

CHAPTER 6

CONCLUSIONS

1. The mandibular gland of native honeybee species in Thailand, *A. andreniformis*, *A. dorsata* and *A. cerana* secrete 2-heptanone very low level which are 0.204, 0.425 and 1.322 µg/bee, respectively. however, it is undetectable in *A. florea* foragers, while it is very high level in *A. mellifera* foragers, 7.076 µg/bee.
2. The mandibular gland secretions of honeybee foragers in Thailand show different numbers of chemicals constituents: they are 41, 27, 41, 48 and 18 chemicals in *A. andreniformis*, *A. florea*, *A. dorsata* and *A. cerana*, and *A. mellifera*, respectively.
3. The ten main compositions of mandibular gland pheromones of five species of honeybee foragers in Thailand are homologous for 70% of the different proportions of the same chemicals. Seven compounds of ten components are the same compounds: 1-eicosanol, dibutyl phthalate, nonadecane, 2-hexyl decanol, heneicosanol, eicosane and 2-butyl-1-octanol (30% of the different proportions of different chemicals).
4. The ten main compositions of mandibular gland pheromones of four native species are homologous for 80% of the different proportions of the same chemicals, comprising 1-eicosanol, dibutyl phthalate, nonadecane, 2-hexyl decanol, heneicosanol, eicosane, 2-butyl-1-octanol and 1-butanol-3-methyl acetate. However, they are 100% homology between *A. andreniformis* and *A. dorsata*. All of these pheromones are highly volatile compounds of low molecular weight, notable among which are both attractant and repellent pheromones.
5. Using SEM, the general anatomy of mandibular gland of five *Apis* species are divided into two groups; they are one pair of lobed glands in *A. andreniformis*, *A. dorsata* and *A. florea*, and two pairs of lobed glands in *A. cerana* and *A. mellifera*.

6. The gland and cell sizes of these *Apis* species are different. The largest sizes to the smallest sizes are found in *A. dorsata*, *A. mellifera*, *A. cerana*, *A. florea* and *A. andreniformis*, respectively.
7. The ultrastructure of the mandibular gland of honeybee foragers in Thailand show that relative to the gland secretions which are alcohol, acid, alkane and alkene producing cells.

Table 6.1 The amounts of 2-heptanone of honeybee foragers in Thailand.

<i>Apis</i> species	Appearance of 2-H	Amount of 2-H ($\mu\text{g}/\text{bee}$)	Amount of 2-H ($\mu\text{l}/\text{bee}$)
<i>A. andreniformis</i>	+	0.205	0.002
<i>A. florea</i>	-	-	-
<i>A. dorsata</i>	+	0.425	0.004
<i>A. cerana</i>	++	1.322	0.012
<i>A. mellifera</i>	+++	7.076	0.062

Table 6.2 The ten main compositions of mandibular gland pheromones of honeybee foragers in Thailand.

Priorities	<i>A. andreniformis</i>	<i>A. cerana</i>	<i>A. dorsata</i>	<i>A. florea</i>	<i>A. mellifera</i>
1	1-Eicosanol	1-Eicosanol	1-Eicosanol	1-Eicosanol	1-Eicosanol
2		Heneicosanol	Heneicosanol	Heneicosanol	2-heptanone
3	Dibutyl phthalate	Dibutyl phthalate	2-hexyl-1-decanol	Nonadecane	Heneicosanol
4	Nonadecane	Nonadecane	Nonadecane	2-hexyl-1-decanol	Dibutyl phthalate
5	2-hexyl decanol	Heptadecane	Dibutyl phthalate	Dibutyl phthalate	2-hexyl-1-decanol
6	Heneicosanol	2-hexyl-1-decanol	Eicosane	2-Butyl-1-Octanol	Heneicosane
7	Eicosane	2-Butyl-1-Octanol	Heneicosane	Eicosane	Eicosane
8	1-Octanol	Heneicosane	2-Butyl-1-Octanol	Heneicosane	Nonadecane
9	2-Propyl-1-heptanol		2-Propyl-1-heptanol	Limonene	2-Butyl-1-Octanol
10	2-Butyl-1-Octanol	Eicosane			2-Propyl-1-heptanol
			1-Octanol		

