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<tr>
<td>作者</td>
<td>徳田 信信</td>
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**HOKKAIDO UNIVERSITY**

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INTRODUCTORY.

Setting aside the brief accounts of the Japanese honey bee given by the Japanese writers such as TAMARI (1889) and others, RADOSZKOWSKY (1887) was the first who deals with the systematic position of the bee and regards it as *Apis mellifica* L. var. *japonica*, as following lines show: "Elle se distingue de l'abeille ordinaire en ce que les bases des segments portent des bandes formées de poils couchés blanchâtres et que les segments ventraux sont d'une couleur pâle et garni de poils longs sâles. Cette variété se trouve aussi aux environs de Wladiwostok. Jokohama." 1)

According to v. BUTTEL-REEPEN (1906) *Apis mellifica* is classified into 3 subspecies: 1) *mellifica* proper, 2) *unicolor* from Africa, and 3) the Asiatic which merits the name of *indica*, and our native bee is regarded by him as a variety of the last named subspecies, i. e. as *Apis mellifica*, st. *indica-japonica* Rad. 2)

This view on *indica* is based chiefly upon the criterion to this variety, as pointed out by KOCHENIKOW (1900), which consists in the prolongation of the cubital

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1) Probably *et* is dropped between the two localities, Wladiwosock and Jokohama, by misprint.

2) v. BUTTEL-REEPEN (1906) says that he found in the collection from Japan in the Zoological Museum of Berlin, etc., some examples of *indica-peroni*, 6 of *indica-sinensis* and 3 of *indica-japonica*, and regards the latter as the bastard between *sinensis*-variety and a dark variety of *indica*-subspecies.

vein beyond the medial cell in the hind wings, as his lines go: “Hintetflügel Kubitalader über Medianzelle bedeutend hinaustragend” (p. 170). In addition to this the author gives two further characteristics of *indica*: 1) “Männchen: Tibie III an der dorsalen Seite ausgebuchtet und seitliche äussere Wölbung abgeplattet” (p. 169); 2) “Mandibeln und Labrum stets heller (meist rostrot) gefärbt als der Thorax” (p. 190).

From the statement given above, we see that the Japanese bee has been put by v. Buttel-Reepen for the first time in relation to *indica* established by Fabricius (1798) as the independent species. Bingham (1897), Koščevnikow (1900), Matsumura (1911) and recently v. Buttel-Reepen (1915, 1918) also recognise *indica* as the independent species.

According to Bingham (1897), however, *indica* can not sharply be distinguished from, but “merges into common *A. mellifica* Linn., the honeybee par excellence of Europe.” Koščevnikow (1900) also says: “*A. indica* und *A. mellifica* zeigen viele Ähnlichkeiten miteinander; die Varietäten dieser beiden Arten zeigen noch mehr Übereinstimmung als die typischen Formen.” Frieze (1920, 1922) puts *indica* among *mellifica* on account of his opinion, according to which in the honey bee only 3 species are to be admitted. If I understand correctly the lines given by Frieze in this regard, his view, by which various forms of the honey bee are comprised in the 3 species known as *dorsata*, *floreà* and *mellifica*, is established on 2 points: firstly, the alterations affected by the domestication and adaptation are so great that celebrated systematists such as Bingham, Smith and Radoszkowsky put unicolor from Africa together with the Asiatic *indica* (Bingham) and classify likewise the Asiatic *sinensis* (Smith) and *japonica* (Radoszkowsky) with the European *mellifica*; secondly, the 2 forms of the 3 specise, *dorsata* and *floreà*, which stand morphologically very distinct not only from each other, but also from *mellifica*, can not be crossed with the last named species, while *indica* is crossed with *mellifica* successfully. He also says: “*Apis indica* und *mellifica* sich derart auch biologisch nahestehen, dass wir sie auch unter einen morphologischen Speziesnamen vereinigen können” (1923, p. 344). “Die Honigbiene (*A. mellifica*) ist nur wenig grösser als die *A. indica*, der sie namentlich in ihren afrikanischen Abaraten wie *A. adansonii* und *unicolor* täuschend ähnlich sieht” (loc. cit., p. 357).
The specific value of *indica* and *mellifica* is, therefore, still not clear enough. The present investigation has been carried out with the Japanese bee, and so far as possible, extended to the Corean, Chinese and European bees, so as to enable to compare the anatomical as well as the biological data of the insects from these localities with one another. According to the results arrived at, there is recognised a great similarity among the bees of Japan, Corea and China on one hand and among those from Europe on the other, while the eastern bees show a sharp contrast against the western, so that the latter represented by *A. mellifica* can by no means be mixed with the former which is accordingly to be recognised as a distinct species and signifies as *A. indica* according to Bingham (1887), especially to Fabricius (1798). As the descriptions show, to the species criterions of *indica* pointed out by Koschevnikow and v. Buttel-Reepen are to be added further distinct characteristic made out in our bee in the present work: the abdominal down bands, a peculiar pore on the drone cocoon, the modification of male organs, etc., inasmuch as there is no room to doubt in recognizing the Japanese bee as a variety of *A. indica*.

The present author is placed in a convenient position in procuring the material not only from the colonies of the bees kept by himself in the Experiment Station, but also because he has connections with his friends and beekeepers affording to him the specimens from several localities of this country. He is moreover well acquainted with several races of the European species, *A. mellifica*, such as the Italian, Carniolans and Dutch bees imported from America and their native places by beekeepers as well as by the Government Industry Department.

In addition to this, Dr. L. H. Gough, Director of the Entomological Section, the Ministry of Agriculture, Cairo, Egypt, was so kind to send me 6 specimens of the queen, worker and drone of the Egyptian bees, collected by himself in 1912 and 1913, so as to enable me to extend the anatomical comparison of the present results into the Egyptian bees.

