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Research Article

Analysis of the morphology of the *Apis dorsata* F. pollen-gathering Apparatus

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ABSTRACT

Nectar and pollen are the two main sources of sustenance for bees. The primary source of protein that bees need to achieve their nutritional demands is pollen. Bees and flowering plants have a symbiotic mutualism, as evidenced by their ability and necessity to gather pollen. As a pollinator, bees aid is in pistil to get in pollen. The pollen that is adhered to the body of bees was swept into the basket of pollen grains on their rear limbs, where it is consolidated with nectar and salival mixture. The pollen was ball-shaped and solid will be returned to the honey bee hive and put in one of the colony's existing pollen chambers. If the pollen chamber is filled, propolis will cover the pollen that has been deposited inside. Bees are farmed for their high honey and propolis production, which is one of the reasons for their widespread cultivation. The goal of this study was to ascertain the size and form of the bee *Apis dorsata* F.'s pollen baskets in relation to the movement of plant's pollen grains from the blossom of plant to the colony.

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1. Introduction

Apis dorsata is found in most Indian states, including Rajasthan, Madhya Pradesh, Maharashtra, West Bengal, Karnataka, Arunachal Pradesh, Gujarat, Himachal Pradesh, Tamil Nadu, Uttar Pradesh and Bihar (Oldroyd et al., 2006). Three sets of legs make up a honey bee, and each pair is unique. The purpose of the final set of legs, known as the hind legs, is to compress and transport the honey bee's signature pellets of pollen. The honeybee uses all of its leg pairs to scrape pollen from flowers onto its basitarsus, which is the location on the hind leg. Then, using stiff bristles on the edge of the pollen press, also known as a pollen rake, bees comb it off the basitarsus. Until the open press is full of pollen, the honey bee uses its right leg to clean the left pollen basket and its left leg to clean the right pollen basket. The forelegs of honeybees are used to clean the mouthparts and antennae, among other parts of the head (Rudolf Jander 1976). The incredibly helpful and adaptable pollinators are honeybees. These pollinators are able to gather nectar and pollen from a variety of flowers and crops.

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The comb's adult bees consume honey, while the larvae are fed bee bread—a mixture of pollen and honey—in order to survive. Thus, in addition to gathering pollen, bees also gather nectar, which they use to make honey. Therefore, the availability of nectar-secreting plants surrounding the bee colony determines how much excess honey may be stored inside a hive. Therefore, the presence of bee flora and bees' ability to convey pollen and nectar are necessary for enriching apiculture (Bitner-Mathe et al., 1995). The key characteristics for Apiscerana indica F's honey production were worker foraging ability, nectar collection ability, pollen transporting ability, pollen and honey storage, and colony population optimisation. In addition to the previously listed elements, several biotic and abiotic factors also contribute to bees' ability to produce honey.(Reis & Monteiro, 1999). After removing the pollen pellets from the corbicula, A. cerana indica foraging bees were gathered as they were making their way back to their hives with a load of pollen in their hind leg corbicula (pollen basket) (Joe Traynor, 1966). The purpose of this study is to identify the most popular types and designs of pollen collection devices that are utilised by A. dorsata bee workers to carry pollen to the hive. Bees gather pollen in order to meet the nutritional needs of the hive's population, particularly the larvae cohort. Given that the length and breadth of the wings are associated to the ability to fly, and the shape and size of the pollen baskets are related to pollen production and propolis transfer, morphometrical studies were carried out utilising the characteristics of the pollen baskets (Souza et al., 2009). The majority of A. mellifera's races and subspecies are found worldwide in a diverse variety of natural habitats, and they vary greatly in terms of their physical and behavioural characteristics (Tofilski 2008).

