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A study on the Morphological Variation in Mandibles of Four Wasp Species.

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***Abstract*— Adult wasp have chewing and lapping type of mouthparts. The mandibles are structurally different in different species of wasps, suggesting that the variation in mandible is due to specific activities that it does in its life time. The function of mandibles are retained primarily for biting, chewing and also for handling other material like mud or mastication of plant fibers during nesting. Variation in mandibles of four wasp species is presented in this paper. The structure of the mandibles is elongate with presence /absence of teeth in solitary wasps like Delta pyriforme pyriforme (Fabricius, 1775) and Sceliphron caementarium (Drury 1773). These wasps use the mandibles to excavate wet mud from the ground and carrying it. Mandibles are also used for capturing prey like caterpillars or spiders which are carried to its nesting sites. In case of social wasps like Vespa tropica (Linnaeus, 1758) and Ropalidia marginata (Lepeletier, 1836) the mandible is short with large teeth's. These wasps use mandibles to masticate the wood or plant fibers to convert it into a soft pulp which is utilized in the construction of papery nests. Mandibles are also used in mastication of prey, which is given as feed for the developing wasp larva.**

***Index Terms* — adaptation, morphology, nesting, variation.**

I. INTRODUCTION

The wasps represent both solitary and social life that occupies a diverse range of habitats. Wasps lack grasping forelegs and they compensate it by using mandibles as grasping tool. Mandibles are crucial tool in wasp species, used for diverse array of activities and are constrained by the fact that these insects need to have mandibles that can fulfill many functions. Wasps use their mandibles to manipulate different objects, such as nesting materials like mud, plant fibers and liquids like water, which is suspended between the mandibles like a drop and carried to different places. Successful life in wasps depends on the shape and structure of their mandibles [6] [7]. Mandibles are important for hunting success; it is used as tool to grasp prey during stinging to paralyze it and also in carrying the same. Construction of nests in both solitary and social wasps is an important part of life and its success is assured by the modification of its mandibles [9]. Different type of nests such as burrowing, mud nesting or paper nesting, all involves the use of mandibles. The solitary mud nesting wasps have longer, thinner and few tooted mandibles [5], whereas in social wasps constructing paper nest have short and wider mandibles which are related to use of fibrous hard plant materials [9]. A similar study on variation in mandibles of bees in association with different type of nesting was done [11]. The nests are required for oviposition and developing of larva [10]. A relationship between shape of mandibles and selection of nesting material was observed, suggesting that the nest construction has influenced the evolution of mandible in many taxa that are involved in nesting [9]. Ants are one of the best examples for the relationship between structural characteristics of mandibles based on types of food selected [7]. The strength in mandible depends on whether it is long, slender, little curved or short, thick and hard. Straight, long and little curved mandibles may be weaker than the short hard mandibles. In solitary wasps which are involved in prey capture and mud nesting have long slender mandibles, while in social wasps the short sturdy mandibles are used in mastication of wood or plant materials and also mastication of prey. The present work was to study the variation in mandibles that are adapted to perform various activities in insect life like nesting and other associated works.

Comparison of phylogenic traits was made to understand the relationship between mandible shape between solitary and social wasps. Following two relationships were studied 1) wasps with similar mandible shape in closely related species use similar nesting materials than in distantly related species 2) variation in mandible shape in wasps that use specific nesting materials.

II. METHODOLOGY

1. Selection of species: Only the non-burrowing wasp species that use mutually exclusive nesting material

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were selected. This includes common wasp species representing mud nesting solitary type (Delta pyriforme pyriforme; Fabricius, 1775, Sceliphron caementarium; Drury 1773) (Fig. 1 & 2) collects mud to construct brood cells and paper nesting social type (Vespa tropica; Linnaeus, 1758 and Ropalidia marginata; Lepeletier, 1836) (Fig. 3 & 4) use masticated wood or plant materials to construct nests, were selected.

2. Data collection: the adult females and the newly emerged adult wasps was collected. The head was separated from the thorax and further each mouthpart was separated and mounted using DPX. The Magnus MS-24 binocular stereomicroscope was used to observe the characteristic features of the mandibles.

Fig.1: Adult female Delta pyriforme pyriforme

Fig.2: Adult female Sceliphron caementarium

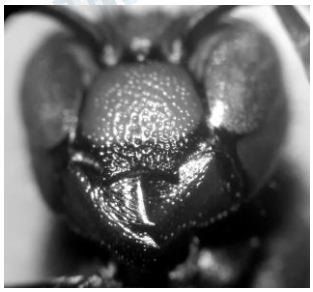

Fig.3: Adult female Vespa tropica

Fig.4: Adult female Ropalidia marginata

III. RESULTS

The wasps use their mandibles for various activities [12] such as prey capturing, feeding the larva, collection and molding of mud, wood materials and applying the masticated pulp for nesting. Of the 4 species studied, the mandible structure of Delta pyriforme pyriforme and Sceliphron caementarium was different, whereas the mandible structure of both Vespa tropica and Ropalidia marginata was similar.