The author will be permitted to express in this place his hearty thanks to Dr. S. Hatta, the professor of the Imperial University, Sapporo, for his kindness in giving valuable advices in the course of the work. My obligations are also due to several other gentlemen for their kindness shown to me in several ways.
I. MORPHOLOGICAL CHARACTERISTICS

1. Color of the Skin

As is well known, the workers of the Japanese bee are generally blackish in color with brown markings of several systems, which are not other than the zones of the ground color turned lighter. The shade of the colors varies according to the age and also to the localities, from which the specimens are collected; young individuals are lighter in color, and the specimens from some localities are so dark that the brown markings come forth hardly.

In the head which comes first in notice, the mandible and labrum are rust-red in color as v. Buttel-Reepen (1906) mentions of all varieties of indica, including japonica; some examples have the labrum of lighter color extending to the clypeus. The scutellum of the mesothorax ranges in color from yellowish to black; even the individuals from one and the same hive differ in this respect, although sometimes there are found colonies which contain uniformly black bees.

Secondly, the abdomen is pale yellowish ventrally, as described by Radoszkowsky (1887), v. Buttel-Reepen (1906) and Matsumura (1911), shading lighter into the ventral parts of the dorsal plates. It is worth of notice that in some examples the ventral side of abdomen is turned into blackish when killed, while in life it is brownish. I mention this, because this change of color misleads often one to recognize the black abdomened specimen of the Japanese race as a normal example; v. Buttel-Reepen (1906), who has 6 examples of sinensis from Japan, seems likely to have been misled by this abnormality. In reality, the pale coloring on the ventral side is to be recognized as one of the important characteristics of the Japanese bee.

Turning to the dorsal plates of abdomen, 2 transverse zones are distinguished on each plate: the posterior broad zone is blackish, while the anterior narrow patch is lighter in color, so far as it is usually overlapped, so as to be hidden by the hind margin of the preceding plate, and becomes visible only when the abdomen is much distended (Fig. 1), so that the characteristic markings are in

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1) I have experienced that some yellowish examples from a central locality (Kanagawa), for instance, have become deep black when they are dead; furthermore black types from a northern locality (Aomori) were still further blackened when killed.
the ordinary position of the body out of notice of an observer, especially in the case of specimens which are shrunked. Bingham (1897) notes on *indica* simply: "The scutellum and basal five segments of the abdomen testaceous yellow"; Benton (1896) says, on the other hand, "The abdomen is yellow underneath. Above it presents a ringed appearance, the anterior part of each segment being orange yellow, while the posterior part shows bands of brown of greater or less width and covered with whitish-brown hairs; tip black." The observation of the last named author is accordingly in this respect in accordance with the results of the present investigation.

The markings on the dorsal plates just referred to are the constant occurence to all the worker bees, though there are naturally some divergencies in shading of color. The second plate is excepted in its being furnished with a striking brownish mark of varying shape and area which occupies the larger or smaller part of the black area (see *k*, Fig. 2), but is entirely lost not unfrequently. There are rarely colonies, the whole members of which lack the mark in question.

Thirdly, the *legs* are black, with a brown oblique streak on the outside of the middle portion of the tibia of hind legs. The black pigment grows more scanty towards the proximal joints, especially on their inner side, being caused by lacking the pigment. The coxa, trochanter and femur of the legs, especially those of the hind legs, look on this account more or less translucent and are turned brownish and opaque, when the bees are dead and dried. The above mentioned streak as well as the brown shading just referred to are not constant; some individuals have legs lacking entirely the streak and brown areas, the whole body being blackened.

The following table (Table I) is intended to show the number of bees with the markings from several localities of this country as well as those from Corea and China. In some examples the brown markings are extremely distinct because the fundamental black color is lighter, while in another lot they are diffused owing to the latter which is intensified; there are of course individuals standing in this respect in the midway between the two lots, ranging to both the extremities. The variation is to some extent due to the geographical position of the localities. So far as proved, the bees from the southern localities such as Fukuoka and Kumamoto are lighter in color, as compared with those
from Hondo or the Main land and from Shikoku (Kōchi and Tokushima).

**TABLE I.** The worker bee individuals with markings, from several localities.

<table>
<thead>
<tr>
<th>Localities</th>
<th>Total number of the worker bees observed</th>
<th>Individuals with scutellum brownish</th>
<th>Individuals with brownish marking on the 2nd abdominal segment</th>
<th>Individuals with brownish markings on the 3rd tibia</th>
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Next come in consideration the queen and drone, in which the coloring is generally simple. In the queen, the head, thorax and abdomen are brownish black; legs are translucent, fuscous and sometimes mottled blackish. Scapus of antennae is often dark brown. Scutellum is black. The anterior half of the abdominal segment is shiny black; its posterior half exposed is not shiny, being covered with finest brownish pubescence. The ventral plates of the abdomen are black, each ranging posteriorly into fuscous. The drones: the head, thorax, abdomen and legs are all black, excepting the surroundings of the anal opening which are brown.

2. Pubescence of the Japanese Bee

The hair bush between compound eyes is not scanty in the Japanese bee, as compared, for instance, with *A. mellifera*. In this respect, our bee can not be distinguished from the specimens from Corea (Seoul and Kôryô), Manchuria (Chikoshan), Peking and Hankau, which agree again in resembling each other. This fact disproves the statement by v. Buttel-Reepen (1906), which runs as follows, “Das Fehlen des Stirnhaarschopfes und spärlichere Behaarung sowie die hellere Abdomen-Unterseite (in the Japanese bee) unterscheiden sie von der *Sinensis*.” About the color the blackishness of the ventral plates of the abdomen can not be accepted, as we have already dealt with in the preceding paragraph; what the hair-tuft is concerned, I do not hesitate to assume that it is lost or diminished owing to some artificial causes.

