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Study on morphometric changes in the successive larval stages of worker carpenter ant, *Camponotus compressus* (Hymenoptera: Formicidae)

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Abstract
The worker carpenter ant, *Camponotus compressus* passes through the successive developmental stages like egg, larva, pupa and adult stages. The pre-adult stages were recognized as the five instar larval stages and four pupal stages as pre, early, mid and late pupae. The time period for pre-adult development under the natural conditions ranged from one to two months with variable size of head, thorax and abdomen. The young larvae were often partly transparent with small scattered white patches on external ridges of each segment of the integument. The mandibles of ant larvae were usually darker than the body, ranging from light amber to dark brown depending upon the degree of sclerotization, the darkness varying directly with the hardness. The larval body had tubercles varying greatly in size and length appearing in the form of stout hairs and could conceivably serve for defensive function. The head region protruded towards the ventral surface. The present investigation aimed at describing the mature worker larvae of this species in deeper detail, while identifying useful morphological characters for taxonomy and cladistics.

Keywords: Cladistic, sclerotization, *Camponotus compressus*, taxonomy

1. Introduction
The carpenter ant, *Camponotus compressus* is a cosmopolitan, social insect forming a large colony consisting of reproductive and sterile castes. The pre-adult development time varies from species to species under natural conditions it ranging from one to three months, except in winters where it is completely halted. The life cycle and general morphological changes in the developmental stages of *Camponotus* shows complex metamorphosis pass through egg, larva and adult stages [8, 10]. Under normal conditions the eggs to adult development required near about 50-60 day [18]. In carpenter ant the queen before egg laying start to moist the brood chamber with the help of workers ants mainly preferred debfris and decaying wood to establish their initial nest to extend their pathways in the forms of tunnels inside the soil layer [17, 18]. The nest of carpenter ant consists a functional winged reproducvtives the queen and the male produced during late summer and overwinter in the nest. During mating the queen ant lays the creamy white eggs in clusters [5, 9]. The pre-adult stages of *Camponotus compressus* are identified depending upon the incubation period, mouthparts and chetotaxy [5, 8]. The unsclerotized mouthparts of larvae consisting micro hairs may facilitate intake of food provided by the adult workers in the colony [12]. In carpenter ant, *Camponotus* during preadult development last instar larvae were stop feeding and start spinning around to construct the cocoon [7, 13, 15]. In Ponerine ants, *Pachycondyla obscuricormyrs* was reported with four developing larval stages with white body and sparsely covered fine hairs known as setae [16]. In the carpenter ant, *C. pennsylvanicus* and in many species of Camponotinae the larval stages shows ascending development of body.

2. Materials and Methods
The polymorphic forms of carpenter ant, *Camponotus compressus* were collected from the naturally forming nest by digging 1-2 feet underground the soil. The adult workers, reproductives, large queen and male were kept in the insect collection box as artificial nest in the laboratory at constant conditions of temperature 21–26 °C, 55–85% RH, and L16:D8 photoperiod to study the larval stages. The nest mainly was prepared from debris, decaying wood and soil mainly processed by the worker ants to establish their initial nest to extend their

pathways in the forms of tunnels inside the soil layer. It should be noted that our samples did not include alates, thus no sexual larvae were expected to be found. The fertile female laid eggs under the soil layer these eggs hatched into tiny larvae and small pupae. The numbers of larval instars determined using the methods described in Parra & Haddad (1989) [20]. The first and the last larval instar could be explicitly identified and used as reference to bracket others. First instar larvae are equivalent to the mature embryo, which can be measured in the egg through the transparent chorion, and last instar larvae usually display the developing pupa from within also termed prepupae. All the experiments were conducted in the Research laboratory, Department of Zoology, RTM Nagpur University Campus, Nagpur, MS (India). All the observations were made with utmost care to avoid any disturbance to the queens and the developing larvae.

3. Observation and Results

The adults of carpenter ants are divisible into two forms, the reproductives and sterile castes. The reproductives are of two forms, the queen (Gyne or fertile female) and the fertile male (King or Aner). The reproductive are easily identified from the sterile caste due to presence of well-developed pairs of wings. During mating the queen laid oval, transparent, glistening, creamish white colour eggs inside the soft, smooth surface of nest tunnel (Fig. 1). The newly laid eggs of *C. compressus* covered with sticky gum-like substance causing the eggs to adhere together in cluster. During complete development the variable changes in the morphology of head, thorax and abdomen of successive larval stages are as follows.

