

PLATE I

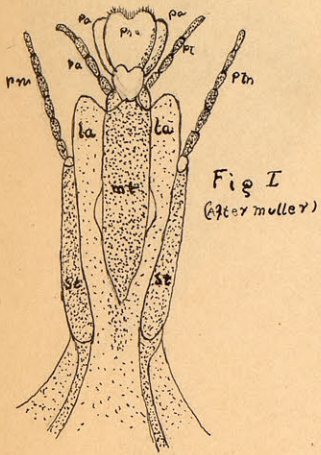


Fig I
(after muller)

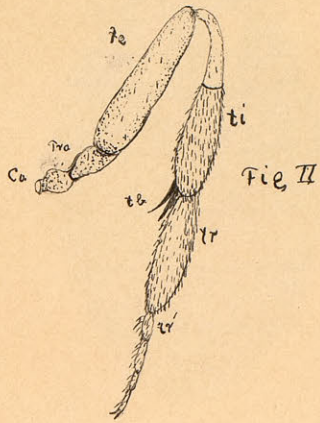


Fig II

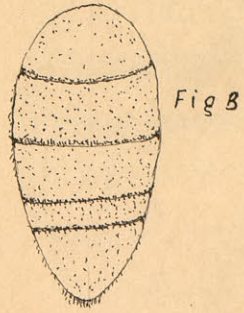


Fig 3

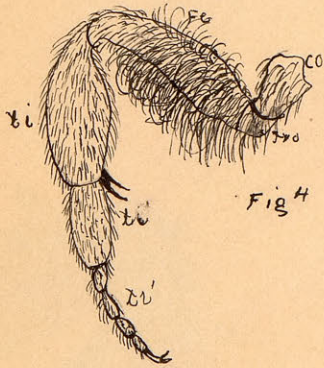


Fig 4



Fig 5

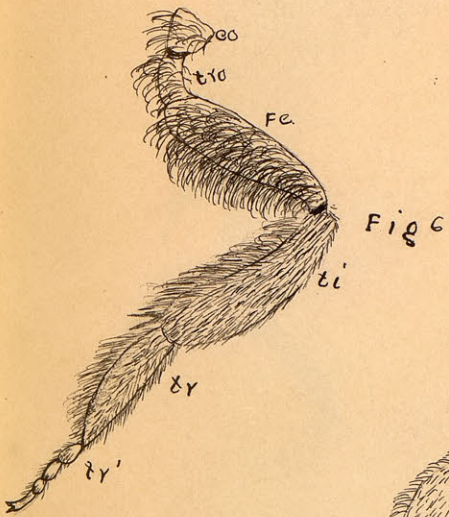


Fig 6

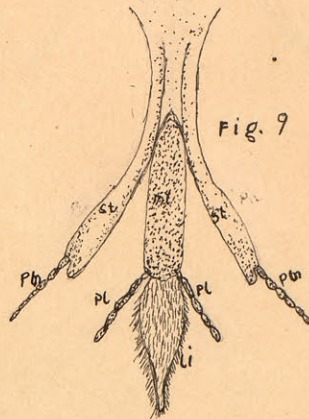


Fig 7

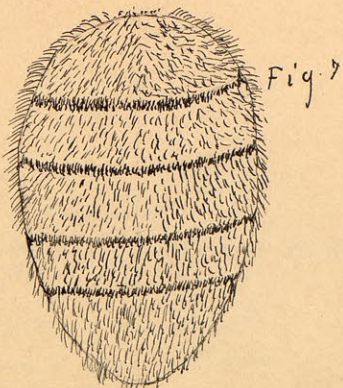


Fig 8

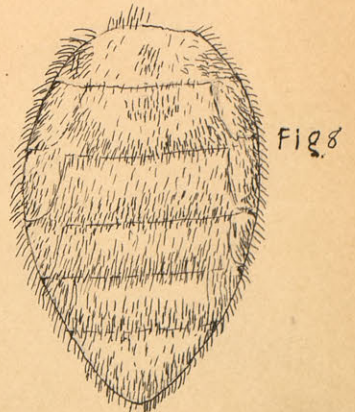


Fig 9

- Fig 1, mouth parts of *Proctos*.
 " 2, hind leg of "
 " 3, upper side of Abdomen.
 " 4, Right hind leg of *Colletes*.
 " 5, upper surface of "
 " 6, Left hind leg of *Halictus*.
 " 7 Mouth parts of "
 " 8 Upper surface of abdomen of *Halictus*.
 " 9 Under side of abdomen "