The second lot of hairs are represented by the hair bands of the abdomen, which are of constant occurrence and merit accordingly the valuable species criterion. According to the previous authors these hair bands are present in the varieties, such as *peroni, picea, sinensis* and *japonica* only three in number, occurring on respective segments from the 3rd to 5th. I have detected one more band on the 6th segment of the Japanese bee (Fig. 1); this band may probably be overlooked in shrunked specimens, because it is found on the hindmost segment of the body which is often concealed in such specimens. Nevertheless, it is an important characteristic not only of the Japanese bee, but also of the bees from Corea and China, in which I have proved this, while *mellifera* is destitute of it. This result suggests further that all other varieties
of *indica* possess the same structures. The hair band in question is yellowish in color and narrow in shape and is found on the basal margin of the black region of each segment.

Now we have in total 4 hair bands distributed respectively on the segments from the 3rd to 6th; it is these white hair bands by which a ringed appearance of the abdomen is distinctly expressed, especially when the abdomen is distended by some causes.

As the third lot of hairing I am going to describe the hairs of the remaining parts of the body. The hairs of the thorax are brownish gray on the backside, becoming whitish on its ventral side and on the legs. From the coxa to the tibia whitish hairs are present; the tarsus is provided with brownish hairs.

As to the hairing of the *queen* the caput is provided with long brownish black hairs, but on the face short black hairs are seen; on the dorsal and ventral sides of the thorax as well as on the legs brownish hairs are present; the abdomen is grown with brownish finest pubescence.

The *drone*: the face is provided with black, the thorax with brownish black, the distal end of the thorax and the basal margin of the abdomen with grayish white hairs; the abdomen is grown with whitish hairs ventrally and with long brownish hairs distally. The coxa, trochanter and femur of the foreand middle legs are provided with whitish hairs, the tibia and tarsus being furnished with brownish long hairs; the hind legs lack hairs from femur to the tip.

3. Wings

The wings are in the three forms hyaline; in the queen they are often more or less darker in color. The wings of drones are iridescent.

The criterion given by Koschevnikow (1900) of the venation on *indica*, that consists in the prolongation of the radial and cubital veins beyond the medial cell in the hind wings, is also valid of the hind wings of all over the worker, queen and drone bees (Figs. 3, 4, 5).

Hooklets of the hind wings of the Japanese bee show greatly numerical divergence. The following table (Table II, a, b, c) are intended to show the number of these hooklets in the workers, queens and drones of the Japanese bees from several localities.
3. On the Size and Shape of the Body.

The Japanese bee is in the dry specimens 9–12 mm in length. But the plump bees attain so greater length, that they are 14 mm or more in total length.

TABLE II.

a.—Workers

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c.—Drones

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1) The figures are from 10 bees taken at random.
In an example of the Japanese bee it is 0.0636 gr$^3$ in weight, in another one 0.07835 gr,$^5$ while a bee of the Italian race weighs 0.0725 gr$^3$ and another one of the latter 0.0875 gr.$^6$

The queen of the Japanese bee is relatively large; it is on the dry specimens 13–17 mm in length; during spawning season, living queen grows as large as 20 mm in length, weighing 0.21185 gr for instance. The drone, on the other hand, is relatively small in size; it is 12–13 mm in length on the dry specimens, but in living ones it is 14.8 mm and 0.124 gr.$^5$

The tongue of the worker is 3 mm in length, 0.5 mm or more shorter than that of the Italian.

Buttel-Reepen (1906) mentions that the distal, dorsal margin of the third tibia is in the drone of indica strikingly projected (j, Fig. 7), while it is in the mellifica drone almost straight (Fig. 8). The stiff hairs of the planta of the first tarsal joint are in 12 rows, 2 of which are obscure.


Now let us turn to the male copulatory organs which show a great deal of characteristics distinguishing our bees from mellifica. For the sake of convenience the description will be commenced with the organ everted. It is simply not other than a membranous, tubular, hollow pouch bent dorsally, and consists of 2 portions, the proximal and the distal; the latter is smooth on its surface (except mellifica in which a pair of so-called symmetrical chitinous plates (s, Figs. 16, 18) are to be seen in the wall of the pouch, at the dorsal aspect of the bending); the former is provided, on the other hand, with a series of appendages which are named by Shafer (1917) respectionely as the doubly pinnate-lobed projection, the cross-striped chitinous ridges, the ventral quadrangular plate, the triangular plate and a pair of pneumophyses.

In the distal part, the Japanese drones are distinguished from mellifica, in the first place, by the neck-like narrowance of the tube (c, Figs. 14, 15, 17), by which the proximal portion is demarkated against the distal, while in mellifica they pass from one to the other; in the second place, the so-called

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1, 2, 3, 4) The bees alarming at the entrance were taken to the weight.
5) It is the average number of 11 drones.
symmetrical chitinous plates are sometimes nearly lost in the Japanese bee (Figs. 15, 17), or are represented simply by a group of slight thickenings of the membranous wall (s, Figs. 14, 20), which are melt together in *mellifaca* into a pair of hard chitinous plates in the dorsal wall of the penis tube (s, Figs. 16, 18). In this respect, the Chinese drone can not be distinguished from the Japanese, showing a slight thickenings of the membranous wall instead of the hard symmetrical chitinous plates. The thickenings are only a ring zone formed of minute outgrowths of the penis wall. The lateral and dorsal views of the zone are shown in Figs. 14 and 20 (s) respectively.

