

The Taxonomy of Recent and Fossil Honey Bees (Hymenoptera: Apidae; *Apis*)

MICHAEL S. ENGEL

Department of Entomology, American Museum of Natural History,
Central Park West at 79th Street, New York, New York 10024-5192, USA

Abstract.—An attempt is made to clarify the complicated and error fraught taxonomic history of the honey bees (genus *Apis* Linnaeus) by cataloguing the numerous names proposed for *Apis*. The 178 species- and 10 genus-group names (including those proposed herein) are brought for the first time into accord with the modern classification of the honey bees. The results of this synthesis reveal a number of names in current usage to be taxonomically confused. The authorship of the species *Apis koschevnikovi* is established as Enderlein and not Buttel-Reepen. The correct names for four subspecies of the Western honey bee, *A. mellifera*, are established as *A. mellifera remipes* Gerstäcker (not *A. mellifera armeniaca* Skorikov), *A. mellifera siciliana* Grassi (not *A. mellifera sicula* Montagano), *A. mellifera jemenitica* Ruttner (not *A. mellifera yemenitica* Ruttner), and *A. mellifera caucasia* Pollmann (not *A. mellifera caucasica* Gorbachev). The correct authorship of the subspecies *A. mellifera iberica* is established as Ruttner and not Goetze, of *A. mellifera syriaca* as Skorikov and not Buttel-Reepen, and of *A. mellifera intermissa* as Maa and not Buttel-Reepen. Three replacement names are proposed for preoccupied subspecific taxa: *A. mellifera artemisia* Engel (new name for *A. mellifera acervorum* Skorikov, *nec* Linnaeus), *A. mellifera iberiensis* Engel (new name for the aforementioned *A. mellifera iberica* Ruttner, *nec* Skorikov), and *A. mellifera sossimai* Engel (new name for *A. cerifera* Gerstäcker, *nec* Scopoli). The previously confused Himalayan honey bee (infrequently associated with *A. cerana skorikovi* Maa, *nomen nudum* or *A. cerana* "Himalaya race") is proposed and validated as *A. cerana skorikovi* Engel (new subspecies). Similarly the large black race of China (Aba race) is proposed as *A. cerana heimifeng* Engel (new subspecies). A lectotype and 11 paralectotypes are designated for *A. mellifera ruttneri* (by Sheppard *et al.*), a lectotype is designated for *A. koschevnikovi*, and a neotype is designated for *A. mellifera iberica* Ruttner. *Apis cuenoti* Théobald is **newly synonymized** under *A. henshawi* Cockerell, *A. mellifera rodopica* Petrov is **synonymized** with *A. mellifera macedonica* Ruttner, while *Hauffapis scheeri* Armbruster, *H. scharmanni* Armbruster, *H. scheeri gallauni* Armbruster, *H. scheeri rahdei* Armbruster, *H. scheuthlei seemanni* Armbruster, and *H. scheuthlei zeuneri* Armbruster are all **synonymized** under *A. armbrusteri* Zeuner (**new synonymies**). The name *A. vetustus* Engel for a fossil from the Oligocene of Europe is emended to *A. vetusta* Engel. All genus-group taxa are characterized on the basis of adult and larval morphology and ethology. Two new subgenera are proposed to accommodate fossil honey bee species: *Cascapis* Engel new subgenus (type: *A. armbrusteri* Zeuner) and *Priorapis* Engel new subgenus (type: *A. vetusta* Engel).

The honey bees (genus *Apis* Linnaeus) are the most famous of all insects owing to their import for the pollination of crops, their social organization, and the honey they produce. There has been a long association between *Apis* and man as is attested by the Paleolithic Araña Cave paintings near Valencia, Spain which de-

pict early humans collecting honey combs. Similarly, the honey bees figure prominently in human cultures, mythologies, and religions (e.g., see Ransome 1937). Numerous world revisions have been attempted for the genus (Gerstäcker 1862, 1863, Smith 1865, Ashmead 1904, Buttel-Reepen 1906, Enderlein 1906, Skorikov

Table 1. Classificatory structure of major honey bee revisions since Gerstäcker (1862); living species only. Subspecies and varieties omitted so as to save space. Species are in alphabetical order and do not necessarily correspond in rows from one column to the next. I have replaced uses of *mellifica* by some of these authors with *mellifera*. Although Maa (1953) observes that Skorikov (1929b) recognized 14 species, the later author left one unnamed (the "Egyptian bee") and I have therefore listed only 13 here. G = genus, sg = subgenus.

Gerstäcker 1862	Smith 1865	Ashmead 1904	Buttel-Reepen 1906	Enderlein 1906	Skorikov 1929b	Maa 1953	Present author 1999
G. <i>Apis</i> <i>dorsata</i> <i>florea</i> <i>indica</i> <i>mellifera</i>	G. <i>Apis</i> <i>adansonii</i> <i>dorsata</i> <i>florea</i> <i>indica</i> <i>mellifera</i> <i>mellifera</i> <i>nigrocincta</i> <i>sinensis</i> <i>zonata</i> 1871 added: <i>laboriosa</i>	G. <i>Apis</i> <i>cerana</i> <i>indica</i> <i>mellifera</i> <i>nigritarum</i> <i>nigrocincta</i> <i>unicolor</i> G. <i>Megapis</i> <i>dorsata</i> <i>zonata</i> G. <i>Micrapis</i> <i>florea</i>	G. <i>Apis</i> <i>dorsata</i> <i>florea</i> <i>mellifera</i>	G. <i>Apis</i> <i>dorsata</i> <i>florea</i> <i>indica</i> <i>mellifera</i>	G. <i>Apis</i> sg. <i>Apis</i> <i>adansonii</i> <i>cerana</i> <i>cypria</i> <i>indica</i> <i>japonica</i> <i>johni</i> <i>meda</i> <i>mellifera</i> <i>remipes</i> <i>syriaca</i> <i>unicolor</i> sg. <i>Megapis</i> <i>dorsata</i> sg. <i>Micrapis</i> <i>florea</i>	G. <i>Apis</i> sg. <i>Apis</i> <i>adansonii</i> <i>intermissa</i> <i>lamareckii</i> <i>meda</i> <i>mellifera</i> <i>remipes</i> <i>unicolor</i> sg. <i>Sigmatapis</i> <i>cerana</i> <i>indica</i> <i>javana</i> <i>johni</i> <i>koschevnikovi</i> <i>lieftincki</i> <i>nigrocincta</i> <i>peroni</i> <i>philippina</i> <i>samarensis</i> <i>vechti</i> G. <i>Megapis</i> <i>binghami</i> <i>breviligula</i> <i>dorsata</i> <i>laboriosa</i> G. <i>Micrapis</i> <i>andreniformis</i> <i>florea</i>	G. <i>Apis</i> sg. <i>Apis</i> <i>cerana</i> <i>koschevnikovi</i> <i>mellifera</i> <i>nigrocincta</i> sg. <i>Megapis</i> <i>dorsata</i> sg. <i>Micrapis</i> <i>andreniformis</i> <i>florea</i>

1929b, Maa 1953) as well as an unpublished faunal revision from Thailand (Malaipan 1972). Since the first detailed study by Gerstäcker (1862), anywhere from 3 to 24 species have been recognized while the four subgenera have at times been treated as distinct genera (Table 1). Despite the consistent and concentrated effort on *Apis* taxonomy for well over a century, a clear picture of the species and the numerous names associated with each has yet to be achieved. It is hoped that this paper (although mostly an exercise in "bookkeeping") will make a small step towards achieving these goals.

The primary objective of this paper has

been to pull together the extensive literature pertaining to the taxonomy of honey bees and to associate the long lists of junior synonyms with their valid counterparts. The last catalogue of *Apis* names was undertaken by Maa (1953); however, his list of names contains a number of errors and his rather extreme classification is not easily reconcilable with current usage. Moreover, Maa did not treat the numerous fossil honey bees and at least 60 names have either been discovered or were proposed since his study (approximately one-third of the total number of names). Below I have compiled a listing of all names applied to honey bees, both liv-

ing and extinct. This compilation contains 178 species- and 10 genus-group names. Although Maa (op. cit.) and Ruttner (1988) noted that over 600 species-group names have been proposed for *Apis*, this does not mean that 600 names have been proposed for honey bees. Many of these names were proposed under a Linnean concept of the genus which included *all* bees. Thus, most of the 600+ names pertain to species now placed in other genera and families (e.g., *Anthophora*, *Bombus*, *Megachile*, *Trigona*, &c.). Interestingly most of the names applicable to honey bees have been proposed during this century. A breakdown of the list reveals eight names appearing between 1758 and 1799, 17 from 1800 through 1849, 26 between 1850 and 1899, 66 in the period 1900 to 1949, and 61 names between the years 1950 and 1999. Of these names 146 are applicable to the living species (90 associated with *Apis mellifera* alone!), 25 for the fossil species, and seven names are of dubious taxonomic status.

Included with this catalogue I have provided descriptions of all genus-group taxa now included in *Apis*, thereby adding to this work a subgeneric revision of the genus. Table 2 summarizes the hierarchical classification of *Apis* as it is proposed herein.

Phylogenetic studies on the genus have recently been undertaken by Alexander (1991a,b), Engel (1998a), and Engel and Schultz (1997: see also works cited therein). The current hypothesis of relationships among the subgenera and species is depicted in Figure 1 (modified from Engel 1998a). General works on honey bee anatomy, biology, behavioral ecology, and diversity have been presented by Snodgrass (1956), Winston (1987), Seeley (1985, 1995), and Smith (1991a) respectively. The distribution of the various species and subspecies has been thoroughly treated by Ruttner (1988, 1992), Otis (1996), and Hepburn and Radloff (1998). The position of the Apini among the other tribes of corbiculate

Table 2. Current hierarchical classification of the honey bees; tribe Apini Latreille (excluding intraspecific taxa). Daggers (†) indicate extinct taxa.

Genus <i>APIS</i> Linnaeus
subgenus <i>Apis</i> Linnaeus
<i>cerana</i> Fabricius
<i>koschewnikovi</i> Enderlein
<i>mellifera</i> Linnaeus
<i>nigrocincta</i> Smith
† subgenus <i>Cascapis</i> Engel
† <i>arnubusteri</i> Zeuner
subgenus <i>Megapis</i> Ashmead
<i>dorsata</i> Fabricius
subgenus <i>Micrapis</i> Ashmead
<i>andreniformis</i> Smith
<i>florae</i> Fabricius
† subgenus <i>Priorapis</i> Engel
† <i>actusta</i> Engel
† subgenus <i>Synapis</i> Cockerell
† <i>henshawi</i> Cockerell
† <i>longitibia</i> Zhang
† <i>miocenica</i> Hong
† <i>petrefacta</i> (Riha)

bees has been considered most recently by Chavarría and Carpenter (1994), Engel (1998b, unpubl. data), Noll (1998, in prep.), and Schultz *et al.* (1999).

FORMAT

Standard formats for taxonomic histories are used. Comments provided for each taxon give information on the assignment of authorship to certain names, sub-specific classifications, studies of the recognition of difficult taxa, and occasionally historical information on the biogeography or biology of the species. Several honey bee names were used in publications as *nomina nuda* and in those cases where no description was later provided they are indicated as such. However, whenever a name was later made available by an associated description I have only listed the publication making the name available under the rules of the I.C.Z.N. (1985) and not the original paper in which it appeared as a *nomen nudum*.

For those species in which subspecies are currently recognized (*A. cerana*, *A. dor-*



Fig. 1. Phylogeny of the honey bees (genus *Apis* Linnaeus) with subgenera indicated (modified from Engel 1998a).

sata, and *A. mellifera*) I have associated each junior synonym with its corresponding subspecies. Names in brackets at the end of each entry indicate which subspecies the name corresponds to. In some cases (e.g., *nomina nuda*) this decision cannot always be made with certainty and so are accordingly noted with an interrogative mark.

Descriptions are provided for genus-group taxa and are based on information from all adult castes, the mature larva (of workers), and ethological information. Too little information exists at this time on *Apis* pupae to know whether additional character data can be gleaned from this life-stage. Characters given for workers also apply to drones and queens (except when indicated), although characters given for drones and queens do not necessarily occur in the worker caste. The abbreviations T1, T2, ..., T8 are used for the

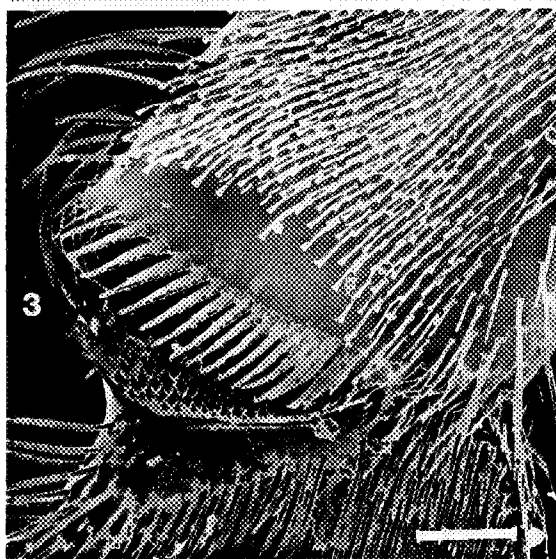
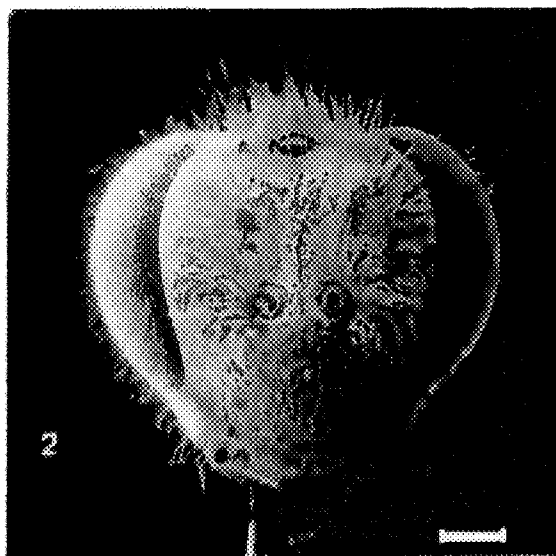
corresponding metasomal terga (S for sternum).

