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Original article

Biology of *Apis dorsata* in Vietnam*

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Abstract – This paper studies the biology of *A. dorsata* in the *Melaleuca* forest of Vietnam. The width of 158 *A. dorsata* combs was from 43–162 cm, and the height from 23–90 cm. About 3–4 weeks after nesting, a colony could store 4.1 ± 2.6 kg of honey. The thickness of the worker brood comb was 3.3 cm and of the drone was 3.7 cm, but that of the honey comb was possibly 19.0 cm. The width of 10 continuous drone cells (58.1 ± 1.4 cm, n = 90) is significantly larger than that of worker cells (55.7 ± 1.7, n = 330). The depth of drone cells was 19.0 ± 0.4 mm (n = 90) and of worker cells was 17.4 ± 1.5 mm (n = 225). The weights of the newly emerged worker, drone and queen bees were 159.9 ± 15.5 mg (n = 30), 168.5 ± 10.4 mg (n = 30), and 272.0 ± 40.1 mg (n = 9), respectively. Development time from egg to adult was 19.7 ± 0.1 days (n = 30) for workers, 23.7 days for drones, and 16.5 days for queen bees. When a colony reached 121 cm × 57 cm in size, it built 9.7 ± 2.4 (n = 32 nests) natural queen cells. The volume of a queen cell was 1.300 ± 0.159 mL (n = 28).

***Apis dorsata* / biology / nest / development time / weight / biometry**

1. INTRODUCTION

The *Melaleuca* forests in southern Vietnam supply many products to local people, play important roles in environmental protection, and provide habitats for many wild animals including the Asian giant honey bee, *Apis dorsata* Fabricius. When the *Melaleuca* flowers bloom, thousands of *A. dorsata* swarms arrive and are lured to build nests on low man-made supports called rafters. *Apis dorsata* bees are an important part in the ecology of the forests and the income of the local people in Vietnam (Crane et al., 1993; Chinh et al., 1995), as well as in Indonesia (Crane et al., 1993) and India (Mahindre, 2000).

The genus *Apis* is the most studied insect because man has collected honey from it for thousands of year. Nowadays, the number of described honey bee species is increasing due to recent studies in the remote areas of Southeast Asia and also further studies on the biology and behaviour of already described species. Ruttner (1988) recognised four honey bee species in the genus, Otis (1997) reported nine and then Michener (2000) proposed eleven species. With more species recognised in the genus *Apis*, the phylogenetic relationship of the species has become more complex and therefore the biology of all species should be well understood. However, *A. dorsata* is the least studied of the four traditionally recognised species and information on its biology is rare and fragmentary because the bee species is very defensive and/or too inaccessible for people to carry out research.

In the global awareness of the need for wildlife protection, the conservation of the Asian giant honey bee, *A. dorsata* in the *Melaleuca* forests should be given greater attention. Information on the biology and

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behaviour of *A. dorsata* is important in bee management for honey production, the conservation of the species, and the conservation of the *Melaleuca* forests, as well as the environment. This paper contributes information on biology of *A. dorsata* in the *Melaleuca* forest, namely: (i) the structure and dimensions of nest and different types of cells; (ii) the weights of the newly emerged queen, drone and workers in different conditions; and some biometrical features of workers; (iii) development times of the queens, drones and workers; (iv) the colony size, queen cells and queen's egg production of the colonies at full development.

2. MATERIALS AND METHODS

2.1. Study site

The *Melaleuca* forests in southern Vietnam are located in Asia's tropical monsoon area. The weather is generally hot and humid. The dominant plant species in the forests is *Melaleuca cajuputi* (Myrtaceae), the flowers of which are a very good source of nectar and pollen. This study was carried out in the forestry and fishery farm of Song Trem, Thoi Binh district (longitude 104°59' E and latitude 9°27' N), Ca Mau province, southern Vietnam from March 2001 to September 2002.