In the proximal portion the so-called pinnately lobed projection shows a fan-shaped arrangement of lobes around the axis (l, Figs. 15, 21), instead of the pinnate structure in *mellifaca*, in which the lobes are arranged principally on each side of the axis, whence the terminology of the organ is derived (l, Figs. 16, 22). What is the cross-striped ridges concerned, the grooves separating them are more depressed than in *mellifaca*, so that the ridges are expressed distinctly (r, Figs. 14, 15, 17). The ridges are furthermore provided with the spinules or hairs, the growth of which is in particular denser and more vigorous towards those in the proximal part; in *mellifaca* they are separated not only by the relatively inconspicuous depressions, but the spinules are most vigorous in the middle ones, as seen in the penis everted. The ventral quadrangular region is very thin in structure and clad with spinules very weakly (q, Figs. 15, 17), connecting with the well developed proximalmost ridge (r, Figs. 15, 17), while in *mellifaca* the former is thick and vigorously haired and set off from the latter by a strong constriction (q, c, Fig. 16). The dorsal triangular region, on the other hand, is larger and more haired in the Japanese drone than in *mellifaca* (t, Figs. 14, 15, 17).

In the pneumophyses I have detected great divergencies from those of *mellifaca*. They are represented by a pair of conical tubes found on each side (p, Figs. 14, 15, 17, 23, 24). They have 3 likewise conical, tubular, accessory outgrowths of unequal length at its basal part (ph, ps, Figs. 14, 15, 17, 23, 24); the proximal one is the longest (p1, Figs. 23, 24) and produces some minute accessory outgrowths, while the distal as well as the shortest middle tubes are simple. The homologous structures are rudimentary in *mellifaca*, being repre-
sented simply by 2 wart-like elevations at the corresponding part of each pneumophysic tube everted. In the resting state, the principal horns are 4-6 \text{mm} in length, which are only 3-4 \text{mm} in \textit{mellifica}.

Now the bees from Egypt, Madagascar and Mauritius come in consideration; they are altogether taken by v. \textit{Buttel-Reepen} (1906, 15) as \textit{unicolor}, a subspecies of \textit{A. mellifica}, whereas those from the two latter localities \textit{Bingham} (1897) puts in \textit{A. indica}. According to the present investigation the Egyptian bee can hardly be, however, distinguished from \textit{mellifica} proper, so far as the structure of the male copulatory organ is concerned (Fig. 19).

II. BIOLOGICAL CHARACTERISTICS

1. Habit of Life

The colony of the Japaness bee is inferior to \textit{mellifica} in population. The hive or box is built accordingly abot 33 \times 33 \times 100 \text{cm}. Besides the fixed hive, a movable hive was offered by \textit{Tamari} (1889), but is not in usual use, for the experience has proved the bees like better the fixed hive. When taken in a new box, the colony established very fine combs from ceiling downwards, arranged vertically and in parallel. According to our old custom, a honey dealer who visits the bee-\textit{yard}, takes out the honey, cutting across the height of the upper half the combs of the honey store opened from the roof. The remaining half of the store is left for the bees' support. In each hive the honery harvest is said to yield about 1 to 3 \textit{kwan} (4-12 kg) of honery per colony.

If the ecological conditions are unfavourable, the bees abandon frequently their hive. I observed case of the migration of the colony from Kumamoto, the members of which were preparing to abandon the hive in the course of about a month in the summer dearth. Almost all cells were full of honey, but the queen was very small in body size and no brood was found. The bees were placed in so restless condition to run out of the entrance when the hive was opened. I found after about 30 days that the hive was vacant, when the day of August 21st of 1922 broke. The propensity of migration may be taken
as a characteristic of the Japanese bees and shows a similarity to the Indian bees, as GHOSH (1920) gives on the bees of Ceylon; he says: "These bees are very prone to swarming and are found to migrate as well to some extent." Our bees cast only 2 or 3 swarms a year, though they build often 10 or more queen cells. The absconding is very often caused by the wax moths which attack almost always the hive of our bees.

As to the mode of ventilation, our bees differ from *melifera*. Whilst the latter fan at the alighting board facing inwardly, our bees sit likewise at the entrance, but their heads are turned away from it (Fig. 6). This has been well known in our country, and recently the same habit of *indica* in Ceylon is reported by DRIEBERG (1922). According to my observation, the fanning bees are resting, however, rather more in number on the upper vertical wall of the hive body than on the bottom board in front of the entrance, as shown in Fig. 6. In addition to this, those of the outside from unbroken rows together with those of inside which are likewise fanning, scattered on the bottom and combs.

Another contrast of the Japanese bee to *melifera* consists in that in the case destitute of their queen the workers are not capable to rear a queen from a worker egg or larva. It is not long after departure of the queen that many fertile workers lay eggs in cells (especially, soon the bees from Fukuoka) which produce always the drone bees. If fertilized eggs or larvae are experimentally put in cells before fertile wokers appear, they are not cared. But I have met with several cases of queen cells which are built on the drone larvae layed by the fertile workers. If the introduction of a queen is done in a queen cage, she is usually abandoned without regards. It follows that a colony once left by the queen is connected with a great difficulty to recover its previous normal condition. Some one reports on the other hand on *indica* of Ceylon that the bees "are able to raise queens from eggs or larvae when suddenly deprived of the reigning queen." If this is proved true, our bees diverge in this respect from those of Ceylon. The union of the Japanese bee with *melifera* in a colony, whether the latter is introduced in the former or inversely, is likewise by no means easy, although sometimes a few of cases of success are

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1) Refer to DRIEBERG (1922)
reported. I have an experience, that the mellific intruders in autumn were shut in a colony of the Japanese bees accidentally by snowfall and cold climate and were found living in harmony with each other in the colony in the following spring.

Lastly, our bee is contrasted to *mellifica* concerning the position of the eggs deposited in the cells. The eggs lie, in the Japanese bee, so inclined on the bottom of the cell that they are almost in parallel with the comb surface with their tip pointed downwards, while in *mellifica* the tip of the eggs is directed towards cell mouths, so as to be placed vertical to the surface referred to.