Since the literature on honey bees is vast, some names may have been inadvertently overlooked. Researchers discovering names (*nomina nuda*, *nova*, &c.) omitted here or of earlier usage than the dates cited are urged to contact me and, if possible, to send a copy of the relevant paper(s). All in all, however, this list should prove a reasonable starting point for future research.

RECENT HONEY BEES

Genus *Apis* Linnaeus

Diagnosis.—Modified and updated from Michener (1990: as *Apinae*). WORKER: Labral apex gently and often weakly concave; labrum three to four times broader than long (median width). Malar space as long as, or longer than basal width of mandible. Mandible without dentition



Figs. 2–3. Honey bee structural characteristics represented by *Apis* (*Apis*) *cerana* Fabricius. 2, Worker head (scale bar = 500 μ m). 3, Inner surface of metatibia-metabasisarsus junction showing pollen press (auricle), rastellum, and absence of tibial spurs (scale bar = 200 μ m).

(Fig. 2) (not so for queens or males). Hairs of compound eye long and erect (Fig. 2). Vertex extremely short, much less than ocellar diameter. Scutellum strongly convex and bulging, obscuring metanotum and basal area of propodeum. Basal area of propodeum extremely short and declivous. Mesocoxae nearly meeting medially. Strigilis with prong on anterior margin. Corbicula, rastellum, and auricle present

(workers only). Metatibial spurs absent (Fig. 3); metatibia without penicillum; inner surface of metabasisarsus with setal comb rows (worker only; referred to as *brush combs* in Michener 1990). Claws cleft; arolia present. Distal wing venation strong and complete; 1r-m and 2r-m strongly angled respective to M (Fig. 3). Marginal cell long (Fig. 3) and bluntly rounded at apex, not gently tapering over its length. Jugal lobe present. Sting straight (worker only). DRONE: Mandible usually bidentate, frequently only weakly. Holoptic (compound eyes meeting at top of head). S8 reduced to transverse bar, without spiculum. Spatha and volsella absent. QUEEN: Mandible bidentate. Inner surface of metabasisarsus unmodified. Sting curved. MATURE LARVA: Without small dorsal tubercles on segments 1–4. Mandible weakly sclerotized, bluntly pointed, without concavity on inner surface. ETHOLOGY: Nest a vertical comb of cells made of wax. Dance language communication system present. Highly eusocial (with morphologically distinct castes). New colonies founded by fission and include the old queen. Brood and storage cells similar. Immatures progressively provisioned.

Biogeography.—Honey bees are predominantly a tropical group and arose in the Indo-Malayan region during the early Oligocene (Engel 1998a). The genus is native to Europe, Africa, Madagascar, Arabia, the Near East, as well as Central and Southern Asia inclusive of most Southeast Asian Islands. Honey bees are not native to the Australian or American continents having been moved to these regions by humans. Species radiated from southern Asia perhaps being limited only by temperature extremes. The clade of living species (subgenera *Apis*, *Megapis*, and *Micrapis*; Fig. 1) arose sometime in the latter half of the Miocene (Engel 1998a). The development of cavity-nesting behavior in the earliest Pliocene (perhaps in the latest Miocene) enabled at least two of the species, *A. cerana* and *A. mellifera*, to extend their ranges

into more temperate areas. In the case of *A. mellifera* this was into Europe and northwestern Asia while for *A. cerana* this was into northeastern China, and the eastern regions of the former Soviet Union. The fossil species were presumably open-nesting (refer to Engel 1998a for a cladistic reconstruction of this behavior) and the slightly warmer temperatures in the Miocene would have partly allowed species such as *A. armbusteri* to exist in Europe even in the absence of well developed thermoregulatory capabilities. As the temperatures continued to cool (e.g., by the Pliocene) open-nesting species would have been forced from these areas and the cavity-nesting species would be free to colonize.

Subgenus *Apis* Linnaeus

Apis Linnaeus 1758: 343, 574. Type species: *Apis mellifica* Linnaeus 1761 (= *Apis mellifera* Linnaeus 1758), designation of Latreille (1810). Michener 1944: 292. Maa 1953: 557. Michener 1990: 140.

Apicula Rafinesque 1814: 29. Unjustified replacement name for *Apis* Linnaeus 1758.

Apiarus Rafinesque 1815: 123. Unjustified replacement name for *Apis* Linnaeus 1758.

Apis (*Sigmatapis*) Maa 1953: 556. Type species: *Apis cerana* Fabricius 1793, original designation.

Diagnosis.—**WORKER:** Forewing length 7–10 mm. Basal vein frequently gently curved, strongly distad cu-a (Fig. 4). Angle of posteroapical margin of first submarginal cell less than 45°. Distal abscissa of vein M in hind wing variable (present [Fig. 5] or absent). **DRONE:** Hind basitarsus without thumb-like process. Vertical arm of T8 longer than horizontal arm; S7 and S8 fused mesally. Gonobase absent. Ventral gonocoxa membranous; dorsal gonocoxa reduced. Ventral cornua of endophallus recurved ventrally. **MATURE LARVA:** Labrum with peg-like setae restricted to apical surfaces and tubercles. Galea smaller than maxillary palpus. Labial palpus not spiculate. Epipharynx with

or without setae. Atrial inner walls smooth. **ETHOLOGY:** Nest constructed in a cavity. Dance language performed on vertical surface; wagging metasoma positioned parallel to dance surface; recruits positioned next to dancer's metasoma (within a near field sound range). Drone cell cap variable (present or absent).

Apis (*Apis*) *cerana* Fabricius

The Eastern or Asian Honey Bee

Apis cerana Fabricius 1793: 327. [*cerana* Fabricius]

Apis indica Fabricius 1798: 274. [*indica* Fabricius]

Apis socialis Latreille 1804a: 390. [*indica* Fabricius]

Apis peroni Latreille 1804b: 173. [? *indica* Fabricius: see treatment of *javana* subspecies]

Apis gronovii Guilou 1841: 323. [? *indica* Fabricius: see treatment of *javana* subspecies]

Apis perrottetii Guérin-Ménéville 1844: 461. [*indica* Fabricius]

Apis delessertii Guérin-Ménéville 1844: 461. [*indica* Fabricius]

Apis sinensis Smith 1865: 380. [*cerana* Fabricius]

Apis mellifica variety *japonica* Radoszkowski 1887: 436. [*japonica* Radoszkowski]

Apis delesserti Buttel-Reepen 1906: 168. Unjustified emendation. [*indica* Fabricius]

Apis indica variety *javana* Enderlein 1906: 337. [*javana* Enderlein]

Apis indrea Baldensperger 1928: 173. *Lapsus calami*. [*indica* Fabricius]

Apis johani Skorikov 1929b: 251. [*johani* Skorikov]

Apis indica philippina Skorikov 1929b: 252. [*indica* Fabricius]

Apis indica skorikovi Maa 1944: 4. *Nomen nudum*. [*skorikovi* Engel]

Apis mellifera gandhiana Muttoo 1951: 153. *Nomen nudum*. [*indica* Fabricius]

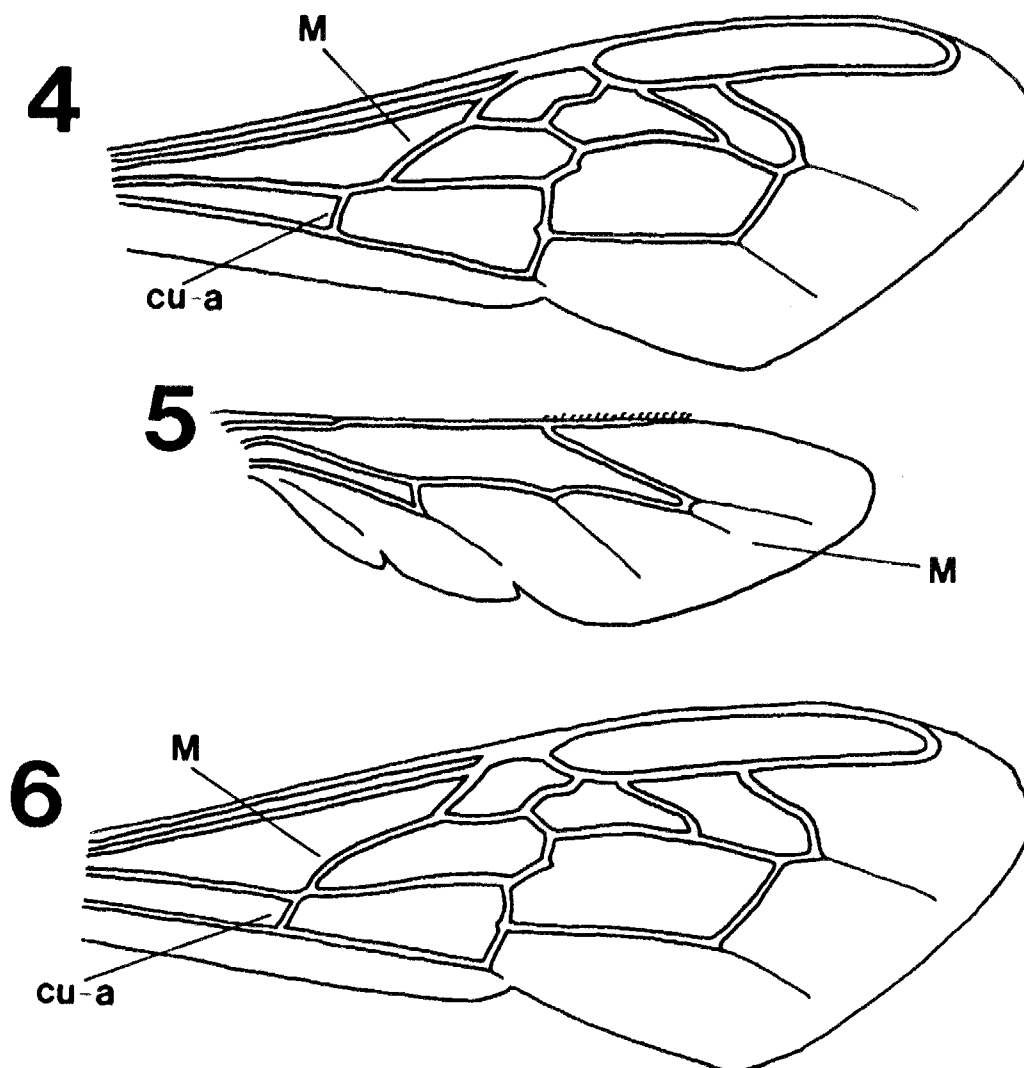
Apis (*Sigmatapis*) *lieftincki* Maa 1953: 572. [*johani* Skorikov]

Apis (*Sigmatapis*) *samarensis* Maa 1953: 580. [*indica* Fabricius]

Apis indica sinensis ussuriensis Goetze 1964: 26. *Nomen nudum*. Refer to comments under *A. mellifera*. [*cerana* Fabricius]

Apis cerana himalaya Smith 1991b: 154. *Nomen nudum* (see below). [*skorikovi* Engel]

Apis cerana Willis, Winston, and Honda 1992: 169. *Lapsus calami*. [*cerana* Fabricius]



Figs. 4-6. Honey bee wing venation. 4, *Apis (Apis) cerana* Fabricius, worker, forewing. 5, *A. (A.) cerana*, worker, hind wing. 6, *A. (Synapis) henshawi* Cockerell, worker, forewing reconstruction. In the forewing M indicates an abscissa of vein M that is called the basal vein, while in the hind wing a distal abscissa is indicated which is referred to as the indica vein by some authors; cu-a is the cubital-anal crossvein, also called cu-v by some authors.

Apis nuluensis Tingek, Koeniger, and Koeniger 1996 [1997]: 116. [*nuluensis* Tingek et al.]

Apis cerana heimifeng Engel 1999: see below. [*heimifeng* Engel]

Apis cerana skorikovi Engel 1999: see below. [*skorikovi* Engel]

Comments.—The name *gandhiana* Muttoo (1951) was also used by Muttoo (1956) for an invalid variety of *A. cerana*. The name *nuluensis* was synonymized by myself in Schultz et al. (1999) and therefore appears here for the first time as a sub-

specific entity of *A. cerana* (see treatment of subspecies below).

Distribution.—Refer to treatment of individual subspecies below.

***Apis (Apis) koschevnikovi* Enderlein,
corrected authorship**

The Sundaland Honey Bee

Apis mellifica indica variety *koschevnikovi* Buttel-Reepen 1906: 192. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, and 50c).

Apis indica variety *koschevnikovi* Enderlein 1906: 335. First available usage.

Apis (Sigmatapis) vechti Maa 1953: 572.

Apis (Sigmatapis) vechti linda Maa 1953: 574.

Apis mellifica adansonii koschevnikovi Goetze 1964: 25. Unjustified emendation.

Comments.—The authorship of this name has almost universally been given to Buttel-Reepen who first proposed it in 1906. However, Buttel-Reepen used the name infrasubspecifically and thus according to the I.C.Z.N. (1985: Art. 10c) does not become available until it is first used as a species or subspecies, and then the authorship is assigned to the author who used the name in such a sense (Arts. 23j and 50c). Enderlein (1906) was the first to use the name *koschevnikovi* subspecifically and he must therefore be considered as the author.