Larval stages

I. Instar larva

The freshly emerged first instar larva hatched within 6-9 days (Fig. 2). The body is white to creamy in colour. The eyes and mouthparts are absent. The body is tubular in structure with the undifferentiated head, thoracic and abdominal segments. The body shows segmentation narrow towards anterior while broad to the posterior with morphological variations (Table-1). The larvae live for 5-8 days and undergo moulting.

II. Instar larva

The freshly moulted second instar larva are likely similar to the first instar larva in colour and structure (Fig. 3) with the observed changes, the rudimentary antennae and hypognathous mouthparts. The body of larva is slightly curved on the anterior segments covered by sparsely distributed fine hairs, setae with the morphological measurements were variable (Table-1). The larvae live for 8-10 days and undergo moulting.

III. Instar larva

The freshly moulted third instar larva is creamy (Fig. 4). The head region of larvae is extended more antero-ventrally than that in the earlier instars. The mandibles are fine and unsclerotized with indistinct labrum and maxillae. The body is well-differentiated into head, thorax and abdominal region showing similarity to earlier developmental stage with variable size (Table-1). The larvae live for 5-8 days and undergo moulting.

IV. Instar larva

The fourth instar larvae are creamy yellow in colour (Fig. 5). The head region is slightly spherical with partially sclerolized mouth parts with setae. Eyes are indistinct. The mandibles are partially sclerotized with dentine ridges. The maxillary palps, galea, labium and labial palps are indistinct. The body of larva is straight and slender from anterior to posterior with distinct head, thoracic region and abdominal region gradually increases in diameter with distinct nine segments (Table-1). The larvae live for 7-10 days and undergo moulting.

Table 1: Measurement of developmental stages and adult polymorphic forms of carpenter ant, *Camponotus compressus* F.

c	Stages	Total Length (mm)	Weight in (mg)	Head		Thorax		Abdomen	
				Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)
1.	Queen	16.5±0.743	182±17.76	3.45±0.043	3.32±0.096	5.53±0.041	3.32±0.056	6.63±0.143	5.17±0.039
2.	Male	12.5±0.101	71.4±5.431	2.1±0.05	1.46±0.073	4.52±0.77	2.11±0.052	4.52±0.031	2.61±0.036
3.	Worker	14.2±0.082	112±5.71	4.48±0.054	4.45±0.056	5.15±0.073	2.51±0.086	4.55±0.021	3.49±0.05
4.	I-Instars larva.	3.54±0.05	16.3±2.46	0.13±0.026	0.12±0.0086	0.72±0.006	0.5±0.008	2.45±0.0581	1.7±0.085
5.	II-Instars Larva.	4.55±0.07	32.2±3.706	0.25±0.0055	0.1±0.0042	1.32±0.004	0.75±0.005	3.35±0.0534	2.8±0.064
6.	III-Instars Larva.	5.65±0.55	46.3±6.53	0.31±0.0145	0.24±0.012	1.85±0.053	1.2±0.035	4.5±0.085	3.5±0.0321
7.	IV-Instars Larva.	6.58±0.085	58.2±3.57	0.35±0.0048	0.28±0.0062	2.24±0.046	1.56±0.038	4.51±0.31	3.1±0.0501
8.	V-Instars Larva.	6.42±0.581	66.3±5.28	2.17±0.094	0.92±0.02	3.23±0.0934	1.62±0.028	4.19±0.051	2.61±0.07
9	Pre-Pupa stage	13.4±1.63	103±22.32	4.12±0.091	4.11±0.014	5.14±0.0113	2.57±0.073	4.5±0.035	3.49±0.45

V. Instar larva

The fifth instar larvae are creamy white in colour (Fig. 6). The body is dorso-ventrally spherical in shape. Eyes are rudimentary. The head shows partially sclerolized mouth parts and thoracic regions becomes curved from rest of the straight and long abdominal region. The body segments are about nine segments differentiated into well-developed head, thorax and a long, cylindrical abdominal region with variable size and weight (Table-1). The anus is situated posteroventrally on the terminal abdominal segment. The larva starts the spinning of cocoon during 5-10 days and undergoes moulting to form pupa.