In connection with the behavior of the workers against the queen, on that against the drone a brief accounts will be given, as seen during a dearth of nectar. Usually the drones are not more reared in the season of a dearth and meantime they disappear in the hive. Among others, I mention a case in which a few drone larvae were reared; they were found crushed at the head before their maturity is attained; the waxy covers were scraped off, and the characteristic cocoons were gnawed roundly at the cell mouths, falling in the shape of a small disc, smaller than those cut down by the emerging drones themselves; this is in the case in the bees from Kumamoto and Kōchi. On the contrary, I observed a single case in the bees from Aomori, in which a few drones were almost always being raised up beyond the flowering season until late autumn or early winter.

Still further contrast of our bee to *mellifica* is seen in a queen in which the anterior half of the fore wing is clipped in order to keep her in the colony at swarming time; meanwhile she disappears, probably being killed and cast away from the nest by the workers. It is, therefore, obvious, that in the Japanese bee the artificial enforcing in the treatment of the queen is not easily accepted by the workers of a colony.

As already referred to, *Friese* (1920, 1922) and others maintain that *indica* crosses with *mellifica*. We can not, however, confirm this statement from our experience with the Japanese bee in more than twenty years, during which we did not recognise the successful results of the crossing.

The Japanese bees are mild in nature and shy and timid in character. They rarely sting weakly and bite their tormentor in some measure, often
crawling in the inside of the clothes. They avoid enemies instead of struggling against them, though they sometimes dash upon. And also Ghosh (1920?) says of *indica*: "They can not defend themselves against enemies so well as the Italian bees, and the Wax Moth plays havoc among them." During a dearth *mellifica* invade the colony of the Japanese bee without much resistance and rob away all the store. The Japanese bees disregard the invaders, even show no sight of hate or struggle against them inside of the hive as if they know nothing about the matter and leave in fact their store upon deprivance of the robbers.

There is a further fact that *mellifica* and the Japanese bee do not flourish with harmony in one and the same locality. The government statistics gives the following numbers, showing the Japanese bee diminishing year after year in number of the colonies in consequence of the struggle against *mellifica*; it is principally due to the deprivance of the store by the latter.

<table>
<thead>
<tr>
<th>Year</th>
<th>Japanese bee</th>
<th><em>mellifica</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1913</td>
<td>84,997</td>
<td>48,054</td>
</tr>
<tr>
<td>1916</td>
<td>63,735</td>
<td>49,703</td>
</tr>
<tr>
<td>1917</td>
<td>46,000</td>
<td>52,604</td>
</tr>
<tr>
<td>1918</td>
<td>44,946</td>
<td>58,865</td>
</tr>
</tbody>
</table>

The Japanese bees produce a peculiar noise of wings like ss all at once at every slight stimulation. This may be assumed as their mutual alarm and is naturally due to timid or irritable nature. They are placed in restless movement, when the irritation is strong; they run about, leaving the brood nest, to hang then at the edge of comb or at the entrance in group. In this respect, the bees from Fukuoka are more irritable than from Aomori and Kōchi.

The Japanese bees defend themselves against the ferocious enemy *Vespa mandarina*, which is a malignant foe of them in this country. *Mellifica* fights against the enemy, but receives nothing else than disastrous damage, being massacred and annihilated; our Japanese bees behave themselves in this regards quite profitable, taking advantage of their timid character; they withdraw inside the hive, as soon as visited by the enemy, and hide themselves, so long as the latter watches. And, further, the offenders are balled and killed by the
bees, as soon as they dare to intrude the inside of the hive.

2. Wax Secretion and Comb-Building.

Our tribe of bee excels *mellifica*, as it seems to me, in the ability of wax-secretion. Their habit to leave their nest at trifle obstacles seems to stand in connection with this ability of the skillful builders; the cell wall of the combs is gnawed down when not satisfied and the old shallow comb-cells are very often found left unused. In this regard they stand in contrast to *mellifica* which are extremely tenacious to take care for the preservation and utilization of any combs. Peculiar it is that they are very often bearing in their wax pockets wax scales considerably thick, more than 1 mm in thickness, bulging outward the covering plates, while this is not so common in *mellifica*.

If supplied with food, our bees build combs readily in the warm climate when no honey is coming in from natural sources. The newly built combs are white or yellow in color and regular in shape and arrangement and of freshy appearance. The cell wall of the new comb is so thin that it is only 32 µ in thickness. The bees do not use propolis. They disregard mellific combs, when given to them, but use often as those of honey or sometimes as those for the drone brood. The comb foundations of mellific type are usually also disregarded, but rarely utilized by them, building up the cells narrowing the cell mouths; thus intermediate forms of cells are left here and there between the groups of the narrowed ones.

In the followings table I have endeavoured to compare the value of 3 diameters of one cell in the Japanese bee with those in *mellifica*.

**TABLE III.**

<table>
<thead>
<tr>
<th>Diameter from side to side</th>
<th>Worker cells</th>
<th>Drone cells</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Japanese bee (80 cells)</td>
<td>Dutch bee (120 cells)</td>
</tr>
<tr>
<td>1</td>
<td>4.65 mm</td>
<td>5.42 mm</td>
</tr>
<tr>
<td>2</td>
<td>4.64 &quot;</td>
<td>4.37 &quot;</td>
</tr>
<tr>
<td>3</td>
<td>4.68 &quot;</td>
<td>4.15 &quot;</td>
</tr>
<tr>
<td>Mean</td>
<td>4.65 &quot;</td>
<td>5.10 &quot;</td>
</tr>
</tbody>
</table>
From the above figures we see that the drone cells surpass slightly the worker cells of mellifica in dimensions.