Material and methods

Examining the morphometric changes in the pollen baskets of A. dorsata honey bees was the aim of this study. Using geometric morphometrics, we were able to identify patterns of variation in size and form in A. dorsata honey bees from Nagpur. Two of Nagpur's well-established colonies provided samples. In order to investigate the structural characteristics of the pollen collecting equipment, live worker bees were collected directly from the blossoms of plants near the established colony during the study period. The biology department at Bhide Girls College in Nagpur completed this job.The collected live bee import was given to the lab. The bee legs were chopped and then placed on a slide. A Karl Zeiss microscope was used to examine the slides under a microscope and take pictures of them using a *Tuscon camera*. Worker bees' pollen-gathering habits were closely observed using both visual and video means. In the Sitabuildi neighbourhood of Nagpur, Maharashtra, research was done on the behavioural characteristics of the rock honey bee, A. dorsata. In an effort to assist locals in determining the seasonal availability of bee fodder, current studies on bee behavioural features have been carried out in this area during the winter seasons of 2021–2022.Bee samples were put under a basic microscope for dissection after being anaesthetized with anaesthetic ether. Because the size, shape, and pollen loads of the pollen baskets were associated with both pollen generation and propolis transit, the morphometrical analyses were carried out utilising the characteristics of the pollen baskets.

Result and discussion

The arrangement of hairs on the tibia of the rear legs of honeybees is known as the pollen basket. The pollen is collected by the bees, who then use their tongues to wet it with saliva before transferring it to their back legs and packing it into the pollen basket (Fig. 2). They condense the pollen by packing it in this way, making it easy to transport back to the hive or nest. In the space between the honeybee's posterior legs' tibia and first tarsus. This joint is extremely unusual; it resembles a steel trap or an animal's jaws. The tibial or inner job is well-covered in sharp teeth. Figure 3. Particularly well developed in bees are the claws and pulvilli that finish the feet of A. dorsata bees (Fig. 2). The two flat plates of the pollen press are hinged together. One plate is located on the tibia's tip, and the other is on the basitarsus section. Figure 3. The basitarsus and the four tiny tarsomeres are the two sub-segments that comprise the segment tarsus. Figure 2 The soft, compound, pollen-gathering hairs are clearly visible in the coxa, trochanter, and femur joints, which are the first three joints of the posterior legs (Figs. 1 and 2). The tibia and first tarsus arcs are marvellously well developed in honey bees (Fig. 3). There are spaces for storing pollen on the exterior. The course hairs that surround these small spaces, one in each joint, act as numerous pegs to help support the heavy pollen piles that bees are frequently observed transporting to the hive.Figure 3. Nine or ten rows of exquisite yellow hairs can be seen on the inside of the tarsal joint opposite the

