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Original article

Morphometric characteristics of *Apis cerana* from Sri Lanka

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Summary — Worker bees from 11 colonies of *A cerana* collected from different geographical regions of Sri Lanka were examined. The coefficients of variability of 19 morphological characteristics were calculated and a tergite colour classification was carried out. The greatest mean coefficient of variability was 24.41% for tergite colour, and 7.94% for proboscis length, while the least variable was 1% for forewing length. The possibility of using highly variable simple characteristics in tandem selection is suggested.

***Apis cerana* / morphometry / Sri Lanka**

INTRODUCTION

Honey production of *A cerana* is relatively low, on average 1.67 kg per colony in Sri Lanka, and a breeding program in order to improve the productivity of this bee has been suggested (Szabo, 1988). The biology and morphology of *A cerana* have been described by Ruttner (1988). Literature on *A cerana* has been reviewed by Peng *et al* (1989). Variability of lengths of proboscis components and number of wing hooks of A cerana have been investigated by Fernando (1979). The purpose of this study was to investigate the variability of various morphological characteristics of *A cerana* in Sri Lanka.

MATERIALS AND METHODS

In February 1988, the 74 colonies of *A cerana* kept at Makandura have been collected from various regions of Sri Lanka. These colonies originated from feral colonies which have been hived 1–2 yr prior to this study and were dispersed throughout a large coconut plantation. Empty frames were provided and the bees built their own natural combs. From 11 of these colonies random samples of ≈ 30 worker bees per colony were collected from the brood combs, preserved in 70% ethyl alcohol, and later examined for morphological characteristics. Numbers of bees collected from colonies 1 to 11 were as follows: 30, 26, 30, 30, 18, 30, 30, 28, 28, 29 and 12. Eighteen morphological characteristics were measured and one was calculated for each bee as listed below. All characteristics were described by Ruttner (1988) unless stated otherwise: 1, Proboscis length; 2, Forewing length; 3, Forewing width; 4, Cubital vein *a;* 5, Cubital vein *b;* 6, Cubital index *a/b;* 7, Number of discoidal cell hairs in 0.4 mm^2 area (Woyke, 1978); 8, Hindwing length (Daly and Balling, 1978); 9, Hindwing width (Daly and Balling, 1978); 10, Number of hamuli (Daly and Balling, 1978); 11, Femur length; 12, Tibia length; 13, Metatarsus length; 14, Metatarsus width; 15, Third sternite length; 16, Wax mirror length; 17, Wax mirror width; 18, Distance bet-

ween wax mirrors; 19, Tergite colour patterns were determined according to the colour classification designed in the present paper.

The dorsal view of the abdomen of each of 291 bees was drawn and a colour classification was made ranging from No 1 the most yellow, to No 10 the least yellow or most black, as illustrated in fig 1.

Eighteen body parts from the right side of each specimen were glued to a microscope slide with Permount. These were then projected to a Kurta (California) series 2 graphic tablets and measured with an IBM personal computer equipped with video image analysis system, version 2.11 (Pelco, California) to the nearest 0.001 mm.

RESULTS

Using the drawings of the 291 bees, a colour classification was made for the *A cerana* collected in Sri Lanka (fig 1). The largest coefficient of variation was found in colour within and between colonies, showing an average of 24.41%. The mean coefficient of variability was 7.94% for proboscis length. The lowest coefficient of variation was 1% for forewing length (table I).

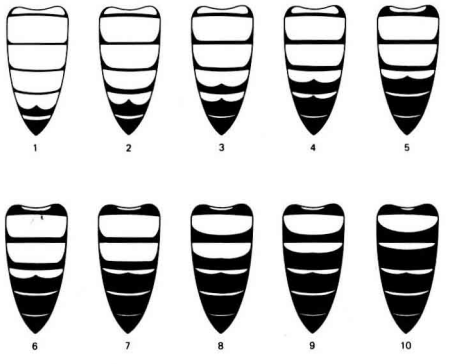

Fig 1. Colour classes of *A cerana* worker bees from Sri Lanka. The white areas represent the different shades of yellow pigmentation.