Queen cells resemble in form those in mellifica; in one case I measured it is 18.7 mm in depth and is 9.8 mm in the maximum inside diameter.

It is well known in this country that wax dealers appreciate the Japanese beeswax owing to its superior quality. The chemical and physical properties are seen in the study by Shibasaki (1900).


As the characteristic of the drone cocoon comes next in consideration a fine circular pore which I have made out at the elevated out tip of it; it comes into view, when the nurse bees take off the waxy cap sealing each cell which covers the cocoon (Fig. 9). This pore is not detected in mellifica at all (Fig. 12), but in our bees it rudiment is already obvious in the cocoon just formed; it is inconspicuous at first, but is recognized at ease by artificial exposition of the tip of the cocoon.

The young drones come out, cutting round the outer cocoon wall circularly, so that it falls in circular disc (Fig. 10, 11). Seen on median transverse section through its pore (Fig. 13), the disc consists of about 10 layers of silky substance which are diminished in number towards the periphery, so as to decrease the disc in thickness, until its sharp edge is brought about. A dark brown substance of unknown matter is deposited along the inner surface of the layered structure just described; it is thicker near the passage of the pore and is thinned out towards the periphery, penetrating probably between the layers of the disc.

The pore is nothing other than the outer opening of the passage communicating the interior of the cocoon with exterior. The passage is a straight canal, but becomes constricted at the neck which is surrounded by the dark brown body, so as to be transformed into the funnel-shaped passage which is 0.4 mm in length, 0.4 to 0.6 mm in diameter at outer and 0.25 mm at the inner opening.

Instead of thin and loose structure of the cocoon wall in mellifica, it is of a considerable thickness in our bees; the reason why the pore of the cocoon is confined to the latter consists, as I dare to assume, in this thickness of cocoon
CONCLUDING REMARKS.

A scope of the external features brought forth in the foregoing descriptions, among which the brown color of the mouth-parts, the distinct banding on the dorsal plates of the abdomen, the pale yellowish coloring of its ventral surface, the peculiar markings and the tibial projection of the drone legs as well as the criterion of the wing-venation are to be enumerated, are so characteristic to the Japanese bee that it can not be classified with, but is put against *A. mellifera*. A new fact that the toment bands which are made out in the present investigation to be extended into the 6th abdominal segment, enforces furthermore us to assume this view.

What is the anatomical details concerned, there are a series of new facts of prime importance which have been added by the present investigation; in particular they are made out in the male copulatory organ. Striking is the constriction which marks off the proximal portion of the penis from its distal part. The simple thickenings of the penis wall is seen instead of the hard chitinous plates of the dorsal wall in *A. mellifera*; not unfrequently they are even nearly lost. The conspicuous structure is seen in the pneumophyses which are not only represented by the principal horns prolonged, but consists also of the 3 well developed accessory conical tubes of unequal length. The deep grooves separating the cross-ridges from one another as well as the characteristic spining on them and on the ventral quadrangular region stand back by no means to the new facts just mentioned. The palmated structure of the so-called doubly pinnate-lobed projection with the well-developed dorsal triangular region must be added to these important facts.

In the biological habitude of life there is a series of sharp contrast in which the Japanese bees stand to *A. mellifera*. First of all our bees are so coward and helpless that they are defeated, without intending a defence, by formidable offence turned by *A. mellifera* upon. The latter are in their turn offended and damaged by dreadful attack of wild wasps which are, however, powerless on the Japanese bees, because at the offence these shy creatures
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retire into the inside of the box instead of risking the struggle and exterminate those fellows of the varacious enemy, which dare to intrude thereinto. It occurs not unfrequently that the cell wall of the old combs is gnawn down by themselves. They abandon their hive at trifle circumstance unfavorable for them; on the other hand, they are skillful in building the nest, each cell of which is in mean 4.65 mm in diamenter and 5.36 mm in depth for the drones, being the latter about equal to that of the worker cell of *A. mellifica*. They are often seen bearing so thick wax-scales, more than 1 mm in thickness in their wax-pockets. The worker bees do not intend to raise the queen either from fertilized egg or from worker larva and become fertile soon, when the latter is lost from their hive. It is, therefore, beyond doubt that a nest in which the queen is once lost, can never be maintained further, so that there happens nothing else than decomposition of the colony.

As further peculialities of the Japanese bees the forward direction of their heads at the entrance of the box, in which they are fanning, and the parts of the latter they rest at fanning are to be mentioned; the arrangement of the eggs along the midrib of the comb, in which they are deposited, is also a striking contrast to that in *A. mellifica*. The circlar pore at the front wall of the drone-cocoon is finally as one of the striking characteriostic of our tribe of bee.

All these prominent biological facts gathered from the facts described prove that our bees stand inferior to *A. mellifica* in the zoological scale and can accordingly be not taken together with, but are to be distinguished from the latter. It is, furthermore, reported and has been experienced by myself that crossing of our male and female with those of *A. mellifica* is unsuccessful.

In connection with the anatomical characteriostics, among which the construction of the male copulatory organ is worth of notice, the biological date just referred to afford us the ground which is strong enough to put the Japanese bees on it against *A. mellifica*. On the other hand, our native bees show a series of characteristics in common with *Apis indica*, as pointed out by recent observers such as KOSCHEVNIKOW (1909), V. BUTTEL-REEFEN (1906) and others. FRIESE (1920, 1922, 1923) puts *indica* among *A. mellifica*, but only because his view advanced in order to condense the conception of the species. The results
of the present investigations are, therefore, proved not only to have elucidated the anatomical and biological details which have yet remained obscure, but also to afford the absolutely solid ground, on which the variety of *A. indica* is established for the Japanese honey bee.
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EXPLANATION OF PRATES

List of Abbreviations

a. alighting board of the hive.
b. hair band of 6th segment.
c. constriction.
d. projection.
e. marking.
f. lobed projection.
g. brown mass.
h. prore.
i. pneumophyses:
1. principal horn.
2. main branch.
3,4. side branches.
j. ventral quadrangular region.
k. cross striped ridges:
1. proximalmost ridge.
l. symmetrical chitinous plates or slight thickenings of penis wall.
m. dorsal triangular region.
n. vertical wall of the hive.