Peak area

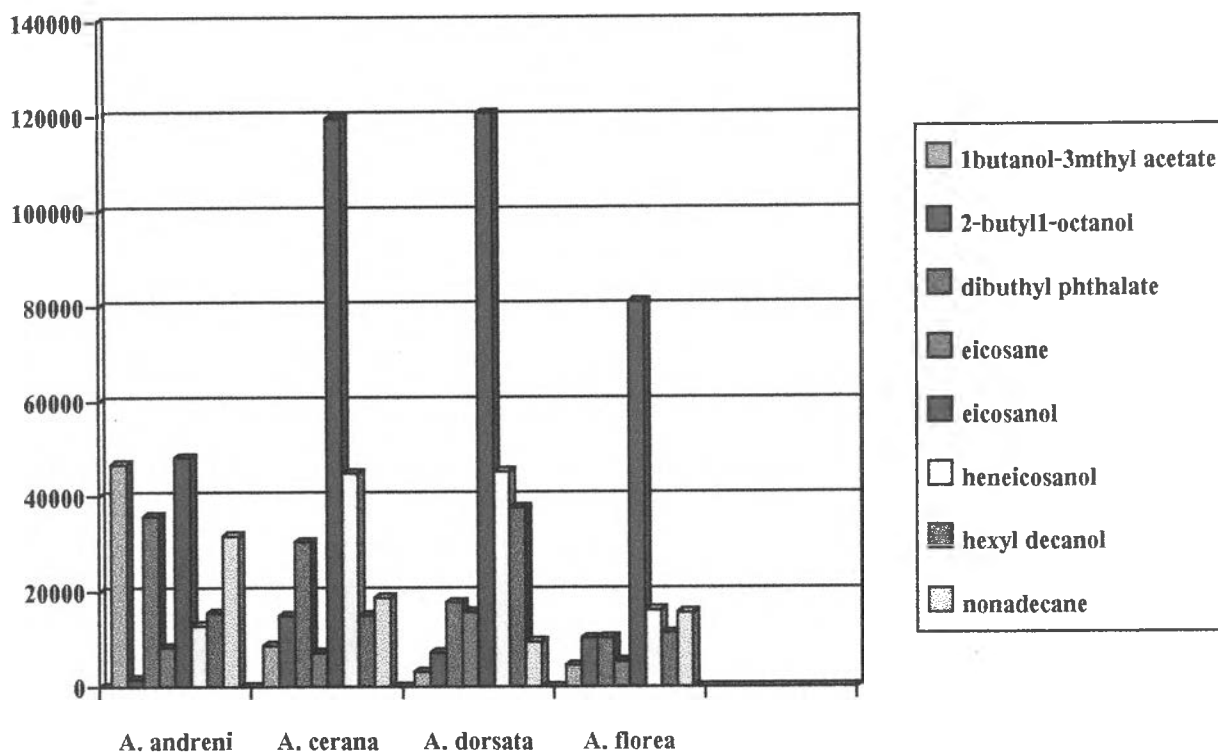


Fig. 6.1 The main composition of mandibular glands of four native honeybee species in Thailand

Table 6.3 Peak areas of the eight main compositions of mandibular gland pheromones of native honeybee species in Thailand.

Chemicals	<i>A. andreniformis</i>	<i>A. cerana</i>	<i>A. dorsata</i>	<i>A. florea</i>
1-butyl-3-methyl acetate	46782	8618	3115	4438
2-butyl-1-octanol	1530	14912	7100	10166
Dibutyl phthalate	35742	30346	17658	10227
eicosane	8253	7104	15696	5333
eicosanol	48230	119376	120536	80837
heneicosanol	12872	44965	45288	16091
2-hexyl-1-decanol	17475	15042	37605	11271
nonadecane	31622	18686	29463	15570