concavity. These hairs create combs or brushes that are used to gather and transfer pollen from various regions of the bee to pollen baskets. One leg's combs are utilised to fill the other leg's pollen basket. Figure 2.With the aid of long, lovely hairs, pollen load forms at the tibia and basitarsus joint. Figures 4a and 4b.Numerous pollen grains are visible in the microscopic analysis of the pollen loads. Figure 5. Pollen gathered by A. dorsata from a variety of nearby flowers that range in size, shape, and type. Poaceae, Brassica sp. (Brassicaceae), Ageratum conyzoid (Asteraceae), Solanum sp. (Solanaceae), Mangifera indica Linn. (Anacardiaceae), Oxalis barreliaeri Linn. (Oxalidaceae), etc. are a few of the pollen types that A. dorsata collects. A full description of the structures connected to Apis mellifera's pollen collection has already been provided (Snodgrass, 1956; Matthes, 1968). While A. dorsata's pollen collecting apparatus shares the same overall structural plan as A. mellifera, there are differences in the number of structural components between the two species. Throughout the study period, foraging bees' mean pollen stocks and honey stores were measured, as well as their pollen carrying ability at various times of the day. The management techniques and increased pollination services in the greater crop output were both greatly benefited by this study. According to this study, the basitarsus, the first of the hind leg's five tarsus segments, is incredibly large and has an inner surface covered in multiple rows of bristles that run perpendicular to the leg's long axis and are referred to as pollen brush. The rear leg's lower tibia is longer than the front, and each row of teeth is quite toothy. We refer to this arrangement as a pollen comb. The hind legs' tibial segments are particularly broad. The outside surface of the tibia is concave and barren, with the exception of a densely packed area known as the corbicula or pollen basket that surrounds the concavity's edge. There is a noticeable layer of bristles on the exposed portion of the pollen basket. A spur that emerges from the top of each hind leg's first tarsal segment and curves outward to press against the pollen comb's inner surface. We call this contraption a pollen press. The potential pollen grains that the bees will gather have most likely become moist by spitting raw honey from their honey stomach that is similar to nectar. Analysing the fluid obtained from the corbicula pollen grains makes this clear. The pulvillus and sensory bristles on the forelegs may aid in the selection of the best pollen grains. Another feature around the arolium, a conspicuous single pair of claws (each bifid in nature), may also aid in the preliminary steps of pollen gathering. Couto and Garcia (2005). Given that pollen baskets are the consequence of modifications in the tibia of the third pair of legs, which become quite wide and somewhat concave in the inner face, with hairs of various lengths and shapes positioned on the side, they have enormous ecological significance. The tibia began to resemble a basket used to store pollen in the form of tiny balls (Thorp, 1979). The results of previous research, which showed that each pair of legs is unique from the other two pairs and is divided into six segments with claws at the tips to enable the bee stick to surfaces, are corroborated by the present study. Bees use their legs to aid in their mobility, but other sections of their bodies have specific functions as well. For example, their mouth, eyes, and head are used to sweep pollen and other particles. i) Cleaner for antennas.

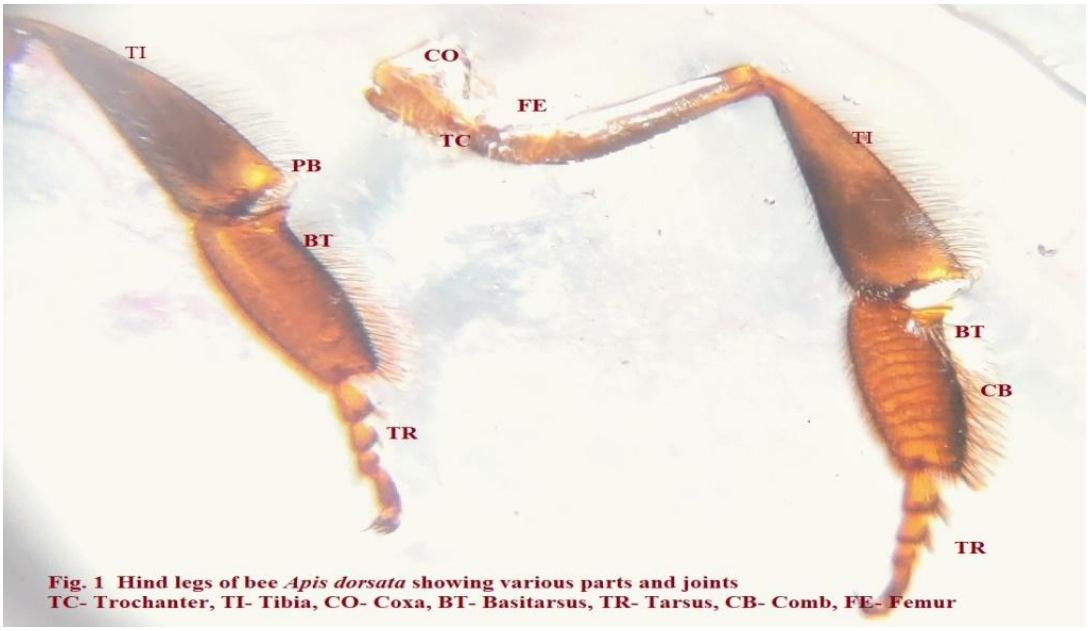

Fig. 1 Hind legs of bee *Apis dorsata* showing various parts and joints
TC- Trochanter, TI- Tibia, CO- Coxa, BT- Basitarsus, TR- Tarsus, CB- Comb, FE- Femur