This species was only recently reinstated although under the junior synonym *A. vechti* (Koeniger *et al.* 1988, Tingek *et al.* 1988). Ruttner *et al.* (1989) recognized that the correct name for this species was *A. koschevnikovi*. There are presently no subspecific forms recognized.

Distribution.—*Apis koschevnikovi* occurs on the Malay Peninsula, Borneo, Brunei, Java, Sabah, Sarawak, and Sumatra.

Lectotype.—Worker; BORNEO: Kinabalu Gebirge, John Worterstradt, L. [leg.]; now with an additional label reading, "Lectotype, *Apis koschevnikovi* Enderlein, desig. M. S. Engel" (deposited in the Museum für Naturkunde, Berlin). The original series of *A. koschevnikovi* used by Buttel-Reepen is located in the Museum für Naturkunde, Berlin. The type series consists of one worker from northern Borneo and eight labeled as from Cameroon. No *cerana*-like bees are natively known from the African continent, yet the specimens from "Cameroon" are clearly conspecific with the one from Borneo, and all correspond to the species widely recognized as *A. koschevnikovi* today. The specimens from Cameroon are very likely mislabeled; something even Buttel-Reepen

(1906) suspected. Although Maa (1953) chose Cameroon as the type locality, this cannot be considered a type fixation since there are eight specimens from this locality and none are labeled as the type (in fact, Maa admits having never seen any specimens of *A. koschevnikovi*). I therefore have selected the single specimen from Borneo to serve as the lectotype.

Apis (Apis) mellifera Linnaeus

The Western Honey Bee

- Apis mellifera* Linnaeus 1758: 576. [*mellifera* Linnaeus]
Apis mellifica Linnaeus 1761: 421. Unjustified emendation. [*mellifera* Linnaeus]
Apis gregaria Geoffroy 1762: 407. [*mellifera* Linnaeus]
Apis cerifera Scopoli 1770: 16. [*mellifera* Linnaeus]
Apis unicolor Latreille 1804b: 168. [*unicolor* Latreille]
Apis fasciata Latreille 1804b: 171. Preoccupied (*nec* Linnaeus 1767, Scopoli 1770). [*lamarckii* Cockerell]
Apis adansonii Latreille 1804b: 172. [*adansonii* Latreille]
Apis ligustica Spinola 1806: 35. [*ligustica* Spinola]
Apis capensis Eschscholtz 1822: 97. [*capensis* Eschscholtz]
Apis caffra Lapeletier de Saint Fargeau 1836: 402. Preoccupied (*nec* Linnaeus 1767). [*scutellata* Lapeletier de Saint Fargeau]
Apis scutellata Lapeletier de Saint Fargeau 1836: 404. [*scutellata* Lapeletier de Saint Fargeau]
Apis nigritarum Lapeletier de Saint Fargeau 1836: 406. [*adansonii* Latreille]
Apis daurica Fischer von Waldheim 1843: 1. [*mellifera* Linnaeus]
Apis mellifica variety *cecropia* Kiesenwetter 1860: 315. [*cecropia* Kiesenwetter]
Apis australis Kiesenwetter 1860: 317. Unjustified replacement name for *Apis ligustica* Spinola 1806. [*ligustica* Spinola]
Apis cerifera Gerstäcker 1862: 60. Preoccupied (*nec* Scopoli 1770). [*sossimai* Engel]
Apis mellifica variety *remipes* Gerstäcker 1862: 61. [*remipes* Gerstäcker]
Apis liguria Smith 1861b: 14. *Nomen nudum*. [*ligustica* Spinola]

- Apis mellifica germanica* Pollmann 1879: 1. [*mellifera* Linnaeus]
- Apis mellifica carnica* Pollmann 1879: 45. [*carnica* Pollmann]
- Apis mellifica hymettiva* Pollmann 1879: 50. Unjustified replacement name for *Apis mellifica carnica* Pollmann 1879. [*carnica* Pollmann]
- Apis mellifica cypria* Pollmann 1879: 52. [*cypria* Pollmann]
- Apis siciliana* Grassi 1881: 1. [*siciliana* Grassi]
- Apis mellifica* variety *nigrita* Lucas 1882: 62. [*mellifera* Linnaeus]
- Apis mellifida* Pollmann 1889: 90. *Lapsus calami*. [*mellifera* Linnaeus]
- Apis mellifida* [*sic*] variety *caucasia* Pollmann 1889: 90. [*caucasia* Pollmann]
- Apis ligurica* Dalla Torre 1896: 602. *Nomen nudum* (*nec* Tegetmeier 1859, 1860: see below). Corrected authorship. [*ligustica* Spinola]
- Apis mellifera carniolica* Koschevnikov 1900: 1. Unjustified emendation. [*carnica* Pollmann]
- Apis mellifera cypriaca* Koschevnikov 1900: 1. Unjustified emendation. [*cypria* Pollmann]
- Apis mellifica mellifica* variety *siziliana* Buttel-Reepen 1906: 168. Unjustified emendation. [*siciliana* Grassi]
- Apis mellifica unicolor* variety *syriaca* Buttel-Reepen 1906: 175. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*syriaca* Skorikov]
- Apis mellifica mellifica* variety *lehzeni* Buttel-Reepen 1906: 184. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*mellifera* Linnaeus]
- Apis mellifica unicolor* variety *intermissa* Buttel-Reepen 1906: 187. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*intermissa* Maa]
- Apis mellifica unicolor* variety *friesei* Buttel-Reepen 1906: 188. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*adansonii* Latreille]
- Apis mellifera lamarckii* Cockerell 1906: 166. Replacement name for *Apis fasciata* Latreille 1804b. [*lamarckii* Cockerell]
- Apis mellifica* Enderlein 1906: 331. *Lapsus calami*. [*mellifera* Linnaeus]
- Apis mellifica unicolor* variety *frisei* Enderlein 1906: 335. *Lapsus calami*. [*adansonii* Latreille]
- Apis mellifera sicula* Montagano 1911: 26. [*siciliana* Grassi]
- Apis adamsoni* Meunier 1915: 210. *Lapsus calami*. [*adansonii* Latreille]
- Apis fuscata* Meunier 1915: 210. *Lapsus calami*. [*lamarckii* Cockerell]
- Apis mellifica kaffra* Jack 1916: 397. *Lapsus calami*. [*scutellata* Lepeletier de Saint Fargeau]
- Apis mellifera caucasica* Gorbachev 1916: 39. Unjustified emendation. [*caucasia* Pollmann]
- Apis mellifica* variety *banatica* Grozdanic 1926: 57. [*carnica* Pollmann]
- Apis fasciata* Baldensperger 1928: 173. *Lapsus calami*. [*lamarckii* Cockerell]
- Apis eurasiatica* Skorikov 1929a: 14. Unjustified replacement name for *Apis mellifica* variety *remipes* Gerstäcker 1862. [*remipes* Gerstäcker]
- Apis mellifera mellifera* natio *tesquorum* Skorikov 1929a: 29. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*artemisia* Engel]
- Apis mellifera remipes* natio *absuatna* Skorikov 1929a: 32. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*remipes* Gerstäcker]
- Apis mellifera remipes* natio *siganica* Skorikov 1929a: 32. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*remipes* Gerstäcker]
- Apis mellifera remipes* natio *georgica* Skorikov 1929a: 32. Proposed as new again in Skorikov (1929b). Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*remipes* Gerstäcker]
- Apis meda* Skorikov 1929b: 253. [*meda* Skorikov]
- Apis mellifera natio acervorum* Skorikov 1929b: 253. Preoccupied (*nec* Linnaeus 1758). [*artemisia* Engel]
- Apis remipes transcaucasica* Skorikov 1929b: 254. [*remipes* Gerstäcker]
- Apis remipes transcaucasica* natio *absuana* Skorikov 1929b: 254. *Lapsus calami*. [*remipes* Gerstäcker]
- Apis remipes transcaucasica* natio *iberica* Skorikov 1929b: 254. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*remipes* Gerstäcker]
- Apis remipes armeniaca* Skorikov 1929b: 254. [*remipes* Gerstäcker]
- Apis mellifera banata* Skorikov 1929b: 263. Unjustified emendation. [*carnica* Pollmann]
- Apis* (*Apis*) *syriaca* Skorikov 1929b: pl. 1. First available usage. [*syriaca* Skorikov]
- Apis mellifica* variety *sahariensis* Baldensperger 1932: 829. [*sahariensis* Baldensperger]
- Apis niger* Baldensperger 1932: 830. *Nomen nudum*. [*? mellifera* Linnaeus]
- Apis mellifera mingrelia* Lavrezhin 1935: 656. *Nomen nudum*. [*remipes* Gerstäcker]
- Apis mellifera taurica* Alpatov 1935: 665. Proposed as new again in Alpatov (1938). [*taurica* Alpatov]
- Apis* (*Apis*) *intermissa* Maa 1953: 591. First available usage [*intermissa* Maa].
- Apis* (*Apis*) *mellifera anatoliaca* Maa 1953: 599. [*anatoliaca* Maa]

- Apis mellifera siriaca* Kerr and Amaral 1960: 12. *Lapsus calami*. [syriaca Skorikov]
- Apis mellifera monticola* Smith 1961a: 258. Proposed as new again in Smith (1961b). [monticola Smith]
- Apis mellifera litorea* Smith 1961a: 259. Proposed as new again in Smith (1961b). [litorea Smith]
- Apis mellifera lamarchii* Smith 1961b: 148. *Lapsus calami*. [lamarckii Cockerell]
- Apis mellifica* Goetze 1964: 9. *Lapsus calami*. [mellifera Linnaeus]
- Apis mellifica intermissa tellica* Goetze 1964: 25. *Nomen nudum*. See also below. [intermissa Maa]
- Apis mellifica mellifica silvarum* Goetze 1964: 26. *Nomen nudum*. See also below. [mellifera Linnaeus]
- Apis mellifica lamarcki* Ruttner 1968: 41. Unjustified emendation. [lamarckii Cockerell]
- Apis mellifica adami* Ruttner 1975: 271. Proposed as new again in Ruttner (1980) with the species called *mellifera*. [adami Ruttner]
- Apis mellifera major* Ruttner 1976a: 354. [intermissa Maa]
- Apis mellifera nubica* Ruttner 1976a: 359. [jemenitica Ruttner]
- Apis mellifera littorea* Ruttner 1976a: 361. *Lapsus calami*. [litorea Smith]
- Apis mellifera jemenitica* Ruttner 1976a: 366. [jemenitica Ruttner]
- Apis mellifera carpatica* Barac 1977: 270. [carnica Pollmann]
- Apis mellifera anatolia* Winston 1987: 12. *Lapsus calami*. [anatoliaca Maa]
- Apis mellifera yemenitica* Ruttner 1988: 212. Unjustified emendation. [jemenitica Ruttner]
- Apis mellifera sudanensis* Ruttner 1988: 214. *Nomen nudum* (see below). [jemenitica Ruttner]
- Apis mellifera iberica* Ruttner 1988: 236. Preoccupied (*nec* Skorikov 1929b, Goetze 1964: see treatment of *A. mellifera* subspecies below); corrected authorship. [iberiensis Engel]
- Apis mellifera macedonica* Ruttner 1988: 249. [macedonica Ruttner]
- Apis mellifera logustica* Kugler 1988: 268. *Lapsus calami*. [ligustica Spinola]
- Apis mellifica rodopica* Petrov 1991: 17. Proposed as new again in Petrov (1996). [macedonica Ruttner]
- Apis mellifera* Willis, Winston, and Honda 1992: 169. *Lapsus calami*. [mellifera Linnaeus]
- Apis mellitera* Petrov 1993: 36. *Lapsus calami*. [mellifera Linnaeus]
- Apis mellifica capratia* Petrov 1996: 58. *Lapsus calami*. [carnica Pollmann]
- Apis mellifera bandasii* Radloff and Hepburn 1997: 57. *Nomen nudum* (see below). [jemenitica Ruttner]
- Apis mellifera ruttneri* Sheppard, Arias, Grech, and Meixner 1997 [1998]: 290. [ruttneri Sheppard et al.]
- Apis mellifera artemisia* Engel 1999: see below. Replacement name for *Apis mellifera acervorum* Skorikov 1929b (*nec* Linnaeus 1758). [artemisia Engel]
- Apis mellifera iberiensis* Engel 1999: see below. Replacement name for *Apis mellifera iberica* Ruttner 1988 (*nec* Skorikov 1929b). [iberiensis Engel]
- Apis mellifera sossimai* Engel 1999: see below. Replacement name for *Apis cerifera* Gerstäcker 1862 (*nec* Scopoli 1770). [sossimai Engel]

Comments.—The term “natio” as used by Skorikov (1929a, b) appears to be synonymous with “variety” as used by other authors.

Both Maa (1953) and Goetze (1964) include the name *A. domestica* Ray (1710) in their taxonomic treatment of the western honey bee. This is a pre-Linnean name and it is therefore excluded from zoological nomenclature (I.C.Z.N. 1985: Art. 3) and my treatment above.

It might be interpreted from my treatment of Pollmann's names above that *A. mellifida* as used by this author was not a *lapsus calami* but in actuality an unjustified emendation due to the fact that it appears to have been used twice (under *mellifida* and *mellifida caucasia*). This is not the case. The name *mellifida* was only used once in Pollmann's (1889) work in the proposal of the variety *caucasia*. It appears twice in my list since two taxonomic entities are involved in this one action by Pollmann; one as the *lapsus calami mellifida* and the second for the proposal of the variety (now subspecies) *caucasia*.