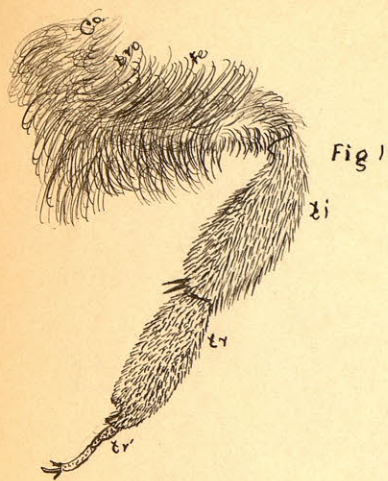


Fig 1

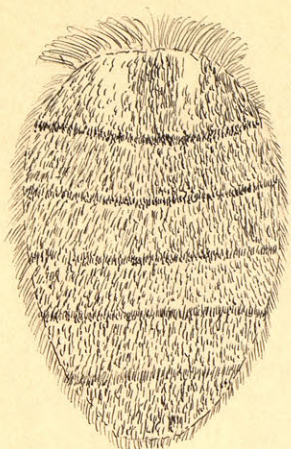


Fig 2

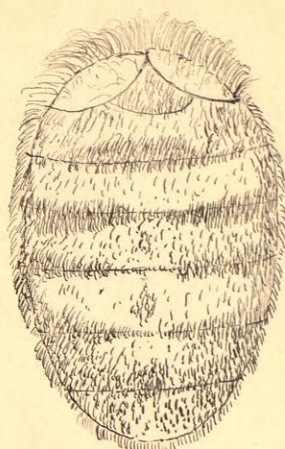


Fig 3

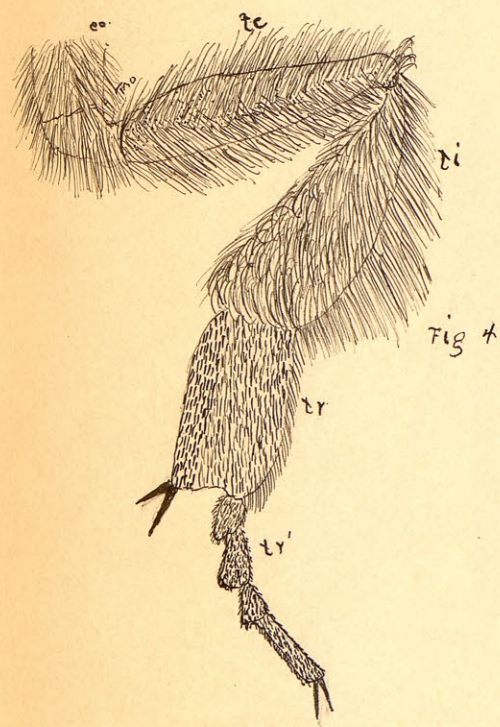


Fig 4

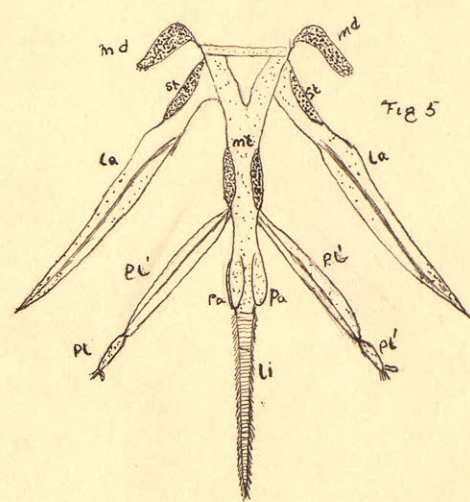


Fig 5

- Figure 1, right hind leg of *Andrena*.
 " 2, The upper side of the abdomen of *Andrena*.
 " 3 The under " " "
 " 4 The hind leg of genus *Bombus*
 " 5 Figure showing mouth part of *Bombus*