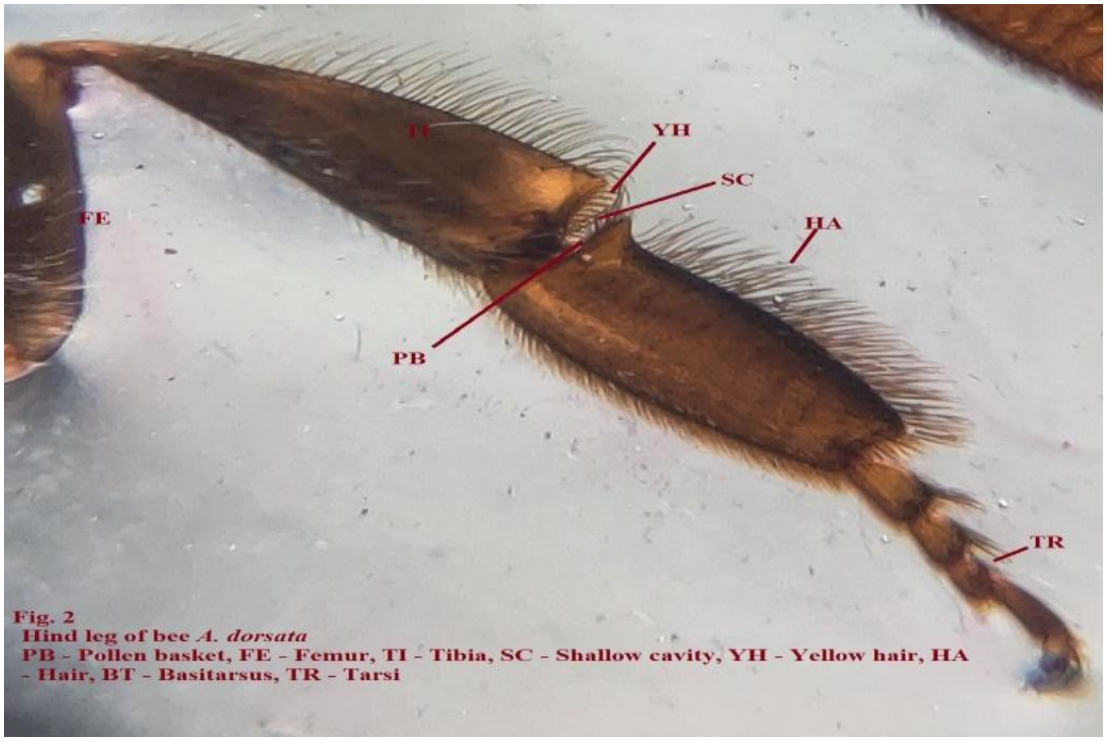

Fig. 2
Hind leg of bee *A. dorsata*
PB - Pollen basket, FE - Femur, TI - Tibia, SC - Shallow cavity, YH - Yellow hair, HA - Hair, BT - Basitarsus, TR - Tarsi