2.2. Measurement of bee nests and cells

Due to the abundance of *A. dorsata* colonies managed by rafter beekeepers, the measurements could be carried out on a large number of colonies. Figure 1 shows the dimensions of the comb and cells to be measured. The width and height of the comb (Fig. 1a) were measured on live colonies on the rafters in the forest using a ruler. Callipers were used to measure the comb thickness, the depth of the cell (Fig. 1b) and the width of ten continuous cells (Fig. 1c) on pieces of combs harvested by beekeepers. Each measurement was always carried out three times on a colony. Thus, the number of observations given in the Results is the number of the investigated colonies multiplied by three. Because the diameter of the cell was determined by measuring the width of ten continuous cells, the measurement on drone cells was done only where these cells were concentrated in bands on the comb (the drone brood

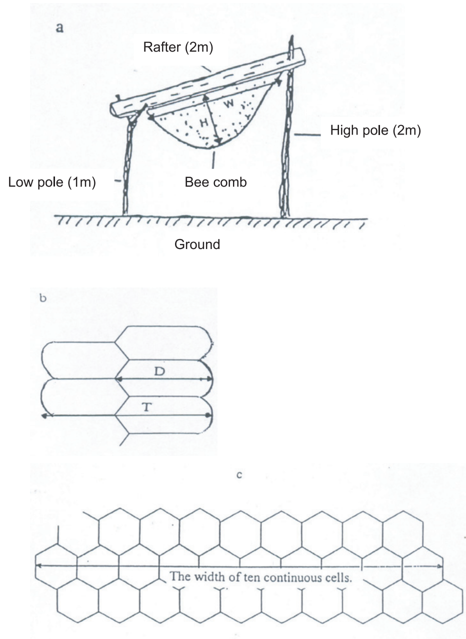

Figure 1. Dimensions of *A. dorsata* comb and cells. (a) The width (W) and height (H) of an *A. dorsata* comb on a rafter. (b) The thickness (T) of the comb and the depth (D) of the cell. (c) The width of ten continuous worker/drone cells.

was scattered irregularly among worker brood or concentrated in bands). Twenty nine queen cells were cut lengthways to measure their maximum inner heights and widths. The volumes of 28 emerged queen cells were measured by dripping water from a micropipette set to an accuracy of 0.01 mL.

2.3. Bee weights

To investigate and compare the weights of bees of different castes and of different conditions, the method was as follows: From each of three *A. dorsata* colonies, about sixty workers on combs were collected randomly. Half of the workers were killed by freezing and weighed immediately using a digital balance (1 mg accuracy), whereas the other half was kept without food in a wire cage (volume of 0.5–1.0 L) for 24 h to empty the load in their stomach before they were weighed alive. Also from the same three colonies, brood combs were incubated at 35 °C and newly emerged workers were weighed alive within five hours after emerging. The drone, worker brood and queen cell of another colony were incubated and the newly emerged bees were weighed alive within five hours after emerging.

2.4. Measurement of biometric data

From each of eight colonies, the following characreristics of thirty worker bees were measured: proboscis length, wing dimensions (Ruttner, 1988), and number of hamuli (Dade, 1962). In each of three colonies, the cubital index (Ruttner, 1988) was measured on thirty worker bees. Worker bees were collected and put into boiling water so that their proboscis could expand fully. Then the bees were preserved in 70% ethanol until the measurements were carried out. Sizes of proboscis and wing dimensions were measured with accuracy of 0.1 mm using a stereo-binocular microscope (7–45×). Measurements (with accuracy of 0.01 mm) of cubital index and counts of hamuli were obtained using another stereo-binocular microscope (100×). The microscopes were equipped with eye piece scale and eye piece graticule.

2.5. Total development time of worker bees

Scout bees exploring potential nest sites were observed and the exact time of the occupation of a nest site by a swarm was recorded. Fifteen days after the occupation of the nest site, a small piece of comb containing the oldest sealed brood was collected and placed in an incubator at 35 °C. The emergence of the first thirty adult bees was then checked every three hours. Total development time from egg to adult of a worker bee was assumed to be the time from the swarm's occupation until the emerging of the worker. Actually, it is longer than the real development time of a worker because the time between occupation and the queen's laying is not known. However, according to experienced rafter beekeepers, the time required for comb construction is less than a day. Ruttner (1988) wrote that if an *A. dorsata* swarm started building a nest, comb construction was rather rapid. Koeniger and Koeniger (1980) reported a swarm to construct a good portion of comb during a night.