Plate I

Fig. 1. Individual of Japanese worker bee, abdomen distended, from right side. × 2.5
Fig. 2. Do., bearing a brownish markings on the 2nd segment, dorsal view. × 2.5
Fig. 3. Venation of hind wing, Japanese worker. × 6.6
Fig. 4. Do., Japanese queen. × 6.6
Fig. 5. Do., Japanese drone. × 6.6
Fig. 6. Do., Japanese bee fanning at the entrance of a hive.
Fig. 7. Hind leg, Japanese drone. × 5
Fig. 8. Do, Dutch drone. × 5
Fig. 9. Pore of drone cocoon, exposed by nurse bees, scraping off waxy cover, natural size.

Fig. 10. Scaly cocoon discs cut down by emerging drones themselves, natural size.

Fig. 11. A cocoon disc magnified; Japanese bee. $\times 5.5$

Fig. 12. Do., Italian bee. $\times 5.5$

Fig. 13. Median transverse section of cocoon disc $\times 16$

**Plate II**

Fig. 14. Copulatory organ of Japanese drone, protruded, lateral view, bearing group of minute outgrowths of distal penis wall. $\times 9$

Fig. 15. Do., showing nearly total absence of minute outgrowths on penis wall. $\times 9$

Fig. 16. Copulatory organ, Dutch drone, everted state. $\times 7.4$

Fig. 17. Do., Japanese drone, resting state. $\times 11$

Fig. 18. Do., Dutch drone. $\times 7.7$

Fig. 19. Do., Egyptian drone. $\times 7$

Fig. 20. Penis-bulb spreaded out, to show distribution of minute outgrowths on penis wall in Japanese drone, dorsal view. $\times 15$

Fig. 21. Pinnately-lobed projection, Japanese drone, facial view. $\times 10$

Fig. 22. Do., Dutch drone. $\times 10$

Fig. 23. Pneumophyses, Japanese drone, resting state. $\times 11.3$

Fig. 24. Do., everted state. $\times 12.7$
本研究は日本土産蜜蜂（以下之ヲ日本蜂ト稱ス）ノ利用ヲ図ルラヶク爲メ＝先ツ其ノ特徴及特性ノ他種＝比シテ顯著ナル差異ノ存在スル諸點ヲ明ニシ、且ツ其ノ分類學上ノ位置ヲ確立セントシタルモノヲナリ。

抑ハ日本蜂＝就テ玉利氏（1889）共他本部諸家ノ之＝関シ記載セル無キ＝非ルモノ、之ヲ分類學上ノ位置＝付キ初メテハ築メタルハRadoszkowsky（1887）ヲ以テ嚆矢トス。即チ氏ハ之ヲApis mellifica L. var. Japonica Rad.ト命名シ、依ツヲmellifica種ノ＝變種ト認メタリ。然＝von Buttel-Reepen（1906）ハ先ツmellifica種ヲ分チラmellifica, unicolor, indicaノ三種トナシ、Apis mellifica st. indica-japonica Rad.ト命名セリ。即チ氏ハ日本蜂ヲ indica＝変種トナシタルコト＝於テR.氏ト異ナルモノ、此 indica ノ＝一異種トナシタラ故＝、氏＝亦日本蜂ヲmellifica種＝編入シタルモノ＝謂フヘシ。

元來 indica＝獨立ノ種トナシタルハFabricius(1798)＝シテ、Bingham(1897)松村氏（1911）亦ハ採用シ。Butte-Reepenハ1906年＝於テ前記ノ如ク之ヲ mellifica種＝一異種トナシタルモノ、1915年、1918年＝ハ同シク之ヲ獨立ノ種トナセリ。獨りFriese（1920）ハ依然トシテ indica＝ mellifica＝包含セシム＝キトヲ主張シ、此意見ハ1922年＝至ルモノヲナラズ。斯ノ如ク論義＝一致セルハ indica＝特徴カ全く十分明瞭ナルサル＝因ルモノ＝シテ、之ヲ前メ＝分類學＝諸家＝シテ、例ヘハ Bingham（1897）ハ＝亞非利加産 unicolor＝ indica＝變種トナシ、Smith（1861）ハ＝Sinensis＝ mellifica＝ノ＝變種トセリ＝如き誤謬＝附ラシメタリ。

本著者ハ日本蜂標品ヲ各地ヨリ蒐集シ、且ツ数地方ヨリ其ノ蜂群ヲ得テ自ヲ飼養ヲ試ミ、更＝朝鮮、支那、等ヨリ其ノ土産蜜蜂ノ標品ヲ得、一方＝於テハ欧羅巴産 mellifica＝内Carniolan, Italian, Dutch Bee 等ヲ飼用シ、又＝亞非利加産 unicolor＝標品ヲ得、以テ彼＝此＝比較シ、其ノ間＝極メラ顕著ナル差異ノ存在スルコトヲ明＝シ、斯ヲ＝欠陥ヲ補フラ得ル＝至レシ。以下其ノ概要ヲ記セントス。

日本蜂ノ体色＝ハ其ノ黒色ト相対在セル褐色＝標微アリ。其ノ常存スルモノ＝口部＝錦赤色ヲ呈スルコト、腹板＝淡黄ナルコト＝外、背板各葉＝前半カ褐色＝シテ後半＝黒色ナルコトナリ。而シテ＝在スル＝中＝存在スルモノ＝ハ、第二
徳田-蜜蜂特に日本産に関する研究