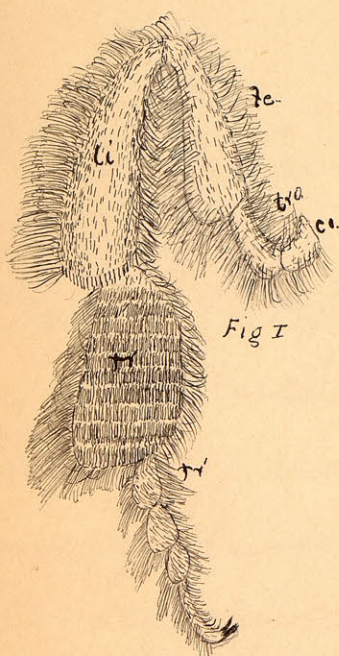


Fig 1

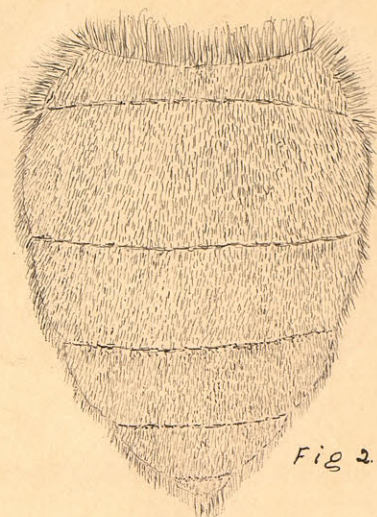


Fig 2

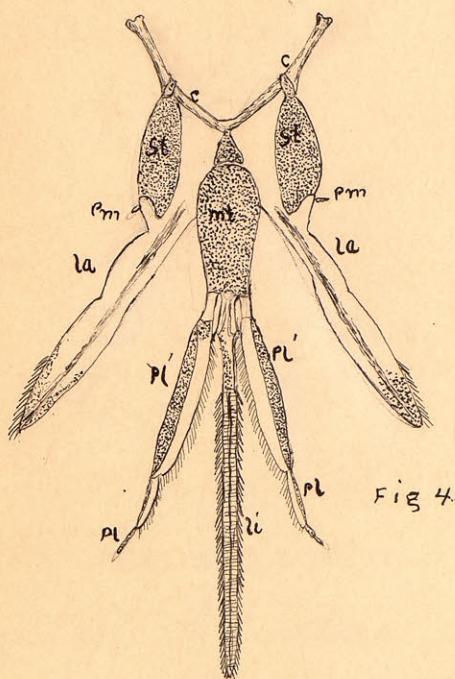


Fig 4

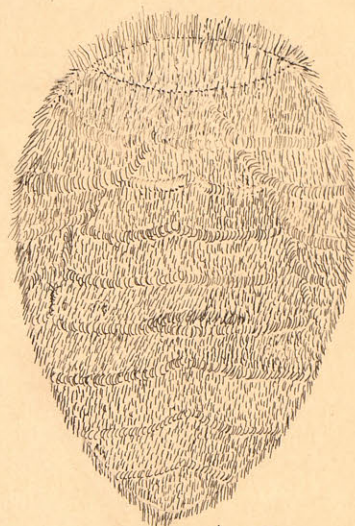


Fig 3

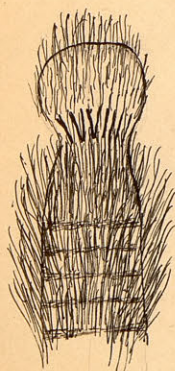


Fig 5

- Figure 1, Hind leg of genus *Apis* or Honey Bee.
 " 2 Upper side of the abdomen of genus *Apis*.
 " 3, Under " " " " " "
 " 4, Mouth parts of Honey bee.
 " 5 The knob or end of tongue.