2.6. Development time of worker egg

In a growing colony of *A. dorsata*, eggs at the lower edge of the comb where there were many newly-built cells nearby were assumed to be newly-laid eggs. A small part of comb containing newly-laid eggs was collected and placed in a 35 °C incubator. Two days later, the hatching of the first thirty eggs was checked every three hours. The development time of an egg was assumed to be the time from comb collection until the larva hatched.

2.7. Development time of sealed worker brood

A small part of comb containing newly-sealed worker brood (which were just nearby large larvae that were being sealed) was collected and placed in a 35 °C incubator. Nine days later, the emergence of the first thirty adult bees was checked every three hours. The development time of sealed brood was assumed to be the time from comb collection until the emergence of the adult bee.

2.8. Total development time of drone bees

A piece of comb which contained thirty-four drone brood scattered among 211 worker brood was collected and incubated at 35 °C and then the emergence of brood was checked every six hours. The development time of drones was inferred by comparison with that of the workers.

2.9. Total development time of the queen bees

Ten queen cells together with nearby worker brood cells were incubated at 35 °C and checked for emergence every three hours. Therefore, the development time of the queen was inferred by comparison with that of the last thirty workers. This method, and that for drones described above, was based on the assumption that, when laying in an area of comb, the queens laid simultaneously in worker cells, drone cells, and queen cells.

2.10. Egg laying output of the queen

The egg laying output per day of the queen was studied on twenty colonies which had natural queen cells. A queen's daily egg production is roughly the

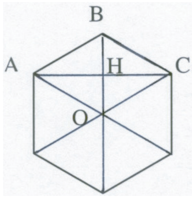

Figure 2. A honey bee cell considered as a regular hexagon and its surface area calculated to be the square of the cell diameter multiplied by 0.8660. The area of the cell equals six areas of the regular triangle AOB = 3 × AH × OB = 6 × AH × BH = 6 × AH × AH/ $\sqrt{3}$ = 2 × $\sqrt{3}$ × AH^2 = $\sqrt{3}$/2 × AC^2 = 0.8660 × AC^2. In practice, AC (the cell diameter) is determined by measuring the width of 10 continuous cells and then dividing it by 10.

total number of brood (eggs, larvae and pupae) divided by the development time from egg to adult worker bee. The total number of brood can be calculated by taking the total surface area of brood and dividing it by the surface area of a worker cell. The total surface area of brood (in square millimetre) was estimated using a transparent measuring sheet marked with 50 mm × 50 mm squares. The area of brood to be measured was drawn on a transparent sheet, and then the measuring sheet was used to estimate its total surface area. Figure 2 shows that a worker brood cell is considered as a regular hexagon and its surface area is calculated to be the square of the cell diameter multiplied by 0.8660.

2.11. Data presentation, statistics and graphics

Most results of measurements in the study are given as the mean ± SD (n). The Student's *t* test, Analyses of Variance and Pearson's correlation were used. All tests are two-tailed. Statistical calculations and graphics were performed using MINITAB package version 12.21.

3. RESULTS

3.1. Bee nest and cell dimensions in *A. dorsata*

The comb of *A. dorsata* is more or less semicircular. Honey was usually stored in the highest part of the comb. Next to the honey

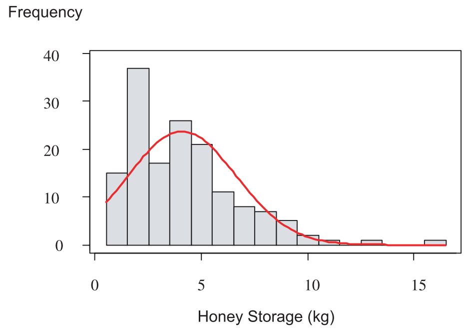

Figure 3. Distribution of the honey storage of *A. dorsata* combs on rafters.