Pre-pupa

The cocoon is creamy white in colour and elliptical in shape (Fig. 7). The pupal stages are observed in three forms as pre-pupa, pink eye pupa and brown eye pupa. All the pupal stages variable size and weight (Table 1).

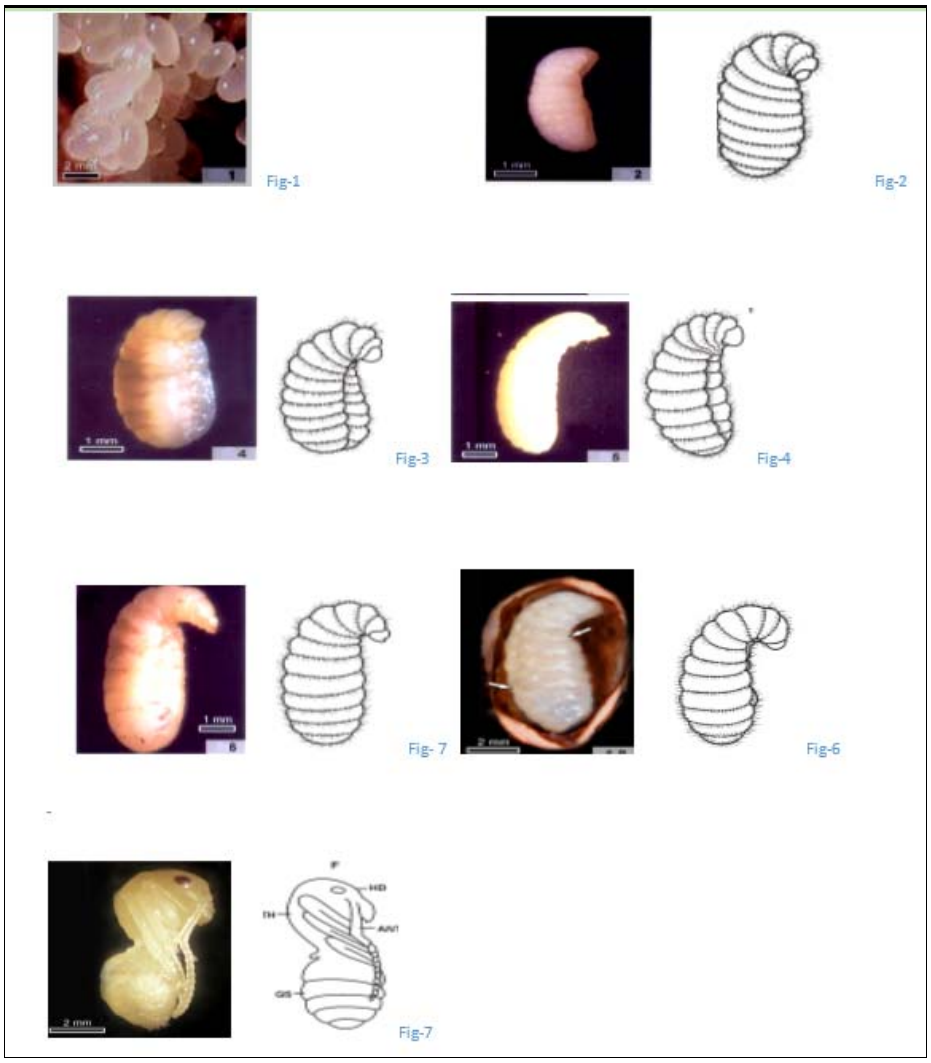

Fig 1 to 7: Shows larval developmental stages along the line diagram of carpenter ant, *Camponotus compressus.*

Fig 1:- Eggs**, Fig. 2- I** Instar Larva**, Fig. 3- II** Instar Larva**, Fig. 4- III** Instar Larva**, Fig. 5- IV** Instar**, Fig. 6- V** Instar Larva and Prepupal stage