DISCUSSION AND CONCLUSIONS

The purpose of the present study was to establish some of the morphological characteristics of *A cerana* in Sri Lanka before initiating a breeding project to improve the productivity of this bee (Szabo, 1988). Specific morphological characteristics in a stock are often desired and some of these depend on simple genetic factors (Tucker, 1986). Careful selection of the base breeding stock will result in a parental population almost uniform for the desired morphological traits and still containing enough additive genetic variance to support the improvement of desired quantitative characteristics (Rinderer, 1986). Of the 19 morphological characteristics investigated, tergite colour was the most variable. The coefficient of variability for tergite colour varied from 27.77–61.20% and the score for tergite colour ranged from 2.8–6.6 from very light yellow to almost black bees. Tsuruta *et al* (1989) described seasonal color dimorphism of *A cerana japonica* in Japan. A predominantly yellow type of worker appeared in summer and a black type in winter. Very minor temperature fluctuations occur in Sri Lanka with the annual range from 2°C in the southwest to 5°C in the northeast (Baptist, 1976). It seems unlikely that the color variations among the *A cerana* within and between the colonies of this study resulted from variation in temperatures. Another highly variable character was the proboscis length, which confirmed Fernando's (1979) results of high variability of tongue lengths of *A cerana* from Sri Lanka. Although proboscis length did not relate to honey production in Alberta, Canada (Szabo and Lefkovitch, 1988) this trait may be economically significant in Sri Lanka. Fernando (1979) demonstrated that the mean number of wing hooks ranged from 17.44–18.02 from different regions of Sri Lanka. In the present study the mean

Table I. Mean morphological measurements (mm) of 11 *A cerana* colonies from Sri Lanka.

Observation	*General mean*	*Colony No 1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
PL	3.92	4.44	3.71	4.03	3.73	3.88	3.80	3.64	3.94	3.63	3.85	4.58
CV	7.94	10.27	11.20	7.20	12.27	11.92	14.54	8.13	13.02	9.57	12.50	9.16
FWL	7.75	7.67	7.84	7.78	7.76	7.64	7.76	7.71	7.78	7.73	7.70	7.92
CV	1.00	2.95	1.79	1.33	1.52	1.94	1.77	1.11	1.48	1.25	2.01	1.53
FWW	2.64	2.59	2.55	2.61	2.65	2.57	2.61	2.71	2.67	2.68	2.65	2.72
CV	2.18	5.44	4.57	2.85	3.46	3.55	3.91	2.99	3.35	3.50	2.72	2.26
CVA	0.40	0.35	0.39	0.38	0.43	0.39	0.41	0.41	0.41	0.40	0.42	0.44
CV	6.14	14.74	10.51	14.09	6.30	8.19	9.12	9.13	9.43	8.56	8.70	7.20
CVB	0.14	0.14	0.15	0.15	0.14	0.15	0.14	0.13	0.13	0.14	0.13	0.14
CV	4.83	16.72	16.86	11.57	15.74	13.51	12.15	8.43	12.19	15.60	13.38	19.06
CI	2.97	2.61	2.76	2.59	3.21	2.70	3.03	3.31	3.08	3.00	3.20	3.19
CV	8.81	20.26	18.52	14.38	15.07	15.30	10.47	12.25	14.22	16.77	19.02	19.62
HRS	54.31	56.67	52.61	55.84	59.18	55.63	55.23	57.04	52.03	51.10	53.98	48.05
CV	5.80	9.53	7.89	9.04	9.25	11.14	8.17	8.09	12.65	9.19	9.85	9.70
HWL	3.67	3.63	3.65	3.66	3.70	3.60	3.71	3.63	3.68	3.70	3.65	3.74
CV	1.14	2.88	2.32	2.23	2.70	2.21	1.77	2.18	2.32	2.10	2.20	1.37
HWW	1.57	1.53	1.52	1.54	1.57	1.51	1.56	1.59	1.57	1.59	1.53	1.61
CV	3.21	4.50	5.04	3.97	3.86	3.72	3.39	3.39	3.80	3.17	3.21	2.40
HA	17.52	17.77	17.08	17.33	17.57	16.88	17.33	17.40	17.96	18.50	17.62	17.25
CV	2.55	6.56	7.58	5.53	7.72	8.35	5.93	8.21	7.18	6.50	6.51	7.87
FE	2.10	2.11	2.12	2.14	2.10	2.08	2.10	2.10	2.08	2.06	2.05	2.17
CV	1.73	4.12	4.38	3.55	3.89	3.33	3.53	3.15	2.69	3.16	3.36	2.85
TI	2.55	2.59	2.46	2.56	2.55	2.54	2.54	2.55	2.56	2.52	2.53	2.65
CV	1.89	5.68	4.39	3.22	4.56	3.03	3.16	4.08	3.18	3.02	3.87	3.26
ML	1.62	1.66	1.58	1.66	1.53	1.63	1.62	1.62	1.56	1.59	1.59	1.72
CV	3.34	5.39	5.89	5.27	5.76	3.61	3.32	3.96	5.38	4.01	5.16	3.92
MW	0.91	0.96	0.87	0.91	0.94	0.90	0.90	0.89	0.88	0.93	0.90	0.96
CV	3.38	7.48	10.48	9.17	7.68	8.63	7.73	6.08	8.01	6.24	7.77	5.65
S3	2.09	2.12	2.08	2.05	2.07	2.08	2.10	2.08	2.10	2.08	2.08	2.09
CV	0.90	4.66	7.03	4.46	4.66	3.75	2.83	3.13	3.27	2.57	3.14	4.54
WL	0.93	1.00	0.96	0.92	0.93	0.95	0.95	0.92	0.94	0.92	0.90	0.90
CV	3.32	9.75	11.33	10.52	9.48	8.68	7.93	6.49	3.88	5.56	7.06	4.14
WW	1.67	1.64	1.62	1.65	1.65	1.66	1.67	1.67	1.70	1.70	1.68	1.77
CV	2.37	7.93	4.39	4.31	4.19	4.57	3.52	2.86	2.92	3.24	2.37	3.13
WD	0.29	0.33	0.33	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.31
CV	6.60	18.47	18.46	11.31	10.33	6.09	7.90	7.61	4.15	7.57	6.49	7.39
TC	4.69	4.97	5.73	3.83	4.67	2.78	3.87	4.93	6.57	6.18	4.28	3.75
CV	24.41	37.19	43.47	57.84	41.85	61.20	27.77	43.22	37.38	36.33	24.13	54.69