is a region of stored pollen, and the rest of the comb contains brood. The width of the *A. dorsata* comb was 92.4 ± 26.2 cm (n = 158), ranging from 43 to 162 cm, and the height was 47.8 ± 11.4 cm (n = 146), ranging from 23 to 90 cm. The honey storage is not distributed normally (Fig. 3): about 3–4 weeks after nesting, a colony could store 4.09 ± 2.56 (n = 152) kilograms of honey in the comb but the highest is up to 15.7 kg. Table I shows the dimensions of different types of cells in *A. dorsata* colonies. The thickness of the honey part was highly variable in 200 observed colonies. Its range was from the normal thickness of a worker brood comb to 19 cm in areas containing large honey stores. The width of ten continuous worker cells varied from one colony to another, and the difference among the 110 measured colonies was highly significant (one-way ANOVA, $F_{109,220}$ = 9.09, P < 0.001). Also, the width of ten continuous drone cells among the 30 measured colonies was highly significant (one-way ANOVA, $F_{29,60}$ = 13.05, P < 0.001). The capping of the drone brood cell was domed and elevated. Figure 4 shows the distributions of the widths of 10 continuous worker and drone cells.

3.2. Bee weights and biometric data

Table II shows the weight of worker bees and of the queen and drone. The origin (colony) of the bees affected their weight. The weights of newly emerged worker bees

Table I. Some data on the dimensions of different types of cells in *A. dorsata*.

	No. colonies investigated	Mean ± SD (n)	Range
Comb thickness (mm)			
Worker brood part	75	33.1 ± 2.5 (225) a	28–38
Drone brood part	30	37.1 ± 1.6 (90) b	34–41
	a & b: $P < 0.001$, *t* test		
Width of 10 continuous cells (mm)			
Honey	30	63.9 ± 3.0 (90) a	58–70
Worker	110	55.7 ± 1.7 (330) b	52–61
Drone	30	58.1 ± 1.4 (90) c	55–61
	a & b, a & c, or b & c: $P < 0.001$, *t* test		
Cell depth (mm)			
Worker	75	17.4 ± 1.5 (225) a	16–22
Drone	30	19.0 ± 0.4 (90) b	18–20
	a & b: $P < 0.001$, *t* test		

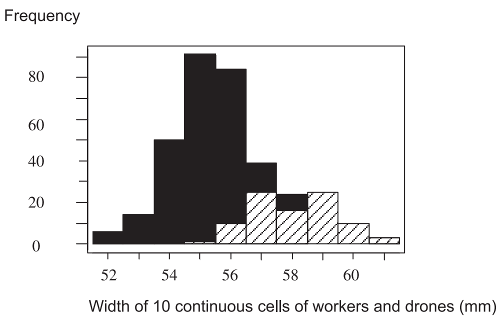

Figure 4. Comparison of the width (mm) of drone cells with that of worker.

in the three colonies (161.1 ± 8.3 mg (n = 30), 142.2 ± 18.7 mg (n = 30) and 169.0 ± 8.8 mg (n = 30); respectively) were highly significantly different (one-way ANOVA, $F_{2,87}$ = 34.53, $P < 0.001$). Table III shows biometric data of *A. dorsata* worker bees in the *Melaleuca* forest of Vietnam in comparison with *A. dorsata* in other countries.

3.3. Development time of *A. dorsata* worker, drone and the queen

The development times of *A. dorsata* worker in Vietnam are shown in Table IV. Figure 5 demonstrates the emergence time of drones compared with that of workers. The observations on the emergence of the 10 queen cells showed that the two first-emerging virgin queens emerged 3.25 days earlier than the workers. Then the next six emerging virgin queens emerged 3.00, 2.25, 1.25, 1.00, 0.75, 0.50 days earlier than the workers. The ninth virgin queen emerged 1.00 day later than workers. The tenth queen cell did not emerge and later inspection found that the pupae had died. I assume that the eggs which developed into the first two virgin queens were laid at the same time as the nearby worker eggs. Based on this assumption, I estimated the developmental time of *A. dorsata* drones and queens (Tab. IV).

3.4. The colony size, number of queen cells and queen's egg production of the colony at full development

At full development, the comb of an *A. dorsata* colony was 120.9 ± 17.6 cm (n = 32) in width, 56.6 ± 5.3 cm (n = 32) in height, and had 9.7 ± 2.4 (n = 32) queen cells. The queen's egg production was calculated to be 940 ± 290 (n = 20) eggs per day, ranging from 500 to 1 600. All of the natural queen cells were at the lower edge of the comb. There is a strongly positive relationship between the size of the colony and the number of the queen cells reared (r = 0.520, $P = 0.002$, DF = 30). High and narrow queen cells, which are similar in shape to the queen cells of *A. mellifera* and *A. cerana*, were observed in a few colonies. However, short and broader queen cells were observed more frequently. For the high-and-narrow queen cells, the maximum inner height

Table II. Weights in milligrams of *A. dorsata* workers in some conditions, drones and the queens.