4. Discussion

The life cycle of black carpenter ant, (Goudzilla's a *C. compressus* is more or less similar to that of other social ants described by earlier workers [8]. The adults of carpenter ants are divided into two forms, the winged reproductives and wing less sterile castes [5, 7]. After mating at the onset of monsoon and winter season the large sized queen ready for egg laying in suitable nest inside the temperate soil surface. The incubation period of eggs is reported from forty hours to two weeks in various species of ants [7, 9]. During the endeavor of summer season in month of June to July the reproductives emerges from the nest for nuptial flight. The male dies during mating while inseminated queen female search a nesting site under the usual site. In laboratory condition the queen select small cavity in a mixture of soil, wood bark, crush of dried plant leaves and formed a tunnel to lay eggs. The queen shed off her wings along lines of predetermined weakness before 2-3 days before egg laying. The eggs were hatched in the form of small tiny larvae which are feed and cared the queen. The queen did not left the nest until the larval development was over. At the end of premature developmental period last instar larvae pupate and eventually emerge as workers [18].

The carpenter ant, *C. compressus* shows an evolved developmental plasticity in the larval stages depending on division of labour which could be an evolutionary consequence of such ecological and social selection pressure [2, 14]. In *Camponotus* ants the chief criteria for separating castes depends upon the larval development to distinguish the workers from reproductive [4, 11]. The present study shows four moultings of worker ant producing five instars of larvae in *C. compressus* [2, 7, 13] similar to *Solenopsis Invicta* [15] and the Ponerinae ants. The significant morphological differences could be noticed among I to V instar larvae of *C. compressus* related to sclerotization of mouth parts, scattered hairs and an increase in size, weight and length of the body [10]. In *C. compressus* ant species the young larvae are often partly transparent with small scattered white patches show through the integument they are said to be urate crystals [15]. The mandibles of ant larvae are only darker than rest of the body, ranging from light amber to dark brown depending upon the degree of sclerotization, the darkness varying directly with the hardness [3, 15]. The larval stages shows head region in first three segments while fourth to segments arranged from eight to fourteen with small triangular plate like petiole similar to fire ants [10]. During the complete metamorphosis the morphometric changes occurred in the successive larval stages of *Camponotus* ants is the chief criteria for separating castes and to distinguish the adult [4, 11]. The mature instar larvae possess salivary glands involved in the secretion of gelatinous silk thread to construct a cream colour cocoon rather than in digestion of food materials [7, 16]. The above study reveals the preadults development of worker *C. compressus* ants with significantly morphometric changes variable in size, weight and length of the body. The head, thorax and abdomen of the

successive larval stages shows distinct fused structure from 1st to 14th segments without sclerotization. The larval stages shows head region in first three segments while fourth to seventh segments shows thoracic region. The abdominal segments arranged from eight to fourteen with enlarged rounded terminal region. During the larval development the prepupal stage shows three distinct separate head, thorax and abdomen region with small triangular plate like petiole formed from seventh segment in between the thorax and abdomen [11]. In *C. compressus* ants the possible functions of the body hairs of the larvae provide supports for hanging to adhere the soil surface not only but allow the regulation of body temperature and moisture [18]. The body hairs are also serving as serve as defense organ against cannibalism and clumps or hooks being stimuli. The above study of carpenter ant, *Camponotus* described the chief criteria for separating castes depending upon the distinct morphological features which distinguishes workers larvae independently for species identification study.

Significant morphometric differences between instars were reported, illustrating the usefulness of structures other than head capsules for sorting between different instars (namely mandibles, spiracles, and bodily di- mensions). This new information can aid systematic and taxonomical studies of ants based on larvae and clarify some biological aspects of their life cycles and social organization. In the present study on morphometric changes occurred in larval stages were reported, illustrating the structure of different instars may be the new information can aid systemic study of ants for sorting the species of different genera and also be useful to resolve phylogenetic relationship between different ant species groups [15, 20]. The study of ant larvae stand as the base of social organization in ants [5, 18] and describe the deeper knowledge about larval morphology to clarify different aspect of general ant biology [22].