Polliniferous Structures in Typical
Bees.

— By —

Frederick Hugo Meyer.

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We pass by the blooming plants of spring and summer, such as the plum crabapple, locust and spiraea and hear the never ceasing hum of the industrious bee, but we seldom think of their place in nature, and the important function they perform in the plant kingdom. The bee while visiting the flowers in search of honey and pollen as food for its young and itself, unknowingly accomplishes another purpose; it carries pollen from the anthers, of one flower to the stigma of another, accomplishing the process of cross-fertilization, which through a well known law, strengthens the species for a battle among the surrounding species. A case of the "survival of the fittest"

The honey bee is widely known to mankind through its wonderful assiduity and skill in collecting and storing of honey, producing an economic product. And for this product they have been studied and guarded from time immemorial.

Indeed many operations of this little instinct are so complex as to induce a suggestion of reasoning in their procedure, instead of working blindly to an end.

It is then, natural, - that the subject of bees should be of great interest to man. There-fore in this production I have chosen to consider not alone the honey^{bee}, but the whole division of bees in the development of collecting apparatus and mouth parts.

Not until the close of the last century did the bee become of such scientific interest, when Conrad Sprengel a botanist, labored in a new field, of "light adaptation", to show the useful purposes of singular forms, of color and of scents in flowers.

This, then was a new path in botanical science. He discovered that plants contained nectars within easy reach of insects and that there were colors and scents to attract the insect; also, there was upon the flower pathfinders and honeyguides

and - this led to the discovery that some flowers are incapable of self-fertilization. His conclusions were that these conditions are all produced to bring about cross-fertilization by insects and other animals. The following are the foundations he laid. First - flowers are fertilized by some one specie of insects or several species; second - the insect on approaching the honey bushes pollen from the anthers, with various hairy parts of their bodies, and convey it to the stigmas. Then followed Knight with the law - that in no plant does self-fertilization occur for an unlimited number of generations, and still later came Darwin, the master mind, who gave the laws greater impetus by his brilliant researches.

The order Hymenoptera takes the highest rank in the work of insect fertilization, and the bees of this order are the most highly developed and specialized in the pro-

cess, all other genera are exempt, because of their exceedingly short tongues, which can reach the nectar of but few flowers; also the bees show more of an adaptation for a floral diet and have led more to a corresponding adaptative modifications in the flowers.

Zoologists, then are quite justified in their assertions, - that many of the bodies of bees are correlated with the shape and forms of particular flowers; equally true is it that many of the properties of flowers are likewise in correlation with the forms and habits of flower seeking bees. Therefore we find these bees, which entirely depend upon plants for the food-products, varying greatly in size and shape, also in their coatings, in what they require for nutrition, in respect to flight, development of mouth parts and many other habits.

Collecting is carried on by specially constructed hairs and bristles, which

clothe various parts of the bodies, more especially the abdomen and terminal segments of the hind legs. Only a slight touch or movement is required to jar the pollen from the anthers which readily adheres to the body, even though it is smooth and hairless, and while on flight from flowers the pollen-grains are combed and brushed from it by means of the brushes of the hind legs: it is then collected and transported to the nests, by specially constructed parts. Bees only frequenting flowers for nectar become covered with the pollen grains and so carry it from flower to flower.

There has been a marked and steady development of the different collecting hairs on the abdomen and legs, similarly there has also been a corresponding development in adaptation of the mouth parts for deeply placed nectaries.