マルクサ大形ノ蜂腔、第三股脛節外縁中央ノ膜様、肢ノ基部數節殊=其ノ内面ノ淡赤褐色コト等ヲ発現シテ、被毛=就テハ頭頂=変毛質シトスルノ説=諸=シテ、第六腹環節背板=必ツ毛ヲ存スルハ mellifica ト=ナナル差異點ナルトス。日本蜂=後翅=於テ肘脈デ=中室ヲ越エテ延長スルコトハ朝鮮、支那産=於テケル同様ナリ。日本蜂ノ雌蜂ハ體長 10-13 mm、王蜂 13-17 mm=、雄蜂 12-13 mm ナリ、雌蜂=舌=長サバ 3 mm =シテ、即チ Italian ノソレリミ約 0.5 mm 短シ。雄蜂=第三股節外縁端=凸隆スルハ事實ナリ。雌蜂ノ生殖器ハ日本及支那産ノモ=於テ相=一致シ、又歐羅巴及埃及産ノモ=亦相=一致シ、而シテ此=此ノ間=ハ=顯著ナル差異アリ。先ツソノ体外=突出スル時局曲ノ度ハ日本蜂=方鈍角ヲ呈ス、mellifica=アリテハ陰端ノ背面=著ク発達セル對称キシン板 (Symmetrical chitinous plate) ハ、日本蜂=アリテハ共ノ次=位スル横隆ト顕著ナル溝=依リテ場モラルノノミナルズ、其ノ棘毛ヨリ發達セル=反シ、日本蜂=アリテハ横隆ノ最基端ノモ=ノト連続シ且ソ棘毛モ著シカラス。背面三角板 (Dorsal triangular plate) ハ、日本蜂=於テハ mellifica=於ケルヨリモ比較の大形=シテ共ノ棘毛ノ多シ。又囊状突起 (Pneumomorphyses) ハ日本蜂=於テハ分枝スルヲ特徴トシテ、共ノ主要部ハ=体内=アルトキ 5-6 mm =シテ其ノ長ク、之カ体外=突出スルヨハ三対ノ小突起ヲ共ノ基部=副生ス。生業学的特徴トシテ数ヘキモノ多々アルモ、就中日本蜂ノ=ヨリ逃ぎスル如キ、或ハ巢門=於テ mellificaト反対方面ノ体位ヲ持シテ走風スルカ如キ事實ノ外、ナボ日本蜂=無王トナルトキ雌蜂卵蛆ヨリ王蜂ヲ養成スルコトヲナサスシテ自=産卵スル=至り、而モ住々=シテ此無精卵ヲ生セツル蛆ノ上二=一時の王巣ヲ設キタル如キ、又王蜂=翅ヲ一部剪シトキハ久シカラスシテ其ノ=亡失ヲ見ル如キ、又王蜂=産メル卵=初モノ横断セルカラ如キ事実アリ。日本蜂=又性姑儒=シテ刺戟=感シテヨリ＝亦=短キ翅音ヲ發シ、刺戟衰キトキハ巢面ヲ去リテ一方=集合シ、又害敵=對シ突進スルヨリヲ挙ロノヲ避クル傾キタル、螯サマルノ非＝ルモ又幾分臥性ヲラ、mellificaノ侵入=對シテハ=防禦セツル=至り、内部=スリタルモノ=對シ殆ト開知セナルノ態度ヲトトリ貯蜜ヲ奪ハレタ途=全滅スル=至ル。つしむし=害ヲ受ケルコト甚シク、
すめばちノ攻撃ニ対シ隠匿シテ共ノ危難ヲ免ルノ点ハ mellifica ノ挙措ニ比シテ有利ナルト既ニ知ラル所ナリ。又日本蜂ハヨコツ蜂脅ヲ破リ、或ハ前壁ヲ削ルノヲ残ス。容易＝雖ヲ分滋スルノ性ハーノ長所＝シテ、其ノ腹板下ニハ層ヲ 1mm 以上ノ厚さ鱗ヲ見受ケラル。蜂蠟 (propolis) ハ用ヒス。又房壁ヲ薄ク僅＝32μ＝適キス。巢房小ニシテ蜂房ハ直徑 (邊ヨリ
邊ニ至ル) 4.65 mm、雄蜂房ハ 6.36 mm ノナリ、即チ堆蜂房ノ大サハ mellifica ノ
蜂房ハソレト相近シ、又日本蜂ノ蟻ハ mellifica ノモノト共ノ化学的及物
理学的性狀＝於テ差異アリ。殊＝面白キハ日本蜂ノ雄蜂蛆ハ成熟シテ結晶ス
ルトキハ共ノ繊ノ房口部ノ中央＝小孔ヲ設クルコトナリ。雄蜂出房スルトキハ
此ノ孔ヲ有スル繊ノ一部ハ小圓板状ヲナシテ落ツ。該孔ヲ貫キタル繊ノ断
面ヲ見ル＝孔邊ニ近キ所ハ経層ソシツシト層ヲ減ス。内口線＝暗褐色＝物質ヲ堆積シ、此物質ハ経層間＝渗入シテ之ヲ堅紡ナ
ラシム。孔ハ深サ約 0.4 mm、外口直徑 0.4–0.6 mm、内口直徑 0.25 mm ノ漏斗
状ヲナシセルモノ＝シテ、内外空気ノ流通＝資セルモノ＝如シ。mellifica ノ繊＝
ハカト小孔ヲ認メサルノミナルラス繊層モ亦日本蜂ノソレノ如ク厚カラス、
弾絞シテ気通容易ナルモノ＝如シ。
Y. Tokuta photo.
Y. Tokuta photo.