advantages favourable seasons. The growth index of *Apis mellifera* was higher in spring (16.33) followed by autumn (16.18) and winter**.** The lowest was in summer (14.19) respectively as shown in Table 5.The growth indices in case of *Apis mellifera* worker during different seasons reflected that spring was the most favourable season with optimum temperature (27-30 ˚C) and relative humidity (70-8-%) with abundant blooming of forage plants followed by autumn which is a mild season. But the summer which included prolonged rainy season retards the growth of *Apis mellifera* as the temperature went as high as 38 ˚C and maximum humidity of 95-96% followed by winter as the temperature falls as low as 7-10 ˚C which is well below the threshold temperature of 10 ˚C for the proper growth and development of the species. This is in agreement with the findings of Das and Rahman [7] who reported that both abiotic (temperature and relative humidity) and biotic (food) are key factors for growth and development of *Apis cerana.*

Table 1: Development period of various stages of *Apis mellifera* L. worker

Season	Egg (Days)	Larva (days)	Pupa (days)	Total (days)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean± SD
Spring	3.10	5.90	10.36	19.36
(Mar-May)	±0.026^{b}	±0.245^{b}	±0.129^{c}	±0.358^{b}
Summer	2.90	6.04	12.44	21.38
(Jun-Aug)	±0.024^{c}	±0.019^{a}	±0.226^{a}	±0.247^{a}
Autumn	3.31	5.79	10.48	19.58
(Sept-Nov)	±0.102^{a}	±0.091^{b}	±0.205^{c}	±0.313^{b}
Winter	3.44	610	10.97	20.51
(Dec-Feb)	±0.140^{a}	±0.196^{a}	±0.243^{b}	±0.299^{a}
CD(P=0.05)	0.070	0.131	0.164	0.245

Mean of fifteen samples

Means within the column followed by the same letter are not significantly different at $p<0.05$

Table 2: Measurements of larval head capsule of *Apis mellifera* L. worker at different ages

Season	Length (Means ±SD in mm)					Width (Means ±SD in mm)				
	I instar	II instar	III instar	IV instar	V instar	I instar	II instar	III instar	IV instar	V instar
Spring	0.81	1.09	1.55	2.38	2.41	0.73	0.92	1.29	1.87	1.94
(Mar-May)	±0.078	±0.044	±0.160	±0.152	±0.017	±0.037	±0.051	±0.077	±0.049	±0.059
Summer	0.77	1.04	1.50	2.23	2.23	0.70	0.86	1.21	1.80	1.90
(Jun-Aug)	±0.048	±0.081	±0.018	±0.123	±0.123	±0.027	±0.073	±0.084	±0.077	±0.077
Autumn	0.76	1.10	1.56	2.36	2.36	0.71	0.91	1.26	1.83	1.91
(Sept-Nov)	±0.095	±0.077	±0.016	±0.187	±0.187	±0.033	±0.055	±0.096	±0.081	±0.081
Winter	0.76	1.06	1.53	2.33	2.33	0.70	0.88	1.23	1.84	1.93
(Dec-Feb)	±0.017	±0.047	±0.023	±0.135	±0.135	±0.044	±0.071	±0.095	±0.057	±0.012
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Mean of fifteen larvae
NS = Non significant

Table 3: Measurements of trunk of different larval intars of *Apis mellifera* L.

Season	Length (Means ±SD in mm)					Width (Means ±SD in mm)				
	I instar	II instar	III instar	IV instar	V instar	I instar	II instar	III instar	IV instar	V instar
Spring	2.94	3.78	5.90	9.89	12.76	1.15	1.61	2.77	4.98	5.49
(Mar-May)	±0.083	±0.107	±0.012^{a}	±0.012^{a}	±0.014^{a}	±0.024	±0.311	±0.011^{a}	±0.328	±0.011^{a}
Summer	2.88	3.66	5.68	9.45	12.28	1.09	1.53	2.66	4.79	5.25
(Jun-Aug)	±0.063	±0.157	±0.104^{c}	±0.013^{c}	±0.013^{c}	±0.055	±0.013	±0.012^{c}	±0.076^{c}	±0.095^{c}
Autumn	2.93	3.67	5.78	9.52	12.35	1.10	1.55	2.72	4.85	5.29
(Sept-Nov)	±0.057	±0.244	±0.013^{b}	±0.169^{b}	±0.011^{b}	±0.055	±0.011	±0.013^{b}	±0.010^{b}	±0.012^{b}
Winter	2.90	3.65	5.75	9.50	12.33	1.09	1.50	2.69	4.84	5.27
(Dec-Feb)	±0.066	±0.189	±0.017^{b}	±0.014^{b}	±0.130^{b}	±0.382	±0.010	±0.037^{c}	±0.011^{c}	±0.030^{b}
CD(P=0.05)	NS	NS	0.033	0.052	0.040	NS	NS	0.013	0.103	0.031