According to Professor Hermann Müller an eminent botanist, bees

are descendents from one of the many sand wasps. They like our sand wasps of today capture and disable spiders and insects by means of the sting; carry them to their burrow and deposit an egg besides each, thus providing living food for the future larvae. But the perfect wasp feeds entirely upon honey and pollen collected from flowers of plants. The next higher development finds the insect feeding the young upon pollen and honey, which the adult disgorges from its stomach. Thus this variation at first differing only in habit, increase remarkably fast and form the large group of bees comprised of the two large families, Andrenidae and Apidae.

The family Andrenidae is widely distributed and composed of many genera and species. They are all solitary bees consisting of males and females. Their nests consist of burrows in the ground or sand-banks usually to a considerable depth and in ex-

posed places. The egg is deposited in the different cells at the foot of the burrow and sufficient food composed of pollen dampened with honey is stored with it. In this family the proboscis vary much in length, but not so widely as the species in the family *Spidae*; *Andrenidae* are usually referred to as the short tongued bees.

The hind legs of the many genera are more or less clothed with hair and bristles depending upon their rank in the family. At the lower extremity of the tibia there are two spines, which are used in digging the burrows. Of the many genera in the family we will only examine the following; *Prosofis*, *Sphecodes*, *Halictus* and *Andrena* for modifications in the advancement.

The least developed are the *Prosofis*, which stand nearly on the same level with the ancestral sand wasps. They are the least coated with hairs of all the bees. No other pollingerous

bee is so destitute of hairs on the body. (Plate I fig. 3), shows the upper side of the abdomen. The legs, too are the most naked of all - (plate I fig 2); trochanter femur and the upper portion of the tibia are absolutely bare, while the remaining parts are but sparingly provided with short hairs. The first tarsal joint, which later, in other genera shows marked specialization is little differentiated. Again they resemble the sand wasps in their mouth parts (plate I fig 1); the tongue is but slightly elongated and quite broad, suited for the construction of their nests, which are very smoothly finished. Their food consists of pollen and a little honey; by some authors they are said to be parasitic, in fact it is only through the method of feeding their progeny, that they have been admitted into the family.

The next higher development is the *Sphécodes*. Here, too the tongue is quite short, but not as broad, therefore limited to small simple flowers. As the *Prosofia* on account of the comparative

ly short proboscis is sometimes spoken of as parasitic. The members of this genus may be said to be glabrous because of the few scattering short downy hairs. The abdomen is coal black and nearly naked, consequently destitute of an apparatus for collecting pollen, yet they show an advance in the quantity and arrangement of the hairs, and here too commences the feathery branching of the hairs, which is characteristic of the family. The legs are more thickly clothed with hair than the preceding genus, more especially on the tibia of the hind legs. Here begins the development of the brushes on the inner surface. Like the *Prosopis*, they feed their young upon disgorged honey and pollen.

The third in order is the *colletes*. It is one of the most regular visitors of the family *Andrenidae*, to the flowers in search for food; therefore figure largely in the economy of nature. Similar to *Prosopis* and *Sphecodes*, they feed the progeny upon material disgorged from the stomach. Also no great difference is

found in the mouth-parts, it possessing, as the others a very short tongue. The body is more hairy, especially laterally (plate I fig 5). The segments of the abdomen are marked with bands of closely decumbent hoary or whitish down, formed on both sexes. The posterior legs are more widely provided with long hairs (plate I, fig 4). The first joint of the tarsus is heavily covered with long hairs. On the tibia they are short, but the coxa and trochanter are well provided with long curving hairs. The females are very active collectors of pollen, and frequent the early flowers.

Passing from the Colletes to the Halictus we note a marked advance. It consists of many species, some are the smallest of all bees, being extremely minute. They too, possess the habit of burrowing in sandy banks, or hard exposed places as an old road. A greater change in the hairy covering of the hind leg (plate I fig. 6) is here found. The hairs are well distributed from

coxa to tibia, the coxa and trochanter especially have long curving hairs. A prominent feature is here introduced; the first tarsal joint increases in width, thus the carrying power of the insect is greatly increased. The abdomen too (plate I fig. 7 & 8) is more closely covered with hairs, which have become more feathery. The tongue (plate I fig 9), is longer and more narrow, and is hidden, insuring it from injury, while not collecting; here then is a provision for a more extended proboscis.