Nesting solitary female wasps encloses its egg provisioned with caterpillars or spiders in a brood cell constructed from mud. This brood cell forms the basic structure for nest construction in mud nesting wasps. Nest architecture is diverse in different species and materials used to construct it are equally diverse. In species like Delta pyriforme pyriforme, Sceliphron caementarium, mud is the common material but the amount of it varies with different particle size. During nesting, the mandibles are used to excavate wet mud, moulded to a mud ball along with the help of first pair of legs (Fig. 5 & 6). Mud ball is carried to the nesting site and with the help of mandibles the mud is plastered to a substrate to form brood cell. The mandibles play critical role in nesting, thus mandible shape plays important role in selection of nesting habitat and material used in the construction of mud nest. The shape of the mandible is very effective in manipulating the mud, collecting it and transporting it to nesting site.

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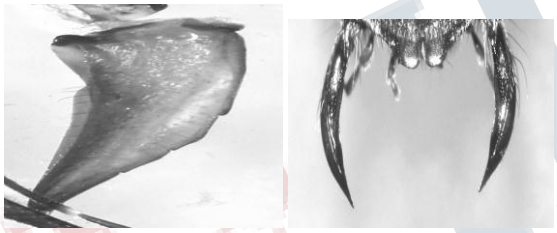
Fig. 5: Mud ball carried by Delta pyriforme pyriforme to the nesting site with the help of mandibles and first pair of leg.

Fig. 6: Mud ball carried by Sceliphron caementarium to the nesting site with the help of mandibles and first pair of leg.

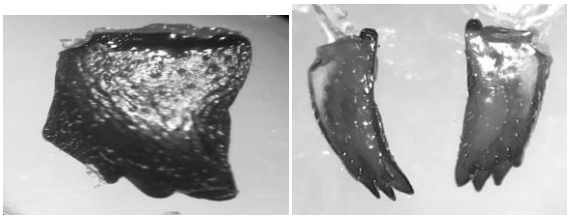
Delta pyriforme pyriforme, has long narrow mandible, which is slightly curved towards the thorax (Fig. 7.a), where as in Sceliphron caementarium the mandible is thin and curved which crossover on each other (Fig. 7.b).



(a) (b)

Fig. 7: Dorsal view of the mandible (a) Delta pyriforme pyriforme, (b) Sceliphron caementarium. Both the species do not possess teeth's on the mandibles.

In social wasps, major uses of mandibles are for i) chewing wood or plant fibers for nesting ii) chewing and feeding prey to developing larvae [12]. The mandible in Vespa tropical is shorter, have shorter apical teeth, longer lover teeth's and mandibles do not overlap (Fig. 8.a), in Ropalidia marginata the shorter mandibles have longer apical teeth, shorter lover teeth's and curved mandibles (Fig. 8.b). Both species are involved in nesting using wood or plant fibers. It has been reported that three tooted mandibles are the modification associated with the nesting in plants or in excavating plant fibers [11] like that are seen in wasps like Vespa tropica, Ropalidia marginata.



(a) (b)

Fig. 8: Dorsal view of the mandible (a) Vespa tropica, (b) Ropalidia marginata.

IV. DISCUSSION

The success of insect to adapt to a wide variety of habitats is due to varying modifications or adaptions that have occurred and continue to occur. These adaptions are at every level of organization from the molecular to ecological level. The first and foremost study of adaption is the comparative study of mouthparts and their adaptation. A correlation between the mandible shape and feeding ecology in different insect orders has been studied. Morphological variation in mandibles of insects has been characterized on the basis of presence/absence of structures, shape and size properties [12].

The variety of adaptations is so great that we can identify the species, location, food habitats and its nesting behavior. The wasps have the various arrangements of mouthparts in different species. The variation in mandibles explains the functional significance in collecting and processing of nest materials and nest construction, which explains the difference in nest material used. The mandibles play a critical role in nesting, nesting habits and materials used might be the driving force to select different mandible shape [12]. Mouthparts are evolved to serve different other functions like, i) facilitating in the emergence from the place of pupation, ii) grasping of prey and handling, iii) excavation of materials like mud, plant fibers for nest construction, iv) chewing of fruit pulp, v) grasping the partner during mating [7].

The mandibles of mud nesting wasps had much more variations than the mandibles of plant fiber users. Suggesting that mud collection involves fewer functional limits; that is, it may be possible to collect and mold the mud effectively with variety of mandible structure. Both these species construct mud nests with varying architecture; nests have been collected from twigs, buildings, unused furniture's etc. it is evident

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that the long mandible is used in collecting, molding and applying the mud on substratum [1]. The mandible is used in capturing caterpillar prey (9.a) by Delta pyriforme pyriforme. The prey is held in mandible [2] and first pair of leg, meantime the abdomen is curved to penetrate the sting into the caterpillar to release the venom, due to which the prey is paralyzed but not killed. The wasp take care not to damage the prey with mandibles as the damaged prey will lose its value as food for the emerging larva in the brood cell. In case of Sceliphron caementarium, the spider is grasped by its pedipalpi or legs by using its mandibles and the first and second pair of legs encircle the prey. The mandible is used by emerging young wasp to break away the soil to make a hole in the mud nest to make way out [10] (Fig. 9.b).