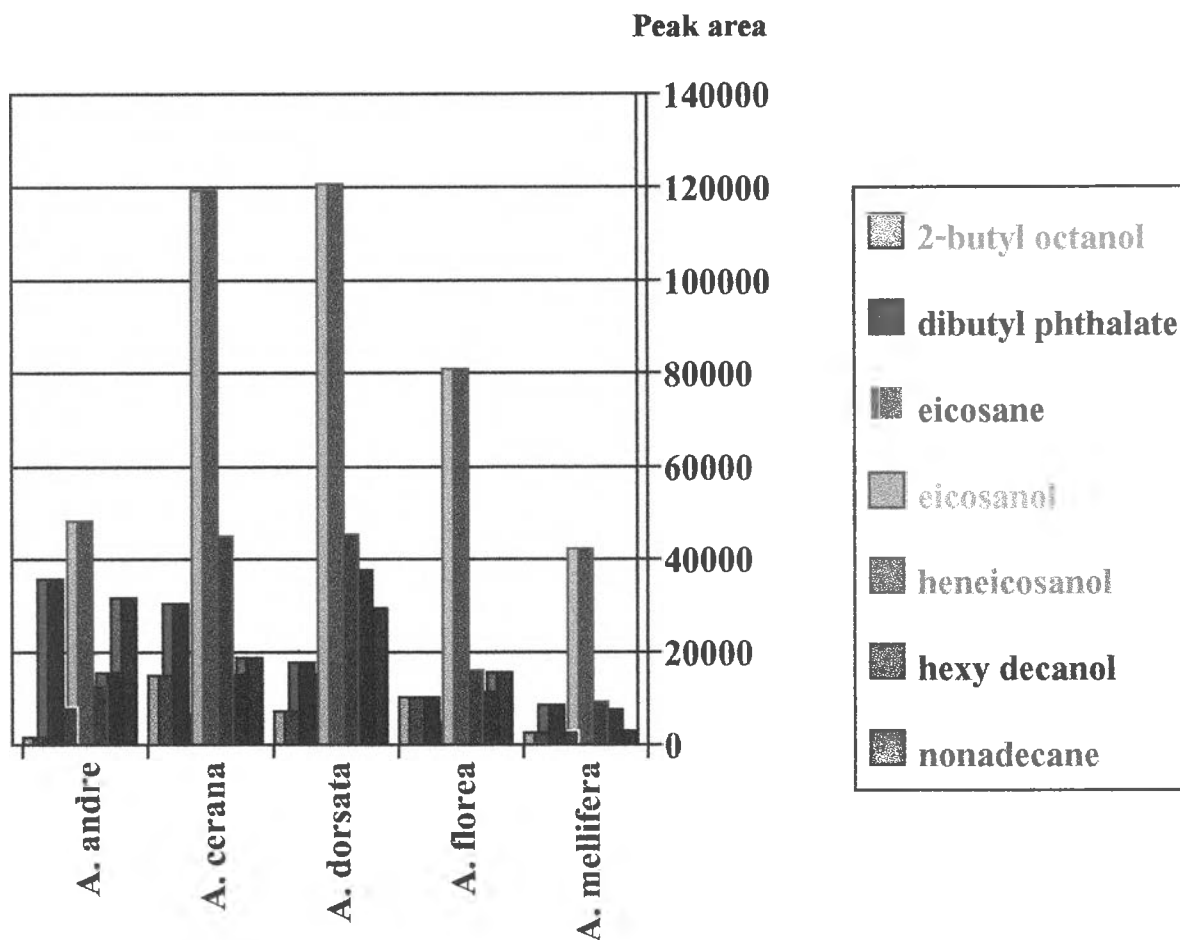


Fig. 6.2 The main composition of mandibular glands of honeybee foragers in Thailand.

Table 6.4 Peak areas of the seven main compositions of mandibular gland pheromones of honeybee foragers in Thailand.

Chemicals	<i>A. andreniformis</i>	<i>A. cerana</i>	<i>A. dorsata</i>	<i>A. florea</i>	<i>A. mellifera</i>
2-butyl-1-octanol	1530	14912	7100	10166	2458
Dibutyl phthalate	35742	30346	17658	10227	8513
eicosane	8253	7104	15696	5333	3115
eicosanol	48230	119376	120536	80837	42286
heneicosanol	12872	44965	45288	16091	9257
2-hexyl-1-decanol	17475	15042	37605	11271	7941
nonadecane	31622	18686	29463	15570	2880