ORIGINAL ARTICLE

Multivariate morphometric study of Apis florea in Thailand

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SUMMARY

Morphometric analyses of Apis florea in Thailand were carried out in order to detect differences within this species. The nine body parts selected for analysis were: proboscis, antenna, forewing, hindwing, hind leg, the third and sixth sternites, and the third and fourth tergites. Twenty-two characters, consisting of widths, lengths or angles, were measured. Factor analysis sorted 14 characters of worker bees into four factors: (Factor 1) characters associated with size, hind leg and antenna; (Factor 2) length of wing venation and forewing; (Factor 3) number of hamuli and venation angle 37; and (Factor 4) venation angle 34. The results of factor and cluster analyses using the 22 characters revealed that the A. florea of Thailand are distributed as one group. Four characters (forewing radial cell length, metatarsus length, 3rd sternite length and antenna length) can be used to separate by Student-Newman-Keuls Statistics the A. florea of Samui and Pha-ngan Islands from the mainland.

Keywords: honey bees, Apis florea, morphometric analysis, Thailand

INTRODUCTION

Based on morphology, behaviour and geographic distribution, taxonomists have separated honey bees into nine species, five of which are found in Thailand. Apis florea, A. andreniformis, A. dorsata, and A. cerana are native species, whereas A. mellifera is introduced (Wongsiri, 1995). These bees are economically important in agriculture, medicine and the environment (Free, 1981). In addition, they are pollinators, especially A. florea which is an excellent pollinator of various economic crops and forest trees and has a wide foraging range (Wongsiri et al., 2000). Most research on honey bee variation has been conducted on A. mellifera using morphometric analysis. Morphometrics is the measurement and statistical analysis of morphological structures of organisms (Daly, 1985). Few data on the native species of Thailand have been reported, especially on the morphometrics of A. florea. Rinderer et al. (1995) reported a comparison of A. florea and A. andreniformis for 44 morphometric characteristics for colonies from south eastern Thailand. Makhmoor & Ahmad (1998) reported studies of 16 morphological characters of 10 bees each of A. florea, A. mellifera, A. cerana and A. dorsata from the Jammu region of India. Narayanan et al. (1960) reported the tongue lengths and number of hamuli for 250 bees from five colonies at Pusa, India. Morphometric studies have been carried out on A. cerana in Thailand (Sylvester et al., 1998) that showed that A. cerana can be separated into four geographic groups. In the present study, morphometric analyses of A. florea in Thailand were carried out in order to determine whether differences could be detected within this species, allowing separation into geographic groups.

MATERIALS AND METHODS

Fifteen worker bees were collected from each of fifty Apis florea colonies from different locations to sample the range of ecological variation in Thailand (table 1, fig. 1). These bees were preserved in 70% ethanol until they were dissected. The nine body parts selected were: proboscis, antenna, forewing, hindwing, hind leg, third and sixth sternites, and the third and fourth tergites. These parts were mounted on slides. A stereo microscope and the Dazzle Digital Video Creator and Digital Photo Marker program were used to take photos of all parts. Measurements of width, length or angle of 22 characters (Hepburn et al., 2001; Ruttner, 1988) were carried out using the Image-Pro Plus program and recorded into a computer. Data were analysed by using factor and cluster analyses and one-way ANOVA.

RESULTS

The first statistical procedure performed a factor analysis on the colony means by using 22 characters for all 750 worker bees collected from the mainland and Samui and Pha-ngan Islands of Thailand. The means for all 750 worker bees are presented in table 2. Fourteen characters that had a high factor loading (greater than 0.6) were selected for further analysis: 3rd tergite length, 4th tergite length, femur length, 6th sternite length, tibia length, metatarsus length, 3rd sternite length, radial cell length, forewing length, apical portion of radial cell length, antenna length, venation angle 37, number of hamuli and venation angle 34. The second factor analysis using the colony means for the selected 14 characters grouped them into four factors with eigen values greater than one as new variables: (Factor 1) the characters associated with size, hind leg and antenna; (Factor 2) length of wing venation and forewing; (Factor 3) number of hamuli and venation angle 37; and (Factor 4) venation angle 34. These factor score values were used in a cluster analysis in an attempt to classify the population structure of A. florea by mainland region, islands, and north and south of latitude 12°N in Thailand (at the Isthmus of Kra, the zoogeographic divide between central and south Thailand). The dendrogram shows that these bees were clumped into one group (fig. 2); that is, there was no discernible population structure based on region.

One-way ANOVA and multiple comparisons with Student-Newman-Keuls were used to test the mean value of the morphological characters in each region. All F tests indicated significant differences among the geographic/climatic groups except the test
FIG. 1. Map of Thailand showing the sampling sites for *Apis florea*. 
FIG. 2. Dendrogram showing the *Apis florea* samples classified by region.
on number of hamuli. It was found that the characters associated with abdominal size (3rd tergite length, 4th tergite length, 3rd sternite length and 6th sternite length) were smaller in the sample bees from Samui and Pha-ngan Islands. In addition, the characters associated with the appendages of bees from both islands (radial cell length, apical portion of radial cell length, metatarsus length and antenna length) were smaller than the mainland samples. Moreover, the characters radial cell length, metatarsus length, 3rd sternite length and antenna length were able to separate *A. florea* of these islands from the mainland. In addition, the comparative result of the mean value of antenna length separated samples from the east from the other regions. The comparative result of the mean value of metatarsus length separated samples from the central region from the other regions, but there were only a few samples from the east and north when compared to the other regions.

**DISCUSSION**

This morphometric study used 22 characters of *A. florea* distributed over different regions throughout the mainland and two of the islands of Thailand and found that the bees were not
different using factor and cluster analyses. However, A. florea from Samui and Pha-ngan Islands tended to separate from the mainland samples by Student-Newman-Keuls statistics.

Fifty colonies of A. florea were classified by cluster analysis. It was found that 48 colonies were separated into the first group. However, two colonies, from Prachuap Khiri Khan (#97) and Samui Island (#87), were separated into a second group. One-way ANOVA and multiple comparisons with Student-Newman-Keuls were used to test the mean value of the morphological characters in each region. It was found that characters associated with the size of the sample bees from the islands (3rd tergite length, 4th tergite length, 3rd sternite length and 6th sternite length) were smaller than the mainland samples. Moreover, only four characters (radial cell length, apical portion of radial cell length, venation angle, radial cell length) were smaller than the mainland samples. In addition, the characters associated with appendages of the sample bees from the north were few when compared to the other sampled regions. Thus, more samples should be studied to find a clearer conclusion.

We conclude that A. florea in Thailand exhibits less division into distinguishable geographic groups than does A. cerana, in which Sylvester et al. (1998) were able to distinguish four groups.

### REFERENCES