The species of the genus *Andrena* are many and the method of feeding the young has not yet changed; indeed, in many respects the *Halictus* and *Andrena* have advanced side by side. The different species vary in the abdominal covering, some are densely covered over the whole body, others are banded with white pubescence (plate II fig 13) and still others are unmarked. The legs (plate II fig 1) are densely coated with rather long hair externally, especially the posterior pair, upon the trochanter,

from the under side locks of long curly hair protrude, this, with the addition-fringes that edge the lower portion of the metathorax, forms an apparatus which no other genus thus far examined possess. With this special addition the insect is able to carry an increased amount of pollen. The anterior and upper surface of the femur is clothed with very long loose hair, which also surrounds the tibia.

Passing from the Andrenidae to the Apidae, or the long tongued bees, we mark a great change in the adaptation of the collecting hairs and mouth parts.

The genus *Bombus* and *Apis* are the most prominent in the family, possessing elongated trunks capable of being folded in the shape of a Σ . The anterior tarsus of the genus *Bombus* (plate II fig 4) is quite heavily covered with long stiff hairs and many times exceedingly stiff. The first tarsal joint is of a triangular shape; on the external surface it is nearly smooth and irreg-

ularly concave, and inner side fringed with a dense brush, but the bristles are not arranged in rows as the *Apis*. The pollen is carried on the outside of the tarsus, thus, an economy in collecting hairs. The upper side of the abdomen is covered with long black hair, but the under side is nearly smooth; in fact the whole insect is well coated with collecting hairs. The bee is often covered with pollen, which is combed off with the posterior legs, then it is collected and placed on the tibia and tarsus, where it is held until it arrives at the nest. The mouth parts are characteristic of the group (plate II, fig 5), mandibles broad at the base, tongue twice the length of the labium, clothed with pubescence, to within a brief distance of the apex, the labial-palpi are three fourths the length of the tongue.

They often obtain their honey by piercing the flower tube, this is the method pursued when the tongue is too short to reach the nectar or when the tube of the flower is too narrow to permit en-

trance. The tongue when the bee is at rest is folded into a cavity on the under side of the head. This genus comprises the largest of our bees, and like *Apis* the colony is composed of three sexes, the workers, males and females. As in the preceding genera the female is the most diligent worker, but in the *Apis* the workers are the ones that supply the food for the progeny and the other sexes.

The honey bee or *Apis mellifica* presents the highest and last grade of perfection in the collecting apparatus of the hind legs and mouth parts in obtaining of nectaries. The colony is composed of three sexes; males or drones, females or queens, and neuters or workers; the workers, however are ^{the} only collectors of the colony.

Apis mellifica gives the best illustration of the process of specialization by addition. The perfection of the collecting apparatus of the posterior leg is peculiar to the honey bee alone; (plate III fig 1) the edge of the tibia is fringed longitudinally with long hairs curving inwards

forming the pollen basket, this is for the conveyance of materials. The most distinctive feature is discovered in the first tarsal joint which is oblong and very broad comparatively, the upper surface is fringed with loose hair, but the whole of the inner surface is clothed with nine parallel transverse rows of short stiff golden hair, forming the tarsal brush. The other joints are short and fringe with stiff hairs or bristles. Tibial spurs which are yet found in the *Bombus* now disappear. Stiff hairs inclining backward varying in length and number, clothe the whole, of the ventral surface of the abdomen (plate III fig 2 & 3). In fact the whole of the body is thickly coated with long curving hairs, upon which the pollen falls and is collected there-from by the tarsal brushes.

Similarly there is a culmination in the perfection of the mouth parts (plate III fig. 4), the tongue nearly twice the length of the labium, linear, pubescent and terminating in a small

knot (plate III fig 5).