Maa (1953) and Dalla Torre (1896) both cite the name *A. ligurica* with one author attributing it to Tegetmeier (1859) and the other to that paper as well as to Tegetmeier (1860). Interestingly enough neither

of Tegetmeier's contributions use this name. Tegetmeier's 1859 paper, the purported first usage of the epithet, is merely an untitled note about an exhibition of *Apis* specimens at a meeting of the Entomological Society of London and simply reads, "Mr. Tegetmeier exhibited specimens of *Apis ligustica*, of which he had lately received living examples of the queen and workers from the Continent, where it is considered a more profitable species to the owner than the common honey bee; he hoped, during the next season, to test the correctness of this opinion." Tegetmeier (1860), a similarly untitled note from a societal meeting, is merely a follow up to his 1859 notice and uses the name *A. ligustica* as well (not *A. ligurica*). A perusal of other issues of the *Proceedings of the Entomological Society of London* failed to find any usage of *A. ligurica*, and it would therefore appear that the first appearance of such a name was in Dalla Torre's catalog (1896).

The name *mingrelica* was used by Lavrezhin (1935) and attributed to Skorikov (1929a); however, Skorikov did not propose such a specific epithet. Skorikov (1929a: 32, 41, 44) used the name

МИНГРЕЛЬСКАЯ

only in Russian and as part of a vernacular name (it even has a Russian adjectival ending which changes in the text as the case of the noun it modifies changes), never once proposing it as a latinized taxonomic entity with a description. The same can be said for several of the *nomina nuda* listed by Goetze (1964); these being *silvarum* attributed to Alpatov (1935), *tellica* attributed to Buttell-Reepen (1906), and *usuriensis* attributed to Lawrjochin (1960). These names, as used by Goetze (op. cit.), are also excluded from nomenclature owing to the fact that they are infrasubspecific names proposed after 1960 (I.C.Z.N. 1985: Art. 1b and 45e-g).

Radloff and Hepburn (1997) employ the subspecific names *bandasii* (attributed to

Mogga) and *sudanensis* (attributed to Rashad) both of which are *nomina nuda*. I failed to find in publications of Rashad available to me any official proposal of a subspecies with the latinized name *sudanensis* that would satisfy the rules of nomenclature, although many of his papers mention the Sudanese bees as variable and distinctive (e.g., Rashad and El-Sarrag 1978). Ruttner (1988) also employs the name *sudanensis* (attributing it to an unpublished manuscript by Rashad) and thus it is a *nomen nudum* with Ruttner apparently being the correct author. The name *bandasii*, however, was proposed by Mogga (1988) and would meet the appropriate criteria except that this name was only treated in his unpublished Master's thesis, is therefore excluded from zoological nomenclature [I.C.Z.N., 1985: Art. 9(11)], and means that its use by Radloff and Hepburn (op. cit.) is a *nomen nudum*. Both of these names were once again used by Hepburn and Radloff (1998) although they were only mentioned as synonyms of *jemenitica* in their consideration of African races, a synonymy considered amply justified by both Ruttner (1988) and myself (above).

This seems an appropriate venue to comment on the apparent confusion of the valid name for this species. The persistent use of the unjustified replacement name *A. mellifica* by some modern authors is distressing and either demonstrates a general ignorance of taxonomic rules or a flagrant dismissal of the International Code of Zoological Nomenclature. Ignorance of the Code is understandable as not all biologists are intimately familiar, or even have an express need to be so familiar, with its rules and nuances. Dismissal of the Code is, however, a more serious situation. The criticism that the name *mellifica* is more descriptive than *mellifera* is beside the point and, if the argument of Benton (1904) is followed, vastly incorrect anyway. Suffice to say, the use of *A. mellifera* versus *A. mellifica* is not a matter of

personal choice. *Apis mellifera* is the only valid name for this species and authors should abide by this.

Distribution.—The western honey bee presumably arose in the Near East or Pontocaspian regions at some point during the early Pliocene. This species subsequently dispersed throughout Africa and Madagascar (entering via the Arabian Peninsula), into Europe, and into North-western Asia as far as the Russian Steppes. Localized adaptation gave rise to the numerous subspecies which are recognized today. Spread of this species elsewhere in the world has been through the action of human interference. Refer to treatment of individual subspecies for further details.

Apis mellifera was introduced into the New World by European settlers during their colonization of the western hemisphere. Although some early authors felt that that North American honey bees were specifically distinct from the European honey bees (e.g., Belknap 1792) it was quickly recognized by naturalists of the time that *Apis* was not native to the New World (e.g., Barton 1793), a belief confirmed by their discussions with the Native American populace. In fact, President Thomas Jefferson commented that the Native Americans referred to the honey bees as "the white man's fly" (Jefferson 1787) and signaled to them the advance of colonists. Early reports that honey bees occurred in the New World (Hernandez 1648) were based on misidentifications with species of *Melipona* (Gerstäcker 1863). Most early authors correctly referred to the transport of honey bee colonies from Europe by colonists (e.g., Josselyn 1674). Despite the arguments raging in the late 1700's over the "distinctiveness" and nativity of *A. mellifera* in the Americas, no names were proposed for them.

Apis (Apis) nigrocincta Smith

The Sulawesi Honey Bee

Apis nigrocincta Smith 1861a: 93.

Apis mellifica indica variety *picea* Buttel-Reepen

1906: 193. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c).

Apis (Sigmatapis) nigrocincta marginella Maa 1953: 575.

Comments.—Although I have previously been hesitant to recognize this species as distinct from *A. cerana* (e.g., Engel 1998a), I here correct this following the excellent work of Hadisoesilo *et al.* (1995), Hadisoesilo and Otis (1996, 1998), and Hadisoesilo (1997). The absence of a pore in the drone cell cap is a plesiomorphic feature of *Apis* in general and for the *cerana*-clade in particular (Fig. 1). *Apis nigrocincta* is the only member of the *cerana*-clade to lack this feature. The apomorphic presence of such a pore unites *A. cerana* and *A. koschevnikovi*. No subspecies are recognized in *A. nigrocincta*.

Distribution.—This species only occurs on the island of Sulawesi except in the extreme southwest corner in a lower elevation band from a bit northwest of Ujung Padang around to Bulukumba and beyond (G. W. Otis pers. comm.). Previous records of this species on Mindanao (Otis 1996, Damus and Otis 1997) are probably *A. cerana* as revealed by the development of the drone cell which had a hard cap with a pore (G. W. Otis pers. comm.), this being a feature of *A. cerana* and not *A. nigrocincta* (Hadisoesilo and Otis 1998). Populations of Mindanao are certainly distinctive from typical *A. cerana* and need to be investigated further.

Subgenus *Megapis* Ashmead

Megapis Ashmead 1904: 120. Type species: *Apis dorsata* Fabricius 1793, original designation. Maa 1953: 552.

Diagnosis.—WORKER: Forewing length 12–15 mm. Basal vein frequently gently curved, strongly distad cu-a (similar to Fig. 4). Angle of posteroapical margin of first submarginal cell less than 45°. Distal abscissa of vein M in hind wing present (similar to Fig. 4). DRONE: Hind basitarsus without thumb-like process. Vertical

arm of T8 as long as horizontal arm; S7 and S8 not fused mesally. Gonobase absent. Ventral gonocoxa membranous; dorsal gonocoxa reduced. Ventral cornua of endophallus not recurved ventrally. MATURE LARVA: Labrum with peg-like setae scattered over surface. Galea larger than maxillary palpus. Labial palpus spiculate. Epipharynx without setae. Atrial inner walls ridged. ETHOLOGY: Nest constructed in the open. Dance language performed on vertical surface; wagging metasoma held above dance surface; recruits potentially far from dancer's metasoma (potentially outside a near field sound range). Drone cell cap without pore.

Apis (Megapis) dorsata Fabricius

The Giant Honey Bee

- Apis dorsata* Fabricius 1793: 328. [*dorsata* Fabricius]
Apis nigripennis Latreille 1804b: 170. [*dorsata* Fabricius]
Apis bicolor Klug 1807: 264. Preoccupied (*nec* Fabricius 1781, Villers 1789). [*dorsata* Fabricius]
Apis testacea Smith 1858: 49. [*dorsata* Fabricius]
Apis zonata Smith 1859: 8. Preoccupied (*nec* Linnaeus 1758). [*binghami* Cockerell]
Apis laboriosa Smith in Moore et al. 1871: 249. [*laboriosa* Smith]
Apis testacea Smith 1871: 396. *Lapsus calami*. [*dorsata* Fabricius]
Megapis zonata (Smith); Ashmead 1904: 121. [*binghami* Cockerell]
Megapis dorsata (Smith); Ashmead 1904: 121. [*dorsata* Fabricius]
Apis dorsata binghami Cockerell 1906: 166. Replacement name for *Apis zonata* Smith 1859. [*binghami* Cockerell]
Apis binghami sladeni Cockerell 1914: 13. [*laboriosa* Smith]
Apis darsata Baldensperger 1928: 173. *Lapsus calami*. [*dorsata* Fabricius]
Apis himalayana Maa 1944: 4. *Nomen nudum*. [*laboriosa* Smith]
Megapis breviligula Maa 1953: 563. [*breviligula* (Maa)]
Megapis binghami (Cockerell); Maa 1953: 564. [*binghami* Cockerell]
Megapis laboriosa (Smith); Maa 1953: 570. [*laboriosa* Smith]

Apis dorsata Ruttner 1988: 118. *Lapsus calami*. [*dorsata* Fabricius]

Apis labortiosa Willis, Winston, and Honda 1992: 169. *Lapsus calami*. [*laboriosa* Smith]

Distribution.—Refer to treatment of individual subspecies below.

Subgenus *Micrapis* Ashmead

Micrapis Ashmead 1904: 122. Type species: *Apis florea* Fabricius 1787, monobasic and original designation. Maa 1953: 557.

Diagnosis.—WORKER: Forewing length 6–7 mm. Basal vein frequently gently curved, strongly distad cu-a (similar to Fig. 4). Angle of posteroapical margin of first submarginal cell less than 45°. Distal abscissa of vein M in hind wing absent. DRONE: Hind basitarsus with thumb-like process. Vertical arm of T8 as long as horizontal arm; S7 and S8 not fused mesally. Gonobase represented by isolated fragments. Ventral gonocoxa sclerotized as transverse bar; dorsal gonocoxa not reduced. Ventral cornua of endophallus not recurved ventrally. MATURE LARVA: Labrum with peg-like setae scattered over surface. Galea larger than maxillary palpus. Labial palpus spiculate. Epipharynx with setae. Atrial inner walls ridged. ETHOLOGY: Nest constructed in the open. Dance language performed on horizontal surface; wagging metasoma held above dance surface; recruits potentially far from dancer's metasoma (potentially outside a near field sound range). Drone cell cap without pore.

Apis (Micrapis) andreniformis Smith

The Black Dwarf Honey Bee

- Apis andreniformis* Smith 1858: 49.
Apis florea andreniformis variety *sumatrana* Enderlein 1906: 339. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c).
Micrapis andreniformis (Smith); Maa 1953: 601.

Comments.—This species was reinstated just over a decade ago by Wu and Kuang (1986, 1987) with additional evidence for this decision provided by Wongsiri et al.

(1989). It's common name comes from the nearly black T1-2 while in *A. florea* these structures are reddish brown. No subspecies are recognized.

Distribution.—*Apis andreniformis* occurs as far north as southern-most Yunnan Province in China, south into Malaysia, eastward on the mainland to the coast of Vietnam, and westward as far as north-western India along the eastern border of Nepal. Although specimens are not recorded from Bhutan, Cambodia, Myanmar, or Nepal the records of *A. andreniformis* in the Bengal, Sikkim, and Assam regions of India suggests that it will eventually be found in these countries (Otis 1996) unless it has since become locally extinct.

Apis (Micrapis) florea Fabricius

The Red Dwarf Honey Bee

Apis florea Fabricius 1787: 305.

Apis semirufa Hoffmannsegg 1818: 60.

Apis lobata Smith 1854: 416.

Apis floralis Horne and Smith 1870: 181. *Lapsus calami*.

Apis testacea Bingham 1898: 129. Preoccupied (*nec* Smith 1858).

Micrapis florea (Fabricius); Ashmead 1904: 122. [see Comments below]

Apis florea variety *rufiventris* Friese in Buttel-Reepen 1906: 167, 170.

Apis florea florea variety *fuscata* Enderlein 1906: 338. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c).

Apis nursei Cockerell 1911a: 319. Replacement name for *Apis testacea* Bingham 1898.

Apis florea nasicana Cockerell 1911b: 241.

Comments.—Although when proposing the genus *Micrapis* Ashmead (1904) did not explicitly transfer the type species, *A. florea*, into this genus (he still referred to the species as *A. florea* and not *Micrapis florea*) he is to be considered as having made the combination as the proposal of *Micrapis* was done prior to 1961 [I.C.Z.N. 1985: Art. 51c(ii)]. There are presently no subspecies recognized in *A. florea*.

Distribution.—This species is distributed

from the eastern regions of the Arabian Peninsula, through southern Iran and Iraq to Pakistan and India as far north as the Himalayan uplift. The species extends eastward as far as Vietnam, north to Yunnan Province, China, and south into Indonesia. Refer to Otis (1996) for more precise locality records. *Apis florea* was introduced into Sudan a little over a decade ago from Pakistan and has become established (Lord and Nagi 1987, Mogga and Ruttner 1988).