	Mean ± SD (n)	Range
Randomly collected worker		
Stomach normal	150.0 ± 22.5 (90) a	107–212
Stomach empty	107.4 ± 13.2 (90) b	80–149
a & b: $P < 0.001$, *t* test		
Newly emerged workers	157.4 ± 17.0 (90)	111–188
Newly emerged bees in same colony		
Worker	159.9 ± 15.5 (30) a	110–177
Drone	168.5 ± 10.4 (30) b	151–191
Queen	272.0 ± 40.1 (9) c	217–327
a & b, a & c, or b & c: $P < 0.001$, *t* test		

Table III. Some biology of *Apis dorsata* workers in Vietnam in comparison with *A. dorsata* elsewhere extracted from Ruttner (1988).

Character	Vietnam	Elsewhere
Cell diameter (mm)	5.23–6.10	5.35–5.64
Weight of unloaded worker (mg)	107.4 ± 13.2 (90)	118.1
Length of proboscis (mm)	6.53 ± 0.23 (240)	6.45
Size of forewing (mm)		
Length	12.96 ± 0.26 (240)	12.5–13.5
Width	4.50 ± 0.15 (240)	-
Size of hind wing (mm)		
Length	8.91 ± 0.22 (240)	-
Width	2.90 ± 0.14 (240)	-
Number of wing hooks	25.7 ± 1.9 (240)	24.3
Cubital index (a/b)	9.01 ± 3.32 (90)	7.25

and width of a queen cell were 28.1 ± 0.7 mm (n = 16) and 8.5 ± 0.4 mm (n = 14), respectively, resulting in a height-to-width ratio of up to 3.3. For the short-and-broad queen cells, the maximum inner height and width were 22.6 ± 1.6 mm (n = 13) and 12.4 ± 1.4 mm (n = 13), resulting in a height-to-width ratio of only 1.8. The average volume of a queen cell was found to be 1.300 ± 0.159 mL (n = 28).

4. DISCUSSION

The smallest colony recorded on rafters of beekeepers was 43 cm wide, but smaller colonies were sometimes observed in the forest. Such small colonies are not managed because very little honey is stored and almost all colonies less than 20 cm in width are usually queenless and will die out. The size of the colonies examined in this study is rather similar to those reported in other areas (Ruttner, 1988). These data are representative for developing colonies in the area.

When the bees collect more honey, the depth of the honey cells is increased by the bees for more storage and for stronger attachment to the substrate. The average honey yield of a colony in the *Melaleuca* forest of Vietnam is the similar to those reviewed by Ruttner (1988) in other countries. Figure 3 shows that there are some colonies with extremely high honey yields and if this has a genetic basis these colonies have high potential for selection in breeding programmes.

The cells for drone brood and worker brood of *A. dorsata* are similarly hexagonal in shape and horizontal in orientation, but the capping of the drone cell is distinguishable by its domed appearance. In regard to the size of brood cells, it was initially assumed that workers and drones of *A. dorsata* were reared

Table IV. Development time (days) of *A. dorsata* in Vietnam and in Pakistan (Qayyum and Ahmad, 1967).

		Vietnam	Pakistan
Worker:	Egg	2.9 ± 0.1 (30)	2.5–3.0
	Open brood	5.6	4.0–5.0
	Sealed brood	11.2 ± 0.2 (30)	9.5–12.0
	Total	19.7 ± 0.1 (30)	17.5–19.5
Drone:	Egg	-	2.5–3.0
	Open brood	-	4.0–5.0
	Sealed brood	-	13.5–15.5
	Total	23.7	21.5–23.5
The queen:	Egg	-	2.0
	Open brood	-	4.5
	Sealed brood	-	6.5–7.0
	Total	16.5	13.0–13.5