Mean of fifteen larvae
NS = Non significant

Table 4: Pupal weight of *Apis mellifera* L. worker at different day

Season	Fresh weight at different days in mg										
	I instar	II instar	III instar	IV instar	V instar	I instar	II instar	III instar	IV instar	V instar	I instar
Spring	90.85	87.35	85.61	83.89	82.28	81.26	80.34	78.39	76.05	71.56	70.07
(Mar-May)	±2.497^{a}	±0.107^{a}	±2.48^{a}	±5.20^{a}	±499^{a}	±2.92^{a}	±1.00^{a}	±3.19^{a}	±0.629^{a}	±2.210^{a}	±1.620^{a}
Summer	79.94	78.36	77.70	75.87	74.48	73.51	72.93	72.03	70.93	63.85	63.04
(Jun-Aug)	±2.502^{c}	±0.998^{c}	±1.53^{d}	±5.18^{c}	±3.42^{c}	±4.66^{c}	±1.78^{c}	±2.73^{b}	±1.80^{b}	±2.770^{c}	±1.83^{c}
Autumn	84.93	84.03	83.73	82.79	80.68	78.60	74.73	74.08	72.79	68.17	67.80
(Sept-Nov)	±2.50^{b}	±2.00^{b}	±1.528^{b}	±3.32^{a}	±6.71^{a}	±3.86^{b}	±1.03^{b}	±2.70^{b}	±2.80^{b}	±2.60^{b}	±2.21^{b}
Winter	83.10	82.11	80.79	80.12	77.16	75.33	73.34	73.0	71.92	66.49	65.23
(Dec-Feb)	±1.52^{b}	±1.02^{b}	±1.00^{c}	±4.16^{b}	±3.55^{b}	±2.65^{c}	±2.76^{c}	±1.41^{b}	±1.58^{b}	±2.22^{b}	±2.80^{b}
CD (P=0.05)	1.83	1.15	1.37	3.62	3.87	2.88	1.43	2.07	1.49	1.97	1.73

Mean of fifteen pupae
Means within the column followed by the same letter are not significantly different at $p<0.05$

Table 5: Growth index of *Apis mellifera* worker during different season of the year

Season	Mean larval period (days)	Percent matured larvae pupated	Growth Index
Spring (Mar- May)	5.90	96.35	16.33
Summer (Jun-Aug)	6.04	85.72	14.19
Autumn (Sept-Nov)	5.79	93.67	16.18
Winter (Dec-Feb)	6.10	91.35	14.97
Mean	5.95	91.77	15.42

4. Conclusion

The study on post-embryonic development of *Apis mellifera* showed variation in duration of life cycle in different season of the year. The shortest life span was found during spring and longest in summer. The post-embryonic development of *Apis mellifera* will provide effective management schedule for the species

5. Acknowledgements

The authors gratefully acknowledge the authority of the Assam Agricultural University, Jorhat and Indian council of Agricultural Research, New Delhi for financing the All India Coordinated Project on Honey bees and Pollinators under which the present work has been carried out.

6. References

1. Imms AD. A General textbook of Entomology. The English Language Book Society and Methuen and Co. Ltd. London. 1965, 221-247.
2. Thomas D, Pal N, Rao KS. Bee management and productivity of Indian honey bees. Proceedings of the 37th International Apicultural Congress Durban, South Africa, 2001.
3. Rahman S, Rahman A. Comparative brood rearing and pollen gathering activities of *Apis cerana* F. and *Apis mellifera* L. under Jorhat condition of Assam. Indian Bee Journal. 1993; 55(3-4):42-46.
4. Bertholf LM. The moults of honeybee. Journal of Ecological Entomology. 1925; 18:380-384.

5. Dyar HG. The number of moults of lepidopterous larvae. Psyche. 1890; 5:420-422.
6. Mishra RC, Dogra GS. Post- embryonic development of *Apis cerana indica* F. worker bee. In: Proc. 2nd Int. Conf. Apic., Trop. Climates, ICAR, New Delhi. 1980, 278-288.
7. Das PK, Rahman A. Biometrical changes during post-embryonic development of *Apis cerana* Fab. Workers in Assam. Indian Bee Journal. 1999; 61(1-4):31-36.
8. Woyke J. Sizes changes of *Apis mellifera* eggs during incubation period. Journal of Apicultural Research. 1988; 37(4):239-246.
9. Nelson JA, Sturtevart AP, Linebrg B. Growth and feeding of honeybee larva.pp.1-24. In: Anatomy of Honey Bee. Snograss, RE (eds), Comstock Publishing Associates, New York, 1924.
10. Rembold H, Kremer JP, Ulich GM. Characterization of post-embryonic developmental stages of female castes of honeybee, *Apis mellifera* L. Apiodologie. 1980; 11(1):29-38.
11. Das PK, Rahman A. Brood rearing and post-embryonic development of *Apis cerana indica* F. (Hymenoptera: Apidae) workers. M. sc. Thesis, Assam Agricultural University, Jorhat, 1994.