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6. References

1. Clarke PS. The Natural history of sensitivity to jack jumper ants (Hymenoptera: Formicidae: *Myrmecia Pilosula*) in Tasmania, Med J. Aust 1986; 145:564–566.
2. Franks NR. Tomb Evaders: House-Hunting hygiene in ant Biol Lett 2005; 1(2):190–192.
3. Hansen LD, Akre RD. Urban Pest Management of Carpenter ant. In K.B. Wildey and W.H. Robinson (Eds). Cambridge, England bpcc Wheatons Ltd., Exeter, Great Britain, 1993, 271-279.
4. Hanns DS. Ant colonies. Science Bulletin, 1999, 108-211.
5. Hölldobler B, Wilson EO. The Ants. Belknap Press, Cambridge, 1990, 732.
6. Lommelen E, Schoeters E, Billen J. Ultra Structure of the labial gland in the ant, *Pachycondyla obscuricornis* (Hymenoptera: Formicidae). Netherlands J of Zoology 2002; 52:61-68.
7. Kadu SG. Study of Life Cycle and Developmental stages of the Carpenter Ant, Camponotus compressus, Fabricius (Formicidae: Hymenoptera). Jour Bio Nano Frontier (Sp. Ed.), 2012, 102-105.
8. Lone SR, Sharma VK. Exposure to Light enhances pre-adult fitness in two dark-dwelling sympatric species of ants. J Developmental Biology 2008; 1:10, 8:113.
9. Narendra A, Sunilkumar M. On A Trail with Ants. A Handbook of the ants of Peninsular India. Tholasi Prints India Pvt. Ltd. Banglore, 2006.
10. Neal OJ, Markin GP. The Larval instars of the imported Fire Ant, Solenopsis invicta. Buren J Kans Entomol Soc 1975; 48:141-51.
11. Okada Y, Miura T, Tsuji K. Morphological differences between sexes in the Ponerine Ant, Dicamma. Sp. (Formicidae: Ponerinae). Lib. Hokudai, Jap /2115 /17077 /Sociobio. Hokkaido University, Sappro, 060-0810, Japan, 2006, 48-2.
12. Petralia RS. Vinson SB. Feeding in the larvae of the imported fire ant, *Solenopsis invicta* Buren: Behavior and morphological adaptations. Ann Ent Soc Ame 1978; 71:643-648.
13. Sehnal F, Akai H. Insect silk glands, their types, development and function, and effects of Environmental factors and morphogenetic Hormones on them. Int J Insect Morphol Embryol 1990; 19:79-132.
14. Ravary F, Lecoutey E, Kaminski G, Châline N, Jaisson P. Individual experience alone can generate lasting division of labour In Ants. Current Biology 2007; 17(15):1308.
15. Wheeler GC, Wheeler J. Ant larvae: Review and synthesis. Memoirs of the Entomological Society of Washington 1976; 7:1-108.
16. Zara FJ, Caetano FH. Ultra morphology and histology of the larval salivary gland of Pachycondyla (neoponera) villosa Fabricius, (Hymeroptera; Formicidae, Ponerinae). Neotrop. Entomol 2003; 32:59.
17. Hansen LD, Klotz JH. Carpenter Ants of the United States and Canada. Ithaca, N.Y.: Cornell University Press, 2005.
18. Solis DR, Fox EGP, Kato LM, Jesus CM, Yabuki AT, Campos-Farinha AEC *et al.* Morphological description of the immatures of the ant, *Monomorium floricola*. Journal of Insect Science (in press), 2009.
19. Klotz JH, Mangold JR, Vail KM, Davis Jr LR, Patterson RS. A Survey of the Urban Pest Ants (Hymenoptera: Formicidae) of Peninsular Florida. Florida Entomolgi 1995; 78:112-3.
20. Parra JRP, Haddad ML. Determinação do número de instares de insetos. FEALQ, Piracicaba, 1989.
21. Schultz TR, Meier R. A phylogenetic analysis of the fungus-growing ants (Hymenoptera: Formicidae: Attini) based on morphological characters of the larvae. Systematic Entomology 1995; 20:337-370.
22. Fox EGP, Solis DR, Jesus CM, Bueno OC, Yabuki AT, Rossi ML. On the immature stages of the crazy ant *Paratrechina longicornis* (Latreille 1802) (Hymenoptera: Formicidae). Zootaxa 2007; 1503:1-11.