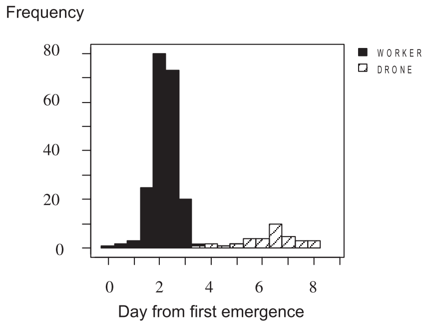

Figure 5. Comparison of the emergence time of 34 drones with that of nearby 211 worker bees.

in cells with the same size, as reviewed by Ruttner (1988). However, my results suggested that drone cells were significantly wider than worker cells, although the ratio of the diameter of drone-to-worker cells was only 1.04. This observed ratio for *A. dorsata* is much lower than that reported for other honey bee species. According to Ruttner (1988, p. 81 and p. 132), the ratios in *A. mellifera*, *A. cerana* and *A. florea* are 1.33, 1.13 and 1.59, respectively.

In an *A. dorsata* colony, a newly-emerged worker bee weighs a little more than a randomly-collected one; but the weight of the latter varies more due to the contents (pollen, nectar or water) in its stomach, perhaps. The comparison of the normal workers and the empty stomach workers shows that a worker can contain a load of about 40 mg, accounting for nearly 40% of its weight. The results of my study also show that the weights of the queen, drones and workers are very different. The ratio of the queen: drone: worker is 1.70: 1.05: 1.00 in this study. Koeniger and Koeniger (1993) investigated and compared the weights of all three castes in *A. dorsata*, *A. mellifera*, *A. cerana* and *A. florea* in Thailand. Their data and mine show that the difference among the three castes in *A. dorsata* is the smallest of the four traditionally recognised honey bee species.

In honey bee taxonomy, differences in behaviour are more important than those of morphology; e.g. the race of *A. cerana* in Himalaya or Japan is much bigger in size than those of *A. mellifera* in tropical Africa. However, morphological characteristics of worker bees as well as sizes of worker cells are still important. Moreover, morphological characteristics can be distinct among sub-species. For bee breeders in Europe, *A. mellifera carnica* can be differentiated from *A. mellifera mellifera* by their cubital index (Ruttner, 1988). In America, beekeepers can discriminate the Africanised bees from the European race in the field (Rinderer et al., 1986), and *Apis cerana cerana* from the North of Vietnam and *A. cerana indica* from the South can be differentiated (Binh and Tan, 1994) by measuring the width of ten continuous cells. Because such detailed studies to the level of subspecies have not been implemented in *A. dorsata*, a collection of these morphological data is necessary for future studies. Data in Table III, which are in the range of data reviewed by Ruttner (1988), are the first account for *A. dorsata* in Vietnam.

To my knowledge, the data on development time from egg to adult of *A. dorsata* in this indirect observation study are only the second study after Qayyum and Ahmad (1967) to examine this phenomenon. Actually, the total development time of 19.7 days for worker bees in this study is the duration from the bee swarm's occupation of nest site to the emergence of the first worker bees. It is longer than the real development time of a worker because the time between occupation and the queen's laying is not known.

Like other honey bee species, *A. dorsata* produces natural queen cells when the colony develops fully. The queen cells can be elongated but the broader shape is more often observed and the reason for this phenomenon is not yet known. In comparison with worker and drone cells, the queen cell is bigger in size, different in shape and vertical in orientation. In general, the number and position of queen cells in *A. dorsata* are not much different from those in other honey bee species. However, my observations on dozens of emerging virgin queens of *A. dorsata* showed that in contrast to *A. mellifera* and *A. cerana*, there is no lid on the top of the queen cell after the virgin queen has emerged. *Apis dorsata* virgin queens perhaps chew off the cap to emerge. Earlier, natural queen cells of *A. dorsata* have also been observed and studied. Viswanathan (1950) shows, perhaps for the first time, the picture of a few queen cells to reject the concept of uniform cells in an *A. dorsata* comb. Thakar and Tonapi (1961) reported the volume of a queen cell but their result was astonishingly about ten times larger than mine. Morse and Laigo (1969) measured the sizes of only four queen cells and their results were different from mine. However, they reported similarly to my study, that there is no lid on the top of the queen cell after the virgin queen has emerged.