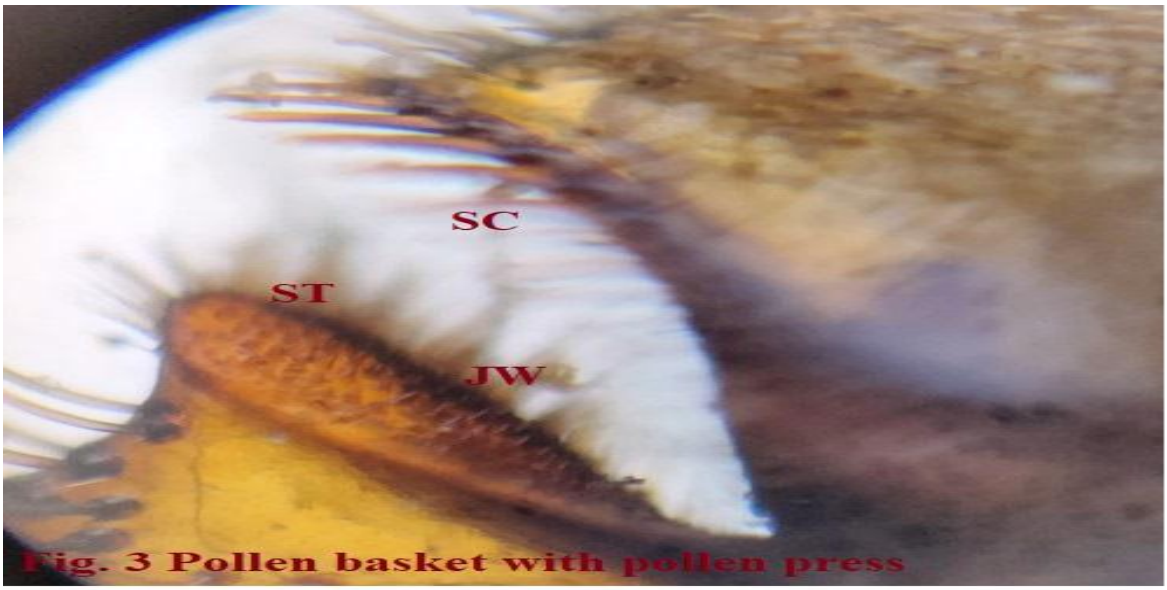

Fig. 3 Pollen basket with pollen press

JW- Jaw, ST- Steel trap , SC- Shallow cavity

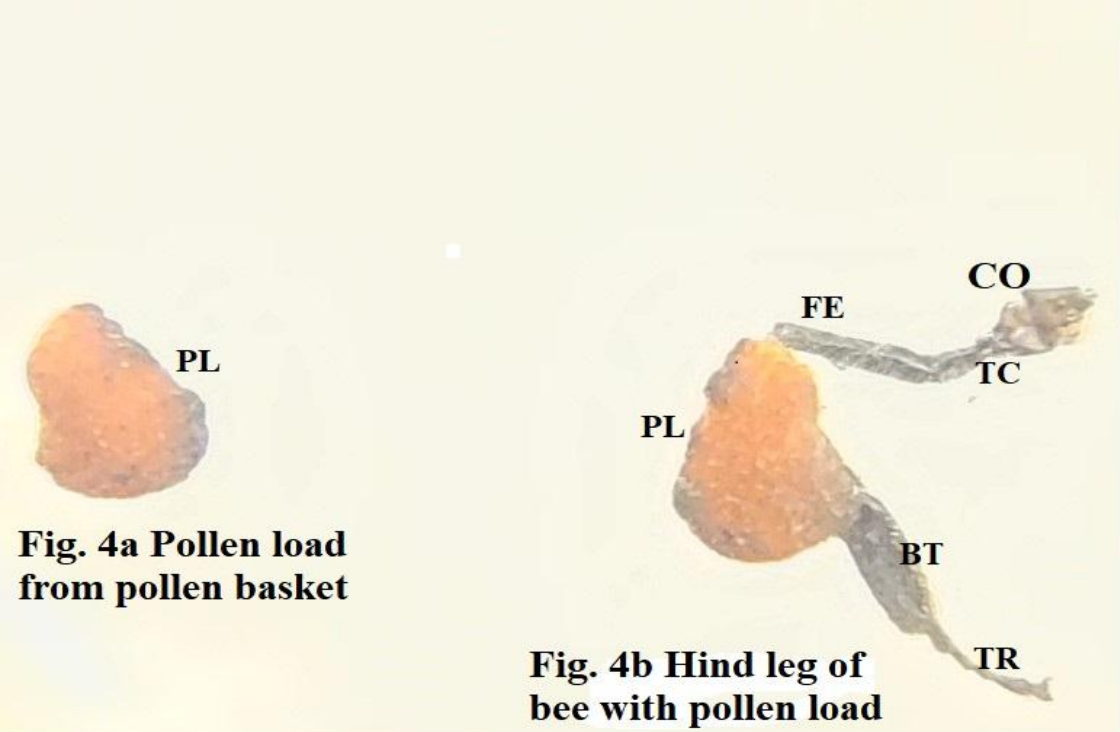

Fig. 4a Pollen load from pollen basket

Fig. 4b Hind leg of bee with pollen load