SUBSPECIES

Owing to both the high visibility and dramatic geographic variation of the honey bees, the more common species have been heavily divided infraspecifically. Below I have attempted to outline the presently recognized subspecies. There are no valid subspecies of *A. andreniformis*, *A. florea*, *A. koschevnikovi*, or *A. nigrocincta* and I have not recognized any subspecies among the fossil forms. A few of the names treated below are used incorrectly under the rules of zoological nomenclature (I.C.Z.N. 1985) and are therefore treated in further detail, otherwise I have not given detailed taxonomic histories for each subspecies. I have tried to provide common names for these morphs as well as historical, geographical, or important biological comments for some taxa.

As far as I have been able to ascertain, holotypes or neotypes have not been designated for certain subspecies. This will be necessary to assure stability in nomenclature. The general problems with the recognition of subspecies have been discussed by several authors, the best critique being that by Wilson and Brown (1953). My recommendation is a complete cessation of proposals of new subspecies in *Apis* (primarily *A. mellifera*) until the taxonomy has been more thoroughly examined (something which I hope this paper will facilitate).

Apis (Apis) cerana Fabricius

The populations of *A. cerana* in the Philippines are somewhat distinctive (e.g., Ruttner 1988, Smith 1991b, Smith and Hagen 1996, Damus and Otis 1997) and could possibly be elevated to subspecific status. If this is done the name of this race would become *A. cerana philippina* Skorikov with *A. samarensis* Maa as a junior synonym.

1. *Apis cerana cerana* Fabricius: The Eastern Honey Bee

Distribution.—This subspecies occurs as far east as Afghanistan and south along the central deserts and mountain ranges. Along the Himalayan uplift in Tibet it is replaced by *A. cerana skorikovi* and further south in India it is replaced by *A. cerana indica*. The subspecies then ranges across most of central and southern China although not in the high regions of central China where the black bee (*A. cerana heimifeng*) occurs. *Apis cerana cerana* then ranges along the eastern edge of Asia up to Korea and the southern-most areas of the former Soviet Union (Ussuria) and south to the northern reaches of Vietnam.

2. *Apis cerana heimifeng* Engel, new subspecies: The Black Chinese Honey Bee

Apis cerana, *Aba* race, Peng *et al.* 1989: 15.

Diagnosis.—Distinguishable from typical *A. cerana cerana* in China by the dark brown to black scutellum and T3-4 (these are yellow in *A. cerana cerana*). In this respect it resembles the Tibetan Honey Bee, *A. cerana skorikovi*, from which it differs in the larger body size (body length 12.5–13.7 mm; forewing length 8.8–9.3 mm) and low tendency to swarm (very strong in *A. cerana skorikovi*). This is the largest *A. cerana* race in China and is a relatively dark bee (hence its common name) with a dark metasoma, scutellum, and legs. This dark coloration is partly owing to the very narrow to completely absent bands of orange on T3-5. Peng *et al.* (1989) provide several

morphometric measures for this bee (as "*Aba* race").

Distribution.—This is a distinctive race in central China and occurs in relatively high elevation areas (although certainly not at the highest points for this region) mostly near river valleys. Its general distribution is in northern Sichuan Province, southwestern Gansu Province, and eastern Qinghai Province.

Holotype.—Worker; CHINA: [Northern Sichuan Province], Nanping, 21 April 1920 (deposited in the American Museum of Natural History, New York).

Etymology.—The specific epithet is derived from the Mandarin words *hei* (meaning "dark") and *mifeng* (meaning "honey bee") and refers to the dark coloration of this race. The name is a noun in apposition.

3. *Apis cerana indica* Fabricius: The Indian Honey Bee

Distribution.—This race occurs through most of India except in the higher regions towards the north where it is replaced by *A. cerana cerana* or in Tibet by *A. cerana skorikovi*.

4. *Apis cerana japonica* Radoszkowski: The Japanese Honey Bee

Distribution.—This race occurs on the islands of Japan.

5. *Apis cerana javana* Enderlein: The Javanese Honey Bee

Comments.—The taxa described as *A. peroni* by Latreille (1804b) and *A. gronovii* by Guillaou (1841) may be the same as Enderlein's *A. cerana javana*. Owing to this uncertainty I have for now retained *A. cerana javana* as the name of this taxon and considered *A. peroni* and *A. gronovii* to be *A. cerana indica*. Researchers, however, should be aware of this uncertainty and if the consubspecific nature of these taxa is confirmed in the future, then the name of the subspecies would have to be changed to *A. cerana peroni* with *gronovii* and *javana*

as junior synonyms. This situation was also noted by Maa (1953: 580). If this unfortunately turns out to be the case, then it would probably be advisable to petition the I.C.Z.N. to suppress *A. peroni* and *A. gronovii* in favor of *A. cerana javana* although such a case would not be a very strong one owing to the fact that *A. peroni* has been in use within the last 50 years (e.g., Maa 1953).

Distribution.—This subspecies is presently known from Java and as far east as Timor.

6. *Apis cerana johni* Skorikov: The Sumatran Honey Bee

Distribution.—This subspecies only occurs on the island of Sumatra.

7. *Apis cerana nuluensis* Tingek, Koeniger, and Koeniger: The Malaysian Mountain Honey Bee

Distribution.—This morph occurs in the mountains of Sabah, Malaysia. Otis (1996) provides details of various collection locales in Malaysia.

8. *Apis cerana skorikovi* Engel, new subspecies: The Himalayan Honey Bee

Apis cerana skorikovi Maa 1944: 4. *Nomen nudum*.
Apis cerana, Himalaya race, Ruttner 1988: 121, 158.

Apis cerana, Xizang race, Peng *et al.* 1989: 15.
Apis cerana himalaya Smith 1991b: 154. *Nomen nudum*.

Diagnosis.—This race is fairly gray in overall body coloration, some areas being slightly more yellow while others are closer to black (e.g., T4 is entirely black) and with paired yellow spots on S3. There are distinctive white hairs on the terga which contribute to the overall grayish appearance. *Apis cerana skorikovi*, like *A. cerana heimifeng*, also differs from *A. cerana cerana* (as well as *A. cerana indica* and other subspecies) in the dark scutellum and slightly larger size (body length around 12.2 mm; forewing length around 8.75 mm). Addi-

tional morphometric values are provided by Peng *et al.* (1989).

Comments.—The Himalayan race of *A. cerana* (sometimes called the Tibetan race) was referred to as *A. cerana skorikovi* by Maa (1944); however he never provided a description for this subspecies. Many authors have subsequently recognized this race as distinctive but never associated a name with the numerous descriptions simply referring to this taxon as the Tibetan honey bee (among other common names). Peng *et al.* (1989) have done the best to characterize and describe this taxon referring to it as the Xizang race (Xizang is Chinese for Tibet, sometimes spelled Sitsang). I here validate the name *A. cerana skorikovi* for this taxon, referring readers to the diagnosis provided above as well as the descriptive comments given by Peng *et al.* (1989: as "Xizang race") and Ruttner (1988: as *A. cerana* "Himalaya race"). Smith (1991b) referred to this race as *A. cerana himalaya* making a Latin name out of Ruttner's "*A. cerana* Himalaya race". Ruttner's name was not used as, nor intended as, a scientific name and *A. cerana himalaya* as used by Smith (1991b) is a *nomen nudum*.

Distribution.—This subspecies occurs along the Himalayan uplift at elevations of 1900–4000 meters.

Holotype.—Worker; NEPAL: Ko Pasi near Panauti, 19 March 1982, B. A. Underwood (deposited in the Cornell University Insect Collection, Ithaca).

Paratypes.—Three workers, same collection data as holotype, deposited in the same collection as the holotype; two workers, same collection data as holotype, deposited in the American Museum of Natural History, New York.

Etymology.—I have retained the specific epithet used by Maa (1944) for this race. The epithet is a patronymic honoring Dr. A. S. Skorikov who did much work on the classification of bees; honey bees and bumble bees in particular.

Apis (Apis) mellifera Linnaeus

The western honey bee, *A. mellifera*, is remarkable for its geographic variation and, for this reason, has been broken into a plethora of taxonomic entities over the past two centuries. In earlier studies these forms were often treated as distinct species; however, today they are recognized as subspecies of a single variable species.

1. *Apis mellifera adami* Ruttner: The Cretan Honey Bee

Comments.—No type has been designated for this race. Ruttner's specimens are among the collection of the Institut für Bienenkunde in Oberursel, Germany. A single worker from this material should be selected as the lectotype and the others designated as paralectotypes.

Distribution.—This race occurs on the island of Crete in the Mediterranean Sea.

2. *Apis mellifera adansonii* Latreille: The West African Honey Bee

Distribution.—This subspecies has a wide distribution in western Africa ranging from Niger in the north, east to Senegal, and as far south as Zaire.

3. *Apis mellifera anatoliaca* Maa: The Anatolian Honey Bee

Distribution.—This race occurs throughout Turkey, bordering with *A. mellifera macedonica* in the European portion of that country. In the east, *A. mellifera anatoliaca* borders with *A. mellifera caucasica* and *A. mellifera remipes* in the area of Azerbaijan, Armenia, and Georgia and with *A. mellifera meda* in the southeastern-most regions of Turkey.

4. *Apis mellifera artemisia* Engel, new name: The Russian Steppe Honey Bee

Apis mellifera mellifera natio tesquorum Skorikov 1929a: 29. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c).

Apis mellifera acervorum Skorikov 1929b: 253. Preoccupied (*nec* Linnaeus 1758).

Etymology.—Named for Artemis (Greek; Diana in Roman mythology), the goddess for whom the honey bee was a symbol and whose temple at Ephesus, the Artemisium, was listed by Callimachus of Cyrene and Philo of Byzantium as one of the seven wonders of the world.

Distribution.—This race occurs in the central Russian Steppes.

5. *Apis mellifera capensis* Eschscholtz: The Cape Honey Bee

Comments.—This subspecies is biologically distinctive for its ability to undergo parthenogenetic reproduction when deprived of a queen (Jack 1916, Anderson 1963, Ruttner 1977).

Distribution.—As is indicated by the name of this race, it occurs in the Cape region of South Africa.

6. *Apis mellifera carnica* Pollmann: The Carniolan Honey Bee

Distribution.—This European race occurs south of the Alps, east into northern Italy, and west into Yugoslavia and Romania.

7. *Apis mellifera caucasica* Pollmann, reinstated name: The Caucasian Honey Bee

Apis mellifida [sic] variety *caucasica* Pollmann 1889: 90.

Apis mellifera caucasica Gorbachev 1916: 39. Unjustified emendation.

Distribution.—This race occurs in the Caucasus Mountains. It is sometimes referred to as the "grey" Caucasian honey bee.

8. *Apis mellifera cecropia* Kiesenwetter: The Greek Honey Bee

Distribution.—This race occurs throughout most of Greece and surrounding Aegean islands. It borders *A. mellifera macedonica* in the northeast regions of Greece and *A. mellifera carnica* in the northwest corner of the country.

9. *Apis mellifera cypria* Pollmann: The Cyprian Honey Bee

Distribution.—This race is presently known only from the island of Cyprus.

10. *Apis mellifera iberiensis* Engel, new name: The Iberian Honey Bee

Apis mellifica intermissa iberica Goetze 1964: 25. Infrasubspecific name proposed after 1960 and therefore unavailable (I.C.Z.N. 1985: Art. 1b); preoccupied (*nec* Skorikov 1929b).

Apis mellifera iberica Ruttner 1988: 236. Corrected authorship (first available usage); preoccupied (*nec* Skorikov 1929b).

Comments.—Goetze (1964) proposed this form as a variety of the subspecies *intermissa*. Since this is a varietal name (i.e., infrasubspecific) proposed after 1960 it is unavailable and does not enter into zoological nomenclature (I.C.Z.N. 1985: Arts. 1b and 45e–g). The first correct application of this name as a subspecies was by Ruttner (1988) which thereby validates the name to that author. Unfortunately, a further complication arises as the name is a primary junior homonym of an available name proposed by Skorikov (1929b) for another type of honey bee from Azerbaijan. Since no type exists for Ruttner's subspecies I here designate a neotype for *A. mellifera iberica*, the name of which will be replaced by *A. mellifera iberiensis*.

Neotype.—Worker; SPAIN: Córdoba, Andalusia, September 1986, D. Smith and R. Hagen; now with additional labels reading "NEOTYPE, *Apis mellifera iberica* Ruttner, desig. M. S. Engel, 1999" and "*Apis mellifera iberiensis* Engel" (deposited in the Snow Entomological Collection, Natural History Museum, University of Kansas, Lawrence). Three additional workers, identical to the neotype, have also been deposited with the University of Kansas and the American Museum of Natural History, New York.

Etymology.—The new subspecific epithet refers to the distribution of this subspecies on the Iberian Peninsula.

Distribution.—This race natively occurs on the Iberian Peninsula in Europe. Colonies were transferred to the South American tropics several decades ago, prior to the introduction of *A. mellifera scutellata*, but populations never became established.

Two ecotypes of *A. mellifera iberiensis* occur in Spain as shown by Santiago *et al.* (1986) as well as two mitochondrial types as demonstrated by Smith *et al.* (1991) and Smith and Glenn (1995). The neotype selected above comes from the Córdoba populations sampled by Smith and Glenn (1995: their colony 1-1).

11. *Apis mellifera intermissa* Maa, corrected authorship: The Tellian Honey Bee

Comments.—As was noted in the taxonomic history of *A. mellifera*, the name *intermissa* as used by Buttel-Reepen (1906) is unavailable for the same reasons as presented for Buttel-Reepen's name *koschevnikovi* (see Comments for *A. koschevnikovi*). The name of this subspecies was first made available by Maa (1953).

Distribution.—This race has a tight distribution along the northern coast of Africa as far west as Morocco, into Tunisia in the east, but bordered by the Atlas range in the south.

12. *Apis mellifera jemenitica* Ruttner, reinstated name: The Arabian or Nubian Honey Bee

Apis mellifera nubica Ruttner 1976a: 359.

Apis mellifera jemenitica Ruttner 1976a: 366.

Apis mellifera yemenitica Ruttner 1988: 212. Unjustified emendation.

Apis mellifera sudanensis Ruttner 1988: 214. *Nomen nudum*. Corrected authorship.

Apis mellifera bandasii Radloff and Hepburn 1997: 57. *Nomen nudum*. Corrected authorship.

Comments.—Ruttner (1988) synonymized *A. mellifera jemenitica* with *A. mellifera nubica* and acting as first reviser (I.C.Z.N. 1985: Art. 24) gave *jemenitica* priority over *nubica*. In addition, the name *je-*

menitica was unnecessarily emended from its original spelling. The correct name of this taxon should be *A. mellifera jemenitica*, not *yemenitica*.

No type has been designated for this race. See comments under *A. mellifera adami* for location of Ruttner's original material.

Distribution.—This subspecies of small bees occurs in hot arid zones of eastern Africa and the Arabian Peninsula. Countries in which it occurs include Chad, Oman, Saudi Arabia, Somalia, Sudan, and Yemen.

13. *Apis mellifera lamarekii* Cockerell:
The Egyptian Honey Bee

Distribution.—This honey bee race occurs in a narrow range along the Egyptian Nile Valley.

14. *Apis mellifera ligustica* Spinola: The Italian Honey Bee

Distribution.—This subspecies occurs along the Italian Peninsula although it has been commercially transported throughout the world. The bees currently distributed in Italy have hybridized much with *A. mellifera mellifera* and *A. mellifera carnica* in the north. In fact, untainted populations of *A. mellifera ligustica* appear to be confined to Kangaroo Island, Australia where they are being maintained as an unhybridized strain (Ruttner 1976b). I recently (January 1999) had the opportunity to visit Kangaroo Island and to see one of these colonies.

15. *Apis mellifera litorea* Smith: The East African Honey Bee

Comments.—This name was originally proposed by Smith (1961a) but was also proposed as new by Smith (1961b). No type appears to have been designated for this subspecies.

Distribution.—This subspecies is distributed along the eastern coast of tropical Africa occurring from Kenya (perhaps even

the southern-most portions of Somalia) south to Mozambique.

16. *Apis mellifera macedonica* Ruttner:
The Macedonian Honey Bee

Apis mellifera macedonica Ruttner 1988: 249.

Apis mellifica rodopica Petrov 1991: 17. **New synonymy.**

Comments.—No type has been designated for this race. See comments under *A. mellifera adami* for location of Ruttner's original material. The name *rodopica* was proposed again as new by the same author five years later (Petrov 1996). There appears to have been no type designated for Petrov's race either.

Distribution.—This subspecies occurs as far north as southern Romania, east to Yugoslavia, and south to northern Greece where it borders *A. mellifera cecropia*. In the Carpathian Mountains and in Yugoslavia it borders *A. mellifera carnica*.

17. *Apis mellifera meda* Skorikov: The Median Honey Bee

Distribution.—This race is most common in Iran and Iraq but does range into southeastern Turkey and northern Syria.

18. *Apis mellifera mellifera* Linnaeus:
The Western or European Honey Bee

Distribution.—This subspecies originally ranged throughout central Europe north of the Alps, as far south as southern France in the west, southern Sweden in the north, central Russia in the east, and on the British Isles. In the Ukraine there is a transition over the steppe region to *A. mellifera sossimai*.

19. *Apis mellifera monticola* Smith: The East African Mountain Honey Bee

Comments.—The name was first proposed by Smith (1961a) but was designated as new a second time in Smith (1961b). No type appears to have been designated for this subspecies.

Distribution.—This race occurs within the mountains of eastern Africa (e.g., in

Kenya and Tanzania). The occurrence of *A. mellifera monticola* in the mountains of Cameroon should be checked carefully.

20. *Apis mellifera remipes* Gerstäcker, reinstated name: The Yellow Armenian Honey Bee

Apis remipes Gerstäcker 1862: 61.

Apis mellifera armeniaca Skorikov 1929b: 254.

Comments.—The name *armeniaca* was subjectively chosen by Ruttner (1988: 192) over *remipes*. This decision is invalid because *remipes* has priority and the senior synonym must be recognized as the name for the subspecies.

Distribution.—This race occurs in Armenia and may be the same as *A. mellifera anatoliaca*, in which case Gerstäcker's name has priority for the subspecies.

21. *Apis mellifera ruttneri* Sheppard, Arias, Grech, and Meixner: The Maltese Honey Bee

Comments.—No type was originally designated for the subspecies but this is here corrected by the original authors thereby stabilizing the name of this taxon.

Lectotype.—Worker; MALTA: St. Julians, 10 August 1995, W. S. Sheppard; designation of W. S. Sheppard, M. C. Arias, A. Grech, and M. D. Meixner. The lectotype now bears a label indicating it as such and is deposited in the M. T. James Entomological Museum, Washington State University.

Paralectotypes.—Nine workers; same collection data as lectotype; deposited in the same collection as the lectotype. A further two paralectotype workers are deposited in the American Museum of Natural History, New York. All paralectotypes designated by W. S. Sheppard, M. C. Arias, A. Grech, and M. D. Meixner.

Distribution.—This race is only distributed on the island of Malta in the Mediterranean Sea.

22. *Apis mellifera sahariensis*

Baldensperger: The Saharan Honey Bee

Comments.—Ruttner (1988) attributed this name to Baldensperger (1923). He has, however, unfortunately confused recognition of the subspecific entity with taxonomic proposal of the subspecies. Although Baldensperger (1923) notes the distinctive character of the Saharan honey bees he does not provide a latinized name for them (in fact, nowhere in his work does he even mention the name *Apis*, let alone *sahariensis*). Instead Baldensperger (1923) only uses the vernacular name "l'abeille saharienne". Thus, as far as I have been able to determine, the name is first made taxonomically available by Baldensperger in his later paper (1932) where he uses the latinized name and provides a diagnosis.

This is one of the races for which I know that no type was ever designated; however I have not been able to confirm whether any material survives of Baldensperger's original colony which he brought back to France. I have therefore hesitated to designate a neotype. This race is markedly lighter in coloration, particularly on T1-3, than the more common *A. mellifera intermissa* (which has a noticeably shiny, dark brown to black integument with more sparse pubescence). See Ruttner (1988) for further descriptive details. It is possible that this race is synonymous with *A. mellifera lamarckii* in which case the name *lamarckii* has priority for the subspecies. This possibility should be closely examined in the future.

Distribution.—This race, like *A. mellifera intermissa*, has a tight range in northwestern Africa. It occurs along the southern side of the Atlas range.

23. *Apis mellifera scutellata* Lepeletier de Saint Fargeau: The African Honey Bee

Comments.—This is the race introduced into Brazil in the 1950's which has capti-

vated the apicultural world as well the imagination of the public; popularly known as the "Africanized Honey Bee" or "Killer Bee". An account of the transport of African bees to Brazil and their accidental release is given by Kerr (1957, 1967; see also Michener 1975, Spivak *et al.* 1991, Taylor 1977, 1985 for information on the introduction, spread, and effect of this race in the western hemisphere and for direction to other literature sources).

Distribution.—This subspecies also has a large distribution in Africa and ranges from South Africa northward along the eastern half of the continent to about Somalia, it apparently does not occur along the eastern coastal plain where *A. mellifera litorea* is found.

24. *Apis mellifera siciliana* Grassi, reinstated name: The Sicilian Honey Bee

Apis siciliana Grassi 1881: 1.

Apis mellifica mellifica variety *siziliana* Buttel-Reepen 1906: 168. Unjustified emendation.

Apis sicula Montagano 1911: 26.

Comments.—Ruttner's (1988) arbitrary choice of the epithet *sicula* over *siciliana* for the Sicilian race of honey bees does not meet the criterion of priority and thus the name *siciliana* must be reinstated for this morph.

Distribution.—This subspecies occurs on the island of Sicily in the Mediterranean Sea.

25. *Apis mellifera sossimai* Engel, new name: The Ukrainian Honey Bee

Apis cerifera Gerstäcker 1862: 60. Preoccupied (*nec* Scopoli 1770).

Etymology.—The new specific epithet is derived from St. Sossima, patron saint of beekeeping in the Ukraine. St. Sossima may be a Christian version of the bee-god Zosim of some early pagan tribes of Russia.

Distribution.—This race occurs along the eastern borders of *A. mellifera carnica*'s range. It occurs mostly in the Ukraine and

easterly over to the northern regions of the Caucasus Mountains where it borders *A. mellifera caucasia*. South in the Crimea it is replaced by *A. mellifera taurica*.

26. *Apis mellifera syriaca* Skorikov, corrected authorship: The Syrian Honey Bee

Comments.—As was noted in the taxonomic history of *A. mellifera*, the name *syriaca* as used by Buttel-Reepen (1906) is unavailable for the same reasons as presented for Buttel-Reepen's name *koschevnikovi* (see Comments for *A. koschevnikovi*). The name of this subspecies was first made available by Skorikov (1929b).

Distribution.—*Apis mellifera syriaca* occurs along the eastern shores of the Mediterranean Sea; north from Syria to the Negev Desert in the south. It is sometimes known as the Palestine honey bee.

27. *Apis mellifera taurica* Alpatov: The Crimean Honey Bee

Distribution.—This race occurs along the north-central shores of the Black Sea; in the Crimea.

28. *Apis mellifera unicolor* Latreille: The Malagasy Honey Bee

Distribution.—The distribution of this race in Madagascar is discussed by Brooks and Michener (1988).

***Apis (Megapis) dorsata* Fabricius**

Some authors prefer to recognize one or more of the *A. dorsata* races as distinct species. This is most often done with *A. dorsata laboriosa* followed by *A. dorsata breviligula* and to a much lesser degree with *A. dorsata binghami*.

1. *Apis dorsata binghami* Cockerell: The Giant Sulawesi Honey Bee

Distribution.—This race of giant honey bees occurs on the island of Sulawesi.

2. *Apis dorsata breviligula* (Maa): The Giant Philippine Honey Bee

Comments.—Since Maa (1953) originally proposed the name *breviligula* in the genus *Megapis* his name should be written in parentheses (I.C.Z.N. 1985: Art. 51c).

Distribution.—This morph of giant honey bees occurs in the Philippines. The species status of this race is oft argued based on nest site characteristics as reported by Morse and Laigo (1969: as *A. dorsata*) and Starr *et al.* (1987).

3. *Apis dorsata dorsata* Fabricius: The Common Giant Honey Bee

Distribution.—This subspecies has the largest distribution of the group; ranging from India, east to the coast of Vietnam, and into the southeast Asian islands where it is sometimes replaced by other subspecies (see accounts for *binghami* and *breviligula*).

4. *Apis dorsata laboriosa* Smith: The Giant Himalayan Honey Bee

Comments.—I currently do not recognize the subspecific form *laboriosa* as a separate species (see also Engel 1998a; but see Sakagami *et al.* 1980, Roubik *et al.* 1985, McEvoy and Underwood 1988, Underwood 1990a, b). Growing evidence, however, suggests that the distinction may be valid and my decision to place *laboriosa* within *dorsata* should be examined more closely. Sakagami *et al.* (1980) provided a detailed account of the morphology of *laboriosa* versus typical *dorsata*. Many of the characters they use to justify specific status are, however, quite variable (e.g., protuberance of the ocelli, general pubescence patterns, &c.) and across a large range of specimens blend naturally into one another except some measures of body size which I presently feel are more indicative of a subspecies rather than of a separate species. One character which appears to me to be somewhat reliable is the minute, broad medioapical extension of the grad-

ulus on S3 in *dorsata* while this is completely absent in *laboriosa*.

Distribution.—This subspecies is distributed at high altitudes (1,200 to 4,000 m) on the slopes of the mountains from northernmost India to the northernmost boundary of Laos. Further details of its distribution are provided by Otis (1996).

FOSSIL HONEY BEES

More paleontological work has focused on the honey bees than on any other group of bees. Recently I have treated some of these extinct species and attempted to place them into a phylogenetic framework with the living species (Engel 1998a: Fig. 1). Petrov (1992, 1997) also discussed *Apis* evolution with reference to the fossil record, in particular focusing on the origin of the Bulgarian honey bee (*A. mellifera rodopica* = *A. mellifera macedonica* in my system). Hong (1984) described a compression fossil from the Early Cretaceous of China as the oldest fossil bee and as a relative of *Apis*. Hong's *Palaeapis beiboziensis* is in actuality a sphecoid wasp (Michener 1997, Engel 1998a) and has no bearing on apine evolution. Lastly, Nel *et al.* (1999) presented a small review of fossil *Apis* specimens but overlooked the species presented by myself, recent treatments of Apini (e.g., Michener 1990), as well as the numerous synonymies within the group, instead simply regurgitating the classification of Zeuner and Manning (1976) which is fraught with errors (e.g., refer to Engel 1998a). Nel *et al.* (op. cit.) have also followed Zeuner and Manning (1976) and other authors in over splitting "species" of honey bees based on minor morphometric differences in wing venation and size (e.g., their unnamed species A-J: Nel *et al.* 1999); characters which distinguish mere subspecies in *Apis* at best. These authors concluded (p. 31) that the fossil honey bees could not be studied from a phylogenetic perspective; however, such an attempt had already been successfully undertaken at least three times previously (e.g., Buttel-

Reepen 1906, Statz 1931, Engel 1998a). I am presently involved in a monographic study of the fossil bees, particularly those from Baltic amber, and cladistic analyses have been successfully completed for the living and fossil corbiculate bees, including Apini (Engel 1998b, in prep.).

In order to maintain the monophyly of the generally recognized subgenera (recent and fossil) it seems appropriate to propose two new subgenera thereby breaking up the paraphyletic subgenus *Synapis*. One of these new groups was called *Hauffapis* by Armbruster (1938), but he failed to designate a type species for the genus, thereby making this name unavailable according to the I.C.Z.N. (1985: Art. 13c) (see also discussions in Michener 1990, 1997). None of the fossil species belongs to the living subgenera *Apis*, *Megapis*, or *Micrapis*.

Subgenus *Cascapis* Engel, new subgenus

Hauffapis Armbruster 1938: 37. Unavailable as no type species was originally designated (I.C.Z.N. 1985: Art. 13c). See also Michener (1990, 1997).

Type species.—*Apis armbrusteri* Zeuner 1931.

Diagnosis.—WORKER: Basal vein gently curved, strongly distad cu-a (similar to Fig. 4). Angle of posteroapical margin of first submarginal cell greater than 45°. Distal abscissa of vein M in hind wing present (similar to Fig. 5). Drone, mature larva, queen, and ethology all unknown.

Etymology.—The new genus-group name is a combination of *cascus* (L. old) and *apis* (L. bee).

Comments.—The subsequent designation of *Hauffapis scheuthlei* by Zeuner and Manning (1976) as the type species was in the synonymy of *Hauffapis* with *Apis* and is therefore invalid (I.C.Z.N. 1985: Art. 11c) (see also Michener 1990).

Apis (Cascapis) armbrusteri Zeuner

Armbruster's Honey Bee

Apis armbrusteri Zeuner 1931: 292.

Hauffapis scheuthlei Armbruster 1938: 43.

Hauffapis scheeri Armbruster 1938: 43. **New synonymy.**

Hauffapis scharmanni Armbruster 1938: 44. **New synonymy.**

Hauffapis scheeri variety *gallauni* Armbruster 1938: 45. **New synonymy.**

Hauffapis scheeri variety *rahdei* Armbruster 1938: 45. **New synonymy.**

Hauffapis scheuthlei variety *seemanni* Armbruster 1938: 45. **New synonymy.**

Hauffapis scheuthlei variety *zeuneri* Armbruster 1938: 45. **New synonymy.**

Apis armbrusteri cheuthlei Hong and Miao 1992: 2. *Lapsus calami*.

Comments.—The species and subspecies of *Hauffapis* proposed by Armbruster (op. cit.) were all described from the Miocene of Randecker Maar and were based on minor wing variations. None of these variations justifies subspecific status even under the extreme criteria used for splitting morphs of extant species (e.g., *A. mellifera*). The species is presently known from the Miocene of Germany.

Subgenus *Synapis* Cockerell

Apis (Synapis) Cockerell 1907: 229. *Type species*:

Apis (Synapis) henshawi Cockerell 1907, monobasic. Zeuner and Manning 1976: 240.

Diagnosis.—WORKER: Basal vein gently curved, only slightly distad cu-a (Fig. 6). Angle of posteroapical margin of first submarginal cell greater than 45°. Distal abscissa of vein M in hind wing present (as in Fig. 5). Drone, mature larva, queen, and ethology all unknown.

Apis (Synapis) henshawi Cockerell

Henshaw's Honey Bee

Apis (Synapis) henshawi Cockerell 1907: 229.

Apis dormitans Cockerell 1907: 228. Preoccupied (*nec* Heyden 1862).

Apis oligocenica Meunier 1915: 210.

Synapis dormitans (Cockerell); Statz 1931: 45.

Synapis henshawi (Cockerell); Statz 1931: 45.

Synapis kaschkei Statz 1931: 50.

Apis cuenoti Théobald 1937: 401. **New synonymy.**

Apis oligocaenica Goetze 1964: 9. *Lapsus calami*.

Apis henshawii Goetze 1964: 9. *Lapsus calami*.

Apis kaschkei Goetze 1964: 9. *Lapsus calami*.

Apis henshawii dormiens Zeuner and Manning 1976: 241. Replacement name for *Apis dormitans* Cockerell 1907.

Apis henshawii kaschkei (Statz); Zeuner and Manning 1976: 243.

Apis aquisextana Nel, Martínez-Delclòs, Arillo, and Peñalver in Arillo et al. 1996: 60. Proposed as new again in Nel et al. (1999).

Comments.—This species is perhaps the most famous of the fossil honey bees. The type was redescribed and new synonymies presented by Engel (1998a). This species is from the Oligocene of Europe (in Germany, France, and Spain).

Apis (Synapis) longtibia Zhang

The Long-legged Honey Bee

Apis longtibia Zhang 1990: 85.

Comments.—Engel (1998a) gave some characters to support the recognition of this species, although far much work remains to be done on the fossil honey bees of Asia. This fossil is from the Miocene of Shandong Province, China.

Apis (Synapis) miocenica Hong

The Chinese Miocene Honey Bee

Apis miocenica Hong 1983: 10.

Apis fota Zhang 1989: 323.

Apis shandongica Zhang 1989: 325.

Comments.—This species was briefly treated by Engel (1998a) and reasons for the synonymy of *A. fota* and *A. shandongica* were given. The species is from the Miocene of Shandong Province, China.

Apis (Synapis) petrefacta (Říha)

The Petrified Honey Bee

Synapis petrefacta Říha 1973: 217.

Apis petrefacta (Říha); Engel 1998a: 275.

Comments.—A fossil form from Miocene

strata of the České Středohoří Mountains of the Czech Republic.

Subgenus *Priorapis* Engel, new subgenus

Type species.—*Apis vetusta* Engel 1998a.

Diagnosis.—**WORKER:** Basal vein straight, confluent with cu-a. Angle of posteroapical margin of first submarginal cell greater than 45°. Distal abscissa of vein M in hind wing present. Drone, mature larva, queen, and ethology all unknown.

Etymology.—The new subgeneric name is derived from *prior* (L. earlier) and *apis* (L. bee).

Apis (Priorapis) vetusta Engel, emended name

The Aged Honey Bee

Apis vetustus Engel 1998a: 271.

Comments.—Through a lapse on my part I failed to adjust the gender of the specific epithet to match that of the genus (which is feminine). I here correct this error. The species occurred in the Oligocene of Germany.

NOMINA DUBIA AND UNASSOCIATED NOMINA NUDA

Apis aenigmatica Rayment, *nomen dubium*

Apis aenigmaticus Rayment 1925: 67.

Comments.—As pointed out by Cardale (1993), this name was based on the drawing of a comb and anecdotal reports of the insect in the absence of any specimens. Rayment (1935) gives another lively account of this elusive "species" which still had not been found at that time (nor has it been found since). See also discussion in Michener (1965: 232).

Apis catanensis Roussy, *nomen dubium*

Apis catanensis Roussy 1960: 8.

Apis catanensis avolii Roussy 1960: 8.

Comments.—Judging from the original

description, which is exceedingly incomplete, this may not be a honey bee at all. The subspecific name *avolii* is unnecessary and invalid since no subspecific forms were recognized; besides, any subspecies based on the type specimen would have to take the nominate specific epithet and would therefore become *A. catanensis catanensis*, with *A. catanensis avolii* being an invalid synonym. This is reportedly a fossil species from Miocene Sicilian amber.

***Apis melisuga* Zeuner and Manning,
*nomen dubium***

"Apidae" *melisuga* Handlirsch 1907: 893. Unavailable (I.C.Z.N. 1985: Art. 11h[iii]).

Apis melisuga Zeuner and Manning 1976: 248.

Comments.—The original proposal of this epithet by the great paleoentomologist Anton Handlirsch (1907) was not in accord with the principles of zoölogical nomenclature and is therefore unavailable under Article 11h (iii) (I.C.Z.N. 1985). Zeuner and Manning (1976) made the name available through their monograph by publishing this name in combination with a genus-group name and a diagnosis; although these authors attributed the name to Handlirsch. Neither Prof. Zeuner nor Dr. Manning had seen the type and their diagnosis of the species was a mere regurgitation of Handlirsch's original descriptive comments that the specimen resembled *A. mellifera*. In the absence of the type (which is presumably lost) and any real character information it is impossible to confidently place this as a species of *Apis*. The specimen was reportedly from the Miocene of Italy. Refer to Engel (1998a) for a more thorough treatment of this name.

***Apis postadamitica* Buttel-Reepen,
*nomen nudum***

Apis postadamitica Buttel-Reepen 1906: 163.

Comments.—Buttel-Reepen (op. cit.) considered this as the hypothetical direct ancestor of *A. mellifera* and postulated its oc-

currence in the Pliocene. No specimen for this species exists, and it was a mere hypothesis of Buttel-Reepen's that this species existed and would someday be discovered. The fact that this name is for a hypothetical taxon means that it is also excluded from zoölogical nomenclature (I.C.Z.N. 1985: Art. 1b).

Apis styriaca* Pongrácz, *nomen nudum

Apis styriaca Pongrácz 1931: 105.

Comments.—A supposed fossil species from the Miocene of Germany represented by a wing fragment. No description or figure was provided and the whereabouts of this material is unknown.

Apis trigona* Rayment, *nomen nudum

Apis trigona Rayment 1925: 69. Preoccupied (*nec* Schrank 1798).

Comments.—The decision to place this as a *nomen nudum* was made by Cardale (1993) and is followed here.

HONEY BEE VERSUS HONEYBEE

In closing I should like to make a brief comment on common names for this group of bees. The great arthropod morphologist Robert E. Snodgrass presented a short discussion on the common name for honey bees in the preface to his work concerning the anatomy of *A. mellifera* (Snodgrass 1956). His brief discussion advocating the use of the two word common name (*honey bee*) over a single word (*honeybee*) does not appear to have been widely accepted since apiculturists still commonly use "honeybee." Although there are no absolute rules for the use of this and other common names, I agree with Snodgrass' preference for a two word name and the logic by which he justified this position. Since I cannot hope to word his position more eloquently, I quote here his short argument: "Regardless of dictionaries, we have in entomology a rule for insect common names that can be followed. It says: If the insect is what the

name implies, write the two words separately; otherwise run them together. Thus we have such names as *house fly*, *blow fly*, and *robber fly* contrasted with *dragonfly*, *caddicefly*, and *butterfly*, because the later are not flies, just as an *aphis* is not a lion and a *silverfish* is not a fish. The honey bee is an insect and is preëminently a bee; 'honeybee' is equivalent to 'Johnsmith.'"

ACKNOWLEDGMENTS

I am sincerely grateful to the librarians of Cornell University's Comstock Memorial Library and the Kroch Rare and Manuscript Collection and of the library of the American Museum of Natural History for their help in locating references examined in the course of this study. Kumar and Valerie Krishna helped locate several older references and provided delightful company during these searches. Numerous bee biologists and paleontologists throughout the world graciously supplied copies of their work and shared discussions on *Apis* classification; to each of them I extend my thanks. David A. Grimaldi, E. Eric Grissell, Charles D. Michener, Gard W. Otis, Wojciech Pulawski, Molly G. Rightmyer, and Jerome G. Rozen, Jr., kindly read versions of the manuscript and made valuable corrections and criticisms. Their assistance greatly improved the presentation of this material. Not all agreed with my classification or conclusions and any errors or idiosyncrasies which remain are, of course, my own. I am particularly thankful to Michener for discussions on this material. I owe additional thanks to Jeffrey G. Engel for assistance during the preparation of the manuscript and to Molly G. Rightmyer and Zhiwei Liu for sharing with me their knowledge of Mandarin in the construction of the epithet *heimifeng*. I am indebted to numerous institutions and individuals for hosting me during my travels and/or for the loan or donation of material; in this regard I should particularly recognize Robert W. Brooks, Gabriela Chavarria, E. Richard Hoebeke, Gard W. Otis, W. Steve Sheppard, and Deborah R. Smith. W. Steve Sheppard and his coauthors kindly allowed me to include their lectotype designation for *A. mellifera ruttneri* herein and I am grateful to them for this honor. Donald B. Baker was the first to recognize the correct authorship of *A. koschevnikovi* (pers. comm. to C. D. Michener); I am grateful for his advice and assistance.

This work is dedicated in memory of Prof. Dr. Friedrich Ruttner (1914–1998), leading authority on *Apis* classification who did much to clarify honey bee systematics (as well as contributing enormously to many other fields of apiculture). A lovely account celebrating Prof. Ruttner's life was given by Koeniger (1998).

LITERATURE CITED

- Alexander, B. A. 1991a. A cladistic analysis of the genus *Apis*. Pages 1–28, in D. R. Smith (ed.) *Diversity in the Genus Apis*. Westview Press, Boulder, Colorado, United States, xiv+265 pp.
- Alexander, B. A. 1991b. A phylogenetic analysis of the genus *Apis* (Hymenoptera: Apidae). *Annals of the Entomological Society of America* 84: 137–149.
- Alpatov, V. V. 1935. Contribution to the study of variation in the honey bee. 3. The cubital cell on the wings of different forms of the genus *Apis* and its taxonomical and evolutionary significance. *Zoologicheskii Zhurnal* 14: 664–673. [In Russian with English summary]
- Alpatov, V. V. 1938. Contribution to the study of variation in the honey bee. 4. Carniolian and Crimean bees and their place among other forms of *Apis mellifera* L. *Zoologicheskii Zhurnal* 17: 473–481. [In Russian with English summary]
- Anderson, R. H. 1963. The laying worker in the Cape honeybee, *Apis mellifera capensis*. *Journal of Apicultural Research* 2: 85–92.
- Arillo, A., A. Nel, and V. M. Ortuño. 1996. Two fossil bees from the Oligocene of Izarra (Alava, Spain) (Hymenoptera, Apoidea). *Bulletin de la Société entomologique de France* 101: 59–64.
- Armbruster, L. 1938. Versteinerte Honigbienen aus dem obermiocänen Randecker Maar. *Archiv für Bienenkunde* 19: 1–48, 97–133.
- Ashmead, W. H. 1904. Remarks on honey bees. *Proceedings of the Entomological Society of Washington* 6: 120–122.
- Baldensperger, P. J. 1923. Sur l'abeille saharienne. 6th Congrès International d'Apiculture, Marseille 1922: 61–64.
- Baldensperger, P. J. 1928. Bees in their natural state and with beekeepers. *Bee World* 9: 173–174.
- Baldensperger, P. J. 1932. Variétés d'abeilles en Afrique du Nord. 5th Congrès International d'Entomologie, Paris 1932: 829–839.
- Barac, I. 1977. Preserving the genetic pool of *Apis mellifera carpatica*. *Proceedings of the International Beekeeping Congress* 26: 270–274.
- Barton, B. S. 1793. An inquiry into the question whether the *Apis mellifica*, or true Honey-bee, is a native of America. *Transactions of the American Philosophical Society*, Philadelphia 3: 251–261.
- Belknap, J. 1792. A Discourse Intended to Commemorate the Discovery of America by Christopher Columbus; Delivered at the Request of the Historical Society in Massachusetts, on the 23d Day of October, 1792, being the Completion of the Third Century since that Memorable Event. To which are added Four Dissertations, connected with various Parts of the Discourse. Apollo, Belknap & Hall, Boston, Massachusetts, United States, 132 pp.
- Benton, F. 1904. The specific name of the common

- honey-bee. *Proceedings of the Entomological Society of Washington* 6: 71-73.
- Bingham, C. T. 1898. On some new species of Indian Hymenoptera. *Journal of the Bombay Natural History Society* 12: 115-130.
- Brooks, R. W., and C. D. Michener. 1988. The Apidae of Madagascar and nests of *Liotrigona* (Hymenoptera). *Sociobiology* 14: 299-323.
- Buttel-Reepen, H., von. 1906. Apistica. Beiträge zur Systematik, Biologie, sowie zur geschichtlichen und geographischen Verbreitung der Honigbiene (*Apis mellifica* L.), ihrer Varietäten und der übrigen *Apis*-Arten. *Mitteilungen aus dem Zoologischen Museum in Berlin* 3: 117-201.
- Cadale, J. C. 1993. Hymenoptera: Apoidea. Pages 1-405, in W. W. K. Houston and G. V. Maynard (eds.) *Zoological Catalogue of Australia*, vol. 10. Australian Government Publishing Service, Canberra, Australia, ix+406 pp.
- Chavarría, G., and J. M. Carpenter. 1994. "Total evidence" and the evolution of highly social bees. *Cladistics* 10: 229-258.
- Cockerell, T. D. A. 1906. New Rocky Mountain bees, and other notes. *Canadian Entomologist* 38: 160-166.
- Cockerell, T. D. A. 1907. A fossil honey-bee. *Entomologist* 40: 227-229.
- Cockerell, T. D. A. 1911a. Descriptions and records of bees, XXXV. *Annals and Magazine of Natural History*, series 8, 7: 310-319.
- Cockerell, T. D. A. 1911b. New and little-known bees. *Transactions of the American Entomological Society* 37: 217-241.
- Cockerell, T. D. A. 1914. Descriptions and records of bees, LX. *Annals and Magazine of Natural History*, series 8, 14: 1-13.
- Dalla Torre, C. G., de [K. W., von]. 1896. *Catalogus Hymenopterarum hucusque Descriptorum Systematicus et Synonymicus*. Vol. 10. Apidae (Anthophila). Engelmann, Lipsiae [Leipzig], Germany, viii+643 pp.
- Damus, M. S., and G. W. Otis. 1997. A morphometric analysis of *Apis cerana* F and *Apis nigrocincta* Smith populations from Southeast Asia. *Apidologie* 28: 309-323.
- Enderlein, G. 1906. Neue Honigbienen und Beiträge zur Kenntnis der Verbreitung der Gattung *Apis*. *Stettiner Entomologische Zeitung* 67: 331-344.
- Engel, M. S. 1998a. Fossil honey bees and evolution in the genus *Apis* (Hymenoptera: Apidae). *Apidologie* 29: 265-281.
- Engel, M. S. 1998b. Comparative morphology and the phylogeny of the corbiculate bees (Hymenoptera: Apidae; Apinae). *Proceedings of the 13th International Congress of IUSSI, Adelaide* 1998: 151.
- Engel, M. S., and I. R. Schultz. 1997. Phylogeny and behavior in honey bees (Hymenoptera: Apidae). *Annals of the Entomological Society of America* 90: 43-53.
- Eschscholtz, J. F. 1822. *Entomographien*, vol. 1. Reimer, Berlin, Germany, 59-186 pp.
- Fabricius, J. C. 1781. *Species Insectorum Exhibentes eorum Differentias Specificas, Synonymia Auctorum, Loca Natala, Metamorphosin adiectis Observationibus, Descriptionibus*, vol. 1. Bohn, Hamburgi et Kilonii [Hamburg and Cologne], Germany, viii+552 pp.
- Fabricius, J. C. 1787. *Mantissa Insectorum Sistens eorum Species nuper Detectas adiectis Characteribus Genericis, Differentiis Specificis, Emendationibus, Observationibus*, vol. 1. Proft, Hafniae [Copenhagen], Denmark, xx+348 pp.
- Fabricius, J. C. 1793. *Entomologia Systematica Emendata et Aucta. Secundum Classes, Ordines, Genera, Species adiectis Synonymis, Locis, Observationibus, Descriptionibus*, vol. 2. Proft, Hafniae [Copenhagen], Denmark, viii+519 pp.
- Fabricius, J. C. 1798. *Supplementum Entomologiae Systematicae*. Proft, Hafniae [Copenhagen], Denmark, [2]+572 pp.
- Fischer von Waldheim, G. 1843. *Observata quaedam de Hymenopteris Rossicis*. *Magasin de Zoologie, d'Anatomie comparée et de Paléontologie* 5: 1-122.
- Geoffroy, E. L. 1762. *Histoire abrégée des Insectes qui se trouvent aux environs de Paris*, 2 vols. Durand, Paris, France, vol. 1, 690 pp., 11 pls.; vol. 2, 744 pp., 12 pls.
- Gerstäcker, C. E. A. 1862. *Über die geographische Verbreitung und die Abänderungen der Honigbiene nebst Bemerkungen über die ausländischen Honigbienen der alten Welt*. Festschrift XI Wander-Versammlung deutscher Bienenwirthe, Potsdam, Germany, 75 pp.
- Gerstäcker, C. E. A. 1863. On the geographical distribution and varieties of the honey-bee, with remarks upon the exotic honey-bees of the old world. *Annals and Magazine of Natural History*, series 3, 11: 270-283, 333-347. [English translation of Gerstäcker 1862]
- Goetze, G. K. L. 1964. Die Honigbiene in natürlicher und künstlicher Zuchtauslese, Teil 1: Systematik. Zeugung und Vererbung. *Monographien zur angewandten Entomologie* 19: 1-120.
- Gorbachev, A. N. 1916. The gray mountain Caucasian bee (*Apis mellifera caucasica*) and its place among other bees. *Tiflis* 1916: 1-40. [In Russian with English summary]
- Grassi, B. 1880. *Saggio di una Monografia delle Api d'Italia*. Milano [Milan], Italy.
- Grozdanic, S. S. 1926. Die "gelbe" banater Biene. *Acta Societatis Entomologicae Serbo-Croato-Slovenae* 1: 45-60.
- Guérin-Ménéville, F. E. 1844. *Iconographie du Règne Animal de G. Cuvier, ou Representation d'après Nature de l'une des Espèces les plus Remarquables et*

- Souvent non Encore Figurées, de Chaque Genre d'Animaux, vol. 3. Texte Explicatif, Insectes.* J. B. Baillière, Paris, France, 576 pp., 106 pls.
- Guillou, E. J. F., le. 1841. Des Insectes Hyménoptères recueillis dans le Voyage de circumnavigation des Corvettes l'Astrolabe et la Zélée. *Annales de la Société entomologique de France* 10: 311-324.
- Hadisoesilo, S. 1997. *A Comparative Study of Two Species of Cavity-Nesting Honey Bees of Sulawesi, Indonesia*. Ph.D. Dissertation, University of Guelph, Guelph, Ontario, Canada, 199 pp.
- Hadisoesilo, S., and G. W. Otis. 1996. Drone flight times confirm the species status of *Apis nigrocincta* Smith, 1861 to be a species distinct from *Apis cerana* F, 1793, in Sulawesi, Indonesia. *Apidologie* 27: 361-369.
- Hadisoesilo, S., and G. W. Otis. 1998. Differences in drone cappings of *Apis cerana* and *Apis nigrocincta*. *Journal of Apicultural Research* 37: 11-15.
- Hadisoesilo, S., G. W. Otis, and M. Meixner. 1995. Two distinct populations of cavity-nesting honey bees (Hymenoptera: Apidae) in South Sulawesi, Indonesia. *Journal of the Kansas Entomological Society* 68: 399-407.
- Handlirsch, A. 1907. *Die fossilen Insekten und die Phylogenie der rezenten Formen. Ein Handbuch für Paläontologen und Zoologen*. Engelmann, Leipzig, Germany, 641-1120 pp., 37-51 pls.
- Hepburn, H. R., and S. E. Radloff. 1998. *Honeybees of Africa*. Springer Verlag, Berlin, Germany, xv+370 pp.
- Hernandez, F. 1648. *Rerum Medicarum Novae Hispaniae Thesaurus: Nova Plantarum, Animalium et Mineralium Historia*. Vitalis Mascardi, Romae [Rome], Italy, 950+[10]+[90]+[6] pp.
- Heyden, C., von. 1862. Gliedertiere aus der Braunkohle des Niederrheins, der Wetterau und der Rhön. *Palaeontographica* 10: 62-82.
- Hoffmannsegg, J. C. G., von. 1818. Entomologische Bemerkungen bei Gelegenheit der Abhandlungen über amerikanische Insekten. *Zoologisches Magazin, von Wiedemann* 1(2): 49-110.
- Hong, Y. C. 1983. Fossil insects in the diatoms of Shanwang. *Bulletin of the Tianjin Institute of Geology and Mineral Resources* 8: 1-11. [In Chinese with English summary]
- Hong, Y. C. 1984. New fossil insects of Laiyang Group from Laiyang Basin, Shandong Province. *Professional Papers of Stratigraphy and Paleontology* 11: 31-41. [In Chinese with English summary]
- Hong, Y. C., and S. J. Miao. 1992. Fossil bee [sic] and its origin with discussion on the origin of the angiosperm. *Memoirs of the Beijing Natural History Museum* 51: 1-19. [In Chinese with English summary]
- Horne, C., and F. Smith. 1870. Notes on the habits of some hymenopterous insects of the NW provinces of India. *Transactions of the Zoological Society of London* 7: 161-196.
- I.C.Z.N. 1985. *International Code of Zoological Nomenclature*. Charlesworth & Co. Ltd., Huddersfield, United Kingdom, xx+338 pp.
- Jack, R. W. 1916. Parthenogenesis amongst the workers of the Cape honey-bee: Mr. G. W. Onions' experiments. *Transactions of the Entomological Society of London* 1916: 396-403.
- Jefferson, T. 1787. *Notes on the State of Virginia*. Stockdale, London, United Kingdom, 382 pp.
- Josselyn, J. 1674. *An Account of Two Voyages to New-England Made During the Years 1638, 1663*. Widdows, London, United Kingdom, vii+211 pp.
- Kerr, W. E. 1957. Introdução de abelhas africanas no Brasil. *Brasil Apicola* 3: 211-213.
- Kerr, W. E. 1967. The history of the introduction of Africanized bees to Brazil. *South African Bee Journal* 39: 3-5.
- Kerr, W. E., and E. Amaral. 1960. *Apicultura: Científica e Prática*. Diretoria de Publicidade Agrícola da Secretaria da Agricultura, São Paulo, Brazil, 148 pp.
- Kiesenwetter, E. A. H., von. 1860. Ueber die Bienen des Hymettus. *Berliner Entomologische Zeitschrift* 4: 315-317.
- Klug, J. C. F. 1807. Species Apiarum familie novas descripsit; generumque characteres adjecit. *Magazin der Gesellschaft Naturforschender Freunde zu Berlin* 1: 263-265.
- Koeniger, N. 1998. Friedrich Ruttner, 15 May 1914-3 February 1998. *Bee World* 79: 110-111.
- Koeniger, N., G. Koeniger, S. Tingek, M. Mardan, and T. E. Rinderer. 1988. Reproductive isolation by different time of drone flight between *Apis cerana* Fabricius, 1793 and *Apis vechti* (Maa, 1953). *Apidologie* 19: 103-106.
- Koschevnikov, G. A. 1900. Materials for the natural history of the honey bee. *Izvestiia Imperatorskago obshchestva lyubitelei estestvoznaniia Antropologii i Etnografii* 99: 1-144. [In Russian]
- Kugler, J. 1988. The zoogeography of social insects of Israel and Sinai. Pages 251-275, in Y. Yom-Tov and E. Tchernov (eds.) *