Egg laying capacity of the queens has been measured in *A. mellifera*, *A. cerana* and *A. florea* (reviewed in Ruttner, 1988; Crane, 1990). However, no information is available at present for other honey bee species, including A. *dorsata*. The data presented here indicate the egg laying capacity of queens in the colonies about to swarm. This great egg production of A. *dorsata* is similar to *A. mellifera*, or *A. cerana*.

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Biologie d'*Apis dorsata* au Vietnam.

***Apis dorsata* / biologie du développement / durée de développement / poids corporel / structure du nid / Vietnam**

Zusammenfassung – Biologie der Riesenhonigbiene *Apis dorsata* in Vietnam. Diese Arbeit beschreibt die Biologie von *Apis dorsata* (Fabricius) im *Melaleuca* Mangrovenwald in Vietnam. Sie soll einen Beitrag für die Bienenhaltung, für den Schutz der Riesenhonigbiene und für vergleichende Studien des Genus *Apis* leisten. Die Breite von 158 *A. dorsata* Waben schwankte von 43 bis 162 cm, und ihre Höhe von 23 bis 90 cm. Drei bis 4 Wochen nach der Nestgründung konnte ein Volk 4,1 ± 2,6 (n = 152) kg Honig in der Wabe speichern. Die größte Menge betrug 15,7 kg (Abb. 3). Honigzellen sind tiefer als Arbeiterinnen- und Drohnenbrutzellen. Die Dicke des Honigteils reichte von der normalen Dicke des Brutteils bis zu 19 cm, weil die Honigzellen entsprechend des Honigeintrags verlängert werden. Der Zellgröße variierte sehr stark zwischen den vermessenen Waben. Tabelle I zeigt, dass die Waben mit Drohnenbrut dicker sind als solche mit Arbeiterinnenbrut. Die Zelltiefe ist tiefer als bei Arbeiterinnen. Es zeigen sich auch Unterschiede im Zelldurchmesser zwischen Arbeiterinnen- und Drohnenbrutzellen von *A. dorsata,* allerdings sind die Zellen mit Drohnenbrut nur 1,04 mal breiter. Dieser kleine Unterschied ist in der Praxis nicht zu erkennen. Die Gewichte von Arbeiterinnen bei unterschiedlichen Bedingungen, von frisch geschlüpften Königinnen und Drohnen sind in Tabelle II gezeigt. Der Gewichtsunterschied zwischen Kasten- und Geschlechtstieren in *A. dorsata* ist der geringste innerhalb der früher anerkannten 4 Bienenarten. Die biometrischen Daten von *A. dorsata* Arbeiterinnen im *Melaleuca* Wald liegen im gleichen Bereich wie die von Arbeiterinnen *A. dorsata* in anderen Ländern (Tab. III). Daten über die Entwicklungszeiten von *A. dorsata* Arbeiterinnen, gemessen als Dauer von der Ankunft des Schwarms bis zum Schlupf der ersten Arbeiterinnen sind in Tabelle IV gezeigt. Dort stehen ebenfalls die Entwicklungszeiten von Drohnen und Königinnen, berechnet aus dem Vergleich mit denen der Arbeiterinnen. Ab einer Volksgröße von 121 cm × 57 cm wurden im Mittel 9,7 ± 2,4 (n = 32) Weiselzellen

gebaut. Im Allgemeinen ist die Zahl und Position der Weiselzellen bei *A. dorsata* kaum anders als bei *A. mellifera* und *A. cerana*. Allerdings wurde eine breite gekrümmte Form (22,6 mm × 12,4 mm) häufiger beobachtet als eine längliche Form (28,1 mm × 8,5 mm), und der Deckel blieb nach Schlupf der Königinnen nicht am Zellrand hängen. Das Volumen der Weiselzellen betrug 1,300 ± 0,59 mL (n = 28). In großen Völkern konnte die Königin täglich 940 ± 290 (n = 20) Eier legen, mit einer Schwankungsbreite von 500 bis 1600 Eiern.

***Apis dorsata* / Biologie / Nest / Entwicklungszeit / Gewicht / Biometrie**

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