PL = proboscis length; FWL = forewing length; FWW = forewing width; CVA = cubital vein *a;* CVB = cubital vein *b;* CI = cubital index *a/b*; HRS = number of discoidal cell hairs in a 0.4 mm2 area; HWL = hindwing length; HWW = hindwing width; HA = number of hamuli; FE = femur length; TI = tibia length; ML = metatarsus length; MW = metatarsus width; S3 = third sternite length; WL = wax mirror length; WW = wax mirror width; WD = distance between wax mirrors; TC = tergite colour score; CV = coefficient of variability.

number of wing hooks ranged from 16.88–18.50.

Résumé — Caractéristiques morphométriques d'*Apis cerana* au Sri Lanka. Des ouvrières ont été prélevées dans 11 colonies réparties dans diverses régions géographiques du Sri Lanka. On a calculé les coefficients de variabilité de 19 caractères morphométriques et classé les tergites selon leur couleur (fig 1). Les mesures ont été effectuées sur les parties droites du corps de 291 spécimens : longueur du proboscis, longueur et largeur de l'aile antérieure, nervure cubitale *a*, nervure cubitale *b*, index cubital *a/b*, nombre de poils de la cellule discoïdale sur une surface de 0,4 mm^2, longueur et largeur de l'aile postérieure, nombre de crochets alaires, longueur du fémur, longueur du tibia, longueur et largeur du métatarse, largeur du 3^e sternite, longueur et largeur du miroir à cire, distance entre les miroirs à cire et coloration des tergites. Le plus grand coefficient moyen de variabilité est de 24,41% pour la couleur des tergites et 7,97% pour la longueur du proboscis, alors que le plus faible est de 1% pour la longueur de l'aile antérieure. On suggère la possibilité d'utiliser des caractères simples hautement variables pour la sélection en tandem.

***Apis cerana* / morphométrie / Sri Lanka**

Zusammenfassung — Morphometrische Merkmale von *Apis cerana* aus Sri Lanka. Es wurden Arbeitsbienen aus 11 Völkern von *Apis cerana* untersucht, gesammelt in verschiedenen geographischen Regionen von Sri Lanka. Es wurden der Variabilitätskoeffizient von 19 Körpermerkmalen berechnet und eine Klassifizierung der Färbung der Rückenschuppen durchgeführt (Abb 1). Es wurden die Körperteile der rechten Seite von 291 Tieren gemessen. Die folgenden Merkmale wurden protokolliert: Länge von Rüssel und Vorderflügel, Breite des Vorderflügels, Aderlängen *a* und *b* sowie der Cubitalindex *a/b*, Anzahl der Borsten in der Discoidalzelle pro 0,4 mm^2, Länge und Breite des Hinterflügels, Anzahl der Flügelhäkchen, Länge von Femur, Tibia und Basitarsus, Breite des Basitarsus, Länge der dritten Bauchschuppe und des Wachsspiegels, Breite des Wachsspiegels, Abstand der Wachsspiegel, Farbmuster der Rückenschuppen. Der größte mittlere Variabilitätskoeffizient betrug 24,41% für die Färbung der Rückenschuppen und 7,94% für die Rüssellänge, dagegen zeigte die Länge des Vorderflügels mit 1% die geringste Variabilität. Es wird die Möglichkeit diskutiert, hochvariable, einfache Merkmale für eine Tandemselektion zu benutzen.

***Apis cerana* / Morphometrie / Sri Lanka**

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