Systematic Entomology (1989) **14**, 411–415

Bombus folsomi and the origin of Philippine bumble bees (Hymenoptera: Apidae)

CHRISTOPHER K. STARR Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. U.S.A.

ABSTRACT. The type female of *Bombus folsomi* (Frison) is redescribed and synomymized with *B. ephippiatus* Say. It is concluded that the putative type locality of *B. folsomi*, Mt Kinabalu in Borneo, is in error and that the genus appears to be absent from Borneo. This lends support to the hypothesis that bumble bees immigrated to the Philippines by an unusual northern route through Taiwan. More rigorous testing of this idea will require further cladistic analysis of the genus *Bombus*.

Introduction

The Philippines are a large group of islands with an insect fauna largely harmonic with that of the southeast Asian mainland (Dickerson, 1928; pers. obs.). The archipelago is readily divided into two subgroups: (a) Palawan and associated smaller islands, which lie on the Sunda shelf and are biotically a part of Borneo, and (b) the presumably oceanic Philippines Proper, comprising the rest of the national territory (Dickerson, 1928; Inger, 1954; Cuy, 1981; Starr *et al.*, 1983; Heaney, 1985). The present biota of the Philippines Proper gives evidence of having originated mainly through immigration from Borneo. Two alternative routes appear to have contributed only very slightly to the successful immigrants: from the south by way of Celebes (Sulawesi), and from the north by way of Taiwan (Fig. 1).

The bumble bee (Hymenoptera: Apidae: *Bombus*) fauna of southeast Asia comprises a small number of species of rather restricted distribution. The four species recorded from the Greater Sunda Islands and the three from the Philippines are mostly known from scattered mountains (Frison, 1930; Baltazar, 1966; pers. obs.), and there is no reason to expect the poorly known fauna of the southeast Asian mainland to differ in this regard. Bumble bees are not recorded from Celebes or the Less Sunda Islands, and their presence their is doubtable.

One striking feature of the island bumble bee fauna as presently known is an almost complete disjunction between the Greater Sunda Islands and the Philippines proper (Fig. 1). Only a single specimen, the holotype of *B. folsomi* (Frison, 1923, 1930), has been reported from the intervening island of Borneo, and none have been collected on Palawan. This disjunction suggests that the bumble bees are among the very few insects – and quite likely the only social insects – in the Philippines descended from northern immigrants. William's (1985) preliminary estimate of phylogenetic relationships among bumble bees does not resolve those among the species-groups found in southeast Asia and Taiwan, so that methods of cladistic biogeography cannot yet be applied to this problem. I therefore propose to treat it indirectly, by considering whether there are in fact bumble bees in Borneo. If there are, a southern route into the Philippines proper remains plausible. If not, this will give added weight to the appearance of at least one effective barrier between Sumatra or Java and the Philippines.

There are two *a priori* reasons to doubt that *B. folsomi* is from Borneo:

Correspondence: Dr C. K. Starr, Department of Horticulture, University of Georgia, Athens, Georgia 30602, U.S.A.

1. The locality information accompanying the holotype consists unambiguously of 'Kina Bala, N. Borneo'. No date or collector is given, and Frison (1923, 1930) said nothing about either. Frison's interpretation of the specified locality as Mt Kinabalu (Fig. 1) is evidently correct, as no similar name is given by the United States Board on Geographic Names (1970) for any other locality in Borneo. However, 'Kina Bala' is not among the accepted variants for that locality, nor is it the sort of spelling mistake which could be made by someone who had been there. I conclude that the collector did not write the label. It is probably not too much to say that there is nothing in particular to connect the specimen with Mt Kinabalu or Borneo.