PL- Pollen load, FE- Femur, TC- Trochanter, BT-basitarsus, TR- Tarsus, CO- Coxa

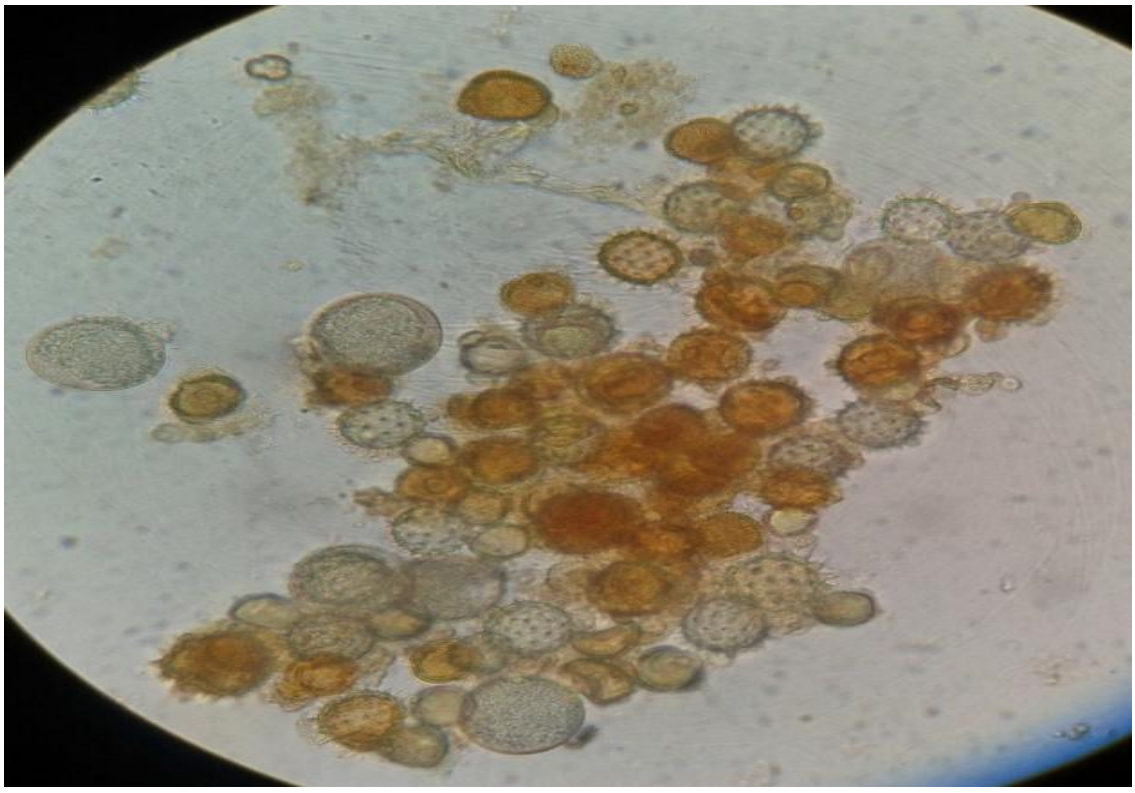

Fig. 5. Showing pollen grains from pollen load

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