(a) (b)

Fig. 9: Delta pyriforme pyriforme (a) holds the caterpillar with the help of mandible to paralyze and later is pushed inside the brood cell (b) fully grown wasp making its way out of the mud nest.

Mandibles in social wasps are short, hard and articulate dorso-ventrally, permitting the mandibles to move in one plane. Similar arrangement of mandibles was reported in ants by Jurgen (2001). This arrangement helps in scraping harder wood surface. The time and energy involved for single female wasp in paper nesting is high when compared to mud nesting. This explains why new colony size is small initially and grows as the number of individuals increase. On the other hand, as said by Sarmiento (2004) that shorter mandibles are efficient in fiber management but not in prey chewing. In our observation it's found that shorter mandibles are more efficient in both fiber management and prey chewing. This indicates that selection of nesting material is based on the characteristics of mandibles.

Plant fiber are the most common materials used by most of the social species [13] the mandibles of paper nesting wasps have much similarity in mandible structure. Vespa tropica and Ropalidia marginata have similar mandible structure and its nest architecture have many common features, except for the size and shape. In social organization of wasp, a foraging wasp capture prey and brings it to the nest, as the wasp settles on the nest it makes a buzzing sound with the help of its wings. All the nearby wasps gather around and immediately tears of the prey into pieces using mandibles. Each wasp then masticates the prey by using mandibles. The masticated prey is then fed to developing larvae (Fig.10). When the fruits are cut open, wasps are attracted to the fruits. The fruit pulp is chewed with the help of mandibles to extract the sweet syrup.

Fig.10: The adult wasps are seen masticating the prey.

CONCLUSION

It is found that diet and nesting plays a major role in the evolution of mandible shape; because nest construction is an important part of their life cycle. Further comparative studies on morphological variation of different wasp species will provide new details on evolution of nesting and feeding behavior in both solitary and social species that have adapted to the varying habitats.

REFERENCES

[1] T.H. Auko, R. Silvestre and J.P. Pitts, "Nest camouflage in the spider wasp Priochilus captivum (Fabricius, 1804) (Hymenoptera: Pompilidae), with notes on the biology" Tropical Zoology, Vol. 26, No. 3, pp.140–144, 2013.

[2] S. C. Buys and C. A. de Oliveira Antunes, "Further observations on the nesting behavior of Penepodium luteipenne (Hymenoptera, Sphecidae)", JHR, 45: pp131–134, 2015.

[3] L. Chatenoud, C. Polidori, M. Federici, V. Licciardi, and F. Andrietti, "Mud-Ball Construction by Sceliphron Mud-Dauber Wasps (Hymenoptera:

Sphecidae): A Comparative Ethological Study" Zoological Studies, 51(7): pp 937-945, 2012.

[4] S.O'Donnell, "The development of biting interactions and task performance in a tropical eusocial wasp", Behavior, 140: pp 255–267, 2003.

[5] M. Hansell, "Nest building as a facilitating and limiting factor in the evolution of eusociality in the Hymenoptera In: Oxford Surveysin Evolutionary Biology (P. Harvey and L. Partridge, Eds)". New York, Oxford University Press. pp 155–181. 1987.

[6] J. Heraty and M. Schauff. "Mandibular teeth in Chalcidoidea: function and phylogeny", J. Nat. Hist. 32: pp 1227–1244, 1998.

[7] M. Jervis "Functional and evolutionary aspects of mouthpart structure in parasitoid wasps" Biological Joumal of the Linnean Society, 63: pp 461- 493, 1998.

[8] P. Jurgen, "Mandible movements in ants", Comp. Biol. Phys., A 131: pp 7–20, 2001.

[9] K. M. O'Neill, "Solitary wasps: behavior and natural history", Cornell Univ. Press, Ithaca, NY, 2001.

[10] E. Nel, J. Kelly and A. Dippenaar-Schoeman, "Notes on the biology of the wasp, Chalybion spinolae (Hymenoptera:Sphecidae), an obligatory predator of Latrodectus (Araneae: Theridiidae) spiders in South Africa" Journal of Natural History, Vol. 48, Nos. 25–26, pp. 1585–1593, 2014.

[11] C.E. Sarmiento, "A test of adaptive hypotheses: Mandibular traits, nest construction materials and feeding habits in neotropical social wasps (Vespidae, Polistinae)", Insect. Soc. 51, pp 387–391 2004.

[12] O. T. Silveira and J.N. A. Santos Jr. "Comparative morphology of the mandibles of female polistine social wasps (Hymenoptera, Vespidae, Polistinae)", Revista Brasileira de Entomologia, 55(4): pp 479–500, 2011.

[13] N. M. Williams and K. Goodell, "Association of Mandible Shape and Nesting Material in Osmia Panzer (Hymenoptera: Megachilidae): A Morphometric Analysis", Annals of the Entomological Society of America, 93(2):pp.318-325, 2000.

[14] J. Wenzel, "Evolution of nest architecture In: The Social Biology of Wasps (K. Ross and R. Matthews, Eds)", Ithaca: Comstock,. pp. 480–519. 1991.