2. The lack of additional bumble bee specimens from Borneo is suspicious. Furthermore, the holotype female of *B.folsomi* is the only reported specimen of its species. In my experi-

FIG. 1. Distribution of *Bombus* spp. on Taiwan and the islands of Southeast Asia. It is assumed that bumble bees are present in most forested highland areas of the mainland. b=*B.baguionensis* Cockerell, c=*bicoloratus* Smith, e=*eximius* Smith, f=*flavescens* (including *mearnsi* Ashmead), i=*irisanensis* Cockerell, l=*formosellus* (Frison), m=*melanopoda* Cockerell, n=*sonani* (Frison), r=*rufipes* Lepeletier, s=*senex* Vollenhoven, w=*wilemani* Cockerell. Distribution points are intended only to show the presence of species on particular islands and in the different parts of larger islands, so that many points represent several nearby localities. The point for *B.melanopoda* is a reasonable guess, as the species is recorded only from 'Sumatra'. Solid triangle=Mt Kinabalu, open triangles=the Dulit Range. The dashed line approximates the limits of the continental shelf (Sunda Shelf).

ence, where bumble bees occur in the Asian tropics they can be found in abundance, and they are not the sort of insects which only specialists collect. Lack of collecting effort is clearly not at issue here. Mt Kinabulu in Sabah and the Dulit Range in Sarawak both provide excellent candidate habitats for bumble bees, and both have been visited by numerous entomologists. I have specifically sought bumble bees on Mt Kinabalu, and several colleagues have noted their apparent absence there.

Frison, (1923, 1930) explicitly left undecided the subgenus or species-group placement of *B.folsomi*. The present study is a taxonomic examination of the species, with a view to reaching a conclusion whether it might reasonably exist in Borneo and to contributing to the question of the geographic origin(s) of Philippine bumble bees.

Materials and Methods

Wing-length measurements were made with an ordinary ruler to the nearest 0.5 mm. All other measurements were made with an ocular micrometer to the nearest 0.02 mm. Material used for direct comparison is as follows (ANSP=Academy of Natural Science of Philadelphia; CKS=collecion of C. K. Starr; USNM=National Museum of Natural History):

B.baguionensis imuganensis Hedicke, one queen from Luzon, Philippines (CKS).

B.ephippiattus Say, nineteen queens from Costa Rica, one queen from Panama, three queens from Guatemala (USNM).

B.eximius tonkinensis Friese, one queen and one worker from southeastern China.

B.flavescens mearnsi Ashmead, one queen from Mindanao, Philippines, one queen from Negros, Philippines (USNM).

B.folsomi (Frison), holotype female (ANSP).

B.irisanensis Cockerell, one queen and one worker from Luzon, Philippines (USNM).

B.rufipes Lepeletier, two queens and two workers from Java (USNM).

The type material of *B.ephippiatus* is presumed lost (Franklin, 1913). Characters of *B.melanopoda* Cockerell and *B.senex* Vollenhoven are taken from Frison (1930).

Redescription of the holotype of *Bremus folsomi* Frison, 1923

Colour of pile. Mainly black-brown on the frons and vertex, with some very long yellowish hairs. Thorax entirely reddish-yellow above, grading into yellow on the sides, abruptly switch to black-brown below at about the level of the coxae. Gaster entirely yellow and red-yellow on segments 1–5 above, with much sparser, yellow, long hairs below; tergum 1 mainly yellow, terga 2–5 reddish-yellow with remnants of a central yellow patch on tegum 2; tergum 6 black, without long pile.

Head. Tubercles of labrum abruptly angled at their inner ends, separated by a deep, broad furrow. Lamella of labrum moderately wide, front edge approximately straight in middle part. Clypeus roundly bulging, with sparse fine punctures, coarser at the lateral edges and ventral angles. Malar space about 1.5 times as broad as long (minimum length). Frons densely, finely punctured. Furrow from middle ocellus to frons deep, wide and smooth, initially almost as wide as ocellus. Side-to-side distance across the ocelli 1.44 mm. Distance from hind edge of lateral ocellus to hind edge of head 1.04 mm. Separation of lateral ocellus from eye about 2.4 times diameter of lateral ocellus. Area between lateral ocellus and eye unpunctured on about the two-thirds next to ocellus.

Thorax. Wings evenly light brown, forewing length 16.5 mm. Surface of pollen basket smooth and shiny, with a very few recumbent small, yellow, feathered hairs. Pollen basket with mainly reddish-yellow hairs at edges, few black hairs. Hind apical angle of hind-tibia only slight acute, not produced into a distinct spur.

Gaster. Acarinarium near basal edge of second tergum in the form of a distinct furrow, acutely bordered basally (Fig. 2). Apical area of sixth tergum distinctly flattened above, tip with a rounded raised border, flat area without a median keel.

Material examined: Female, Kina Bala [sic], N. Borneo. Type no. 10542 (ANSP).

B.folsomi differs conspicuously in colour pattern from all other described species from insular Southeast Asia and from *B.ephippiatus* from Guatemala. It matches the examined specimens of *B.ephippiatus* from Costa Rica and

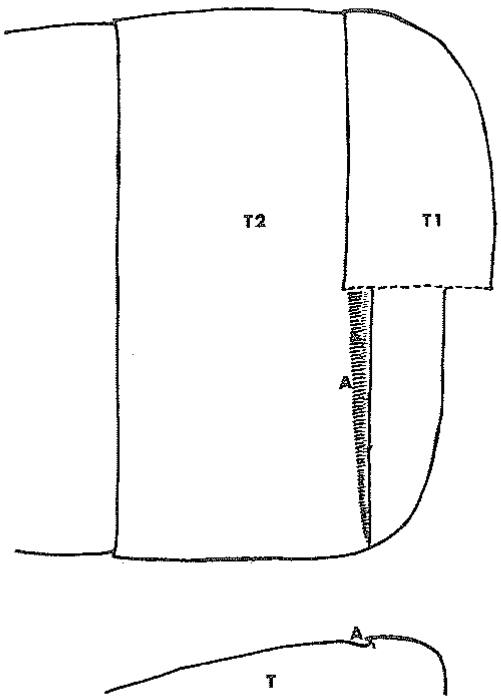

FIG. 2. Above: Dorsal view of the first (T1) and second (T2) terga of a *B.ephippiatus* queen, with the pile removed and right half of the first tergum cut away to reveal the acarinarium (A). Below: Longitudinal section of second tergum along the midline.

Panama, which represent the charateristic colour form of the queen in those areas (Labougle *et al.*, 1985).

The following structural characters are among those which separate the queens and workers of insular Southeast Asian species from *B.folsomi*:

B.irisanensis, *B.melanopoda* and *B.senex*. Mid-basitarsus with the outer apical angle produced into a sharp spur.

B.rufipes (as well as *B.eximius* from southeastern China). Surface of the pollen basket sometimes with a great number of recumbent or semi-recumbent plumose hairs (apparently easily worn away in use), outer apical angle of hind tibia produced to a distinct, acute spur.

B.flavescens mearnsi and *B.baguionensis imuganensis*. Apical area of sixth tergum not markedly flattened above, evenly rounded at the edges.

The holotype of *B.folsomi* is markedly smaller than the queens of *B.rufipes* and *B.eximius* and larger than the workers.

All examined *B.ephippiatus* queens have a forewing length between 15.5 and 17 mm. Aside from difference in pile colour, specimens of *B.ephippiatus* from Guatemala differ from the holotype of *B.folsomi* only in lacking any short hairs on the surface of the pollen basket and in having the hairs at the rim of the pollen basket mainly black. Specimens from Costa Rica and Panama match it in all particulars.

I conclude that the holotype of *B.folsomi* is in fact a *B.ephippiatus* queen, probably from Costa Rica or Panama, and hence that *Bremus folsomi* Frison, 1923: 322–323 is a junior synonym of *Bombus ephippiatus* Say, 1837: 414 (syn.n.).

One other bumble bee specimen putatively from Borneo is known to me. In the British Musuem (Natural History) is a male of *B.rufipes* in indifferent condition, with the following information attached (P. H. Williams, pers. comm.): 'Bandjar, Borneo. *B.rufipes* var. *obscuripes* [male], det. Maidl, Pittioni Coll., Turner Bequest, B.M. 1954–79'. The United States Board on Geographic Names (1968, 1970) records nine localities named Bandjar in Malaysia and Indonesia. One of these is on Borneo, near its southeastern extreme. Six of the others are on Java. Frison (1930) indicates a Bandjar among the localities on Java from which he examined specimens of *B.rufipes obscuripes* Friese loaned to him by Franz Maidl, including several males. I thus find it very likely that the specimen in question is mislabelled and was collected on Java.

Discussion

The synomymy of *B.folsomi* with *B.ephippiatus* renders it certain that the putative type locality of the former is in error. Such a result is not unprecedented, as at least two other available names of neotropical species are based on types mistakenly thought to have come from Asia (Crawford, 1906: Franklin, 1913). There is no apparent evidence of bumble bees occurring in Borneo and good reason to think that none exist there. This conclusion is consistent with the hyopthesis that the bumble bees of the Philippines are descended from immigrants arriving from Taiwan.

Acknowledgments

I am grateful to Borek Tkalců for generous advice on the characters of Oriental bumble bees, to Donald Azuma of the Academy of Natural Sciences of Philadelphia for loaning the type of *B.folsomi*, and to Karl Krombein and Paul Williams for criticism of an earlier version of this paper.

References

Baltazar, C.R. (1966) A catalogue of Philippine Hymenoptera (with a bibliography, 1758–1963). *Pacific Insects Monographs,* **8,** 1–488.

Crawford, J.C. (1906) Some Costa Rican bees. *Transactions of the American Entomological Society,* **32,** 157–163.

Cuy, L.S. (1981) Geographical distribution of Philippine Nycteribiidae and their hosts. *Kalikasan,* **10,** 197–213.

Dickerson, R.E. (ed.) (1928) *Distribution of Life in the Philippines.* Philippine Bureau of Science, Manila.

Franklin, H.J. (1913) The Bombidae of the New World. Part II. Species south of the United States. *Transactions of the American Entomological Society,* **39,** 73–200.

Frison, T.H. (1923) Systematic and biological notes on bumblebees (Bremidae; Hymenoptera). *Transactions of the American Entomological Society,* **18,** 307–326.

Frison, T.H. (1930) The bumblebees of Java, Sumatra and Borneo. *Treubia,* **12,** 1–21.

Heaney, L.R. (1985) Zoogeographic evidence for middle and late Pleistocene land bridges to the Philippine Islands. *Modern Quaternary Research in Southeast Asia,* **9,** 127–143.

Inger, R.F. (1954) Systematics and zoogeography of Philippine amphibia. *Fieldiana: Zoology,* **33,** 181–531.

Labougle, J.M., Ito, M. & Okazawa, T. (1985) The species of the genus *Bombus* (Hymenoptera: Apidae) of Chiapas, Mexico and Guatemala; with a morphometric and altitudinal analysis. *Folia Entomologica Mexicana,* **64,** 55–72.

Say, T. (1837) Descriptions of new species of North American Hymenoptera, and observations on some already described. [part 2]. *Boston Journal of Natural History,* **1,** 360–416.

Starr, C.K., Schoenig, E. & Cañete, M.J.P. (1983) USC-ViSCA biological expedition to Palawan, May–June 1982. I. Entomological record. *Philippine Scientist,* **20,** 129–138.

United States Board on Geographic Names (1968) *Official Standard Names Gazetteer,* No. 13. *Indonesia and Portuguese Timor,* 2nd edn. Office of Geography, Department of the Interior, Washington, D.C.

United States Board on Geographic Names (1970) *Official Standard Names Gazetteer,* No. 10. *Malaysia, Singapore,* and *Brunei,* 2nd edn. U.S. Army Topographic Command, Washington, D.C.

Williams, P.H. (1985) A preliminary cladistic investigation of relationships among the bumble bees (Hymenoptera, Apidae). *Systematic Entomology,* **10,** 239–255.

Accepted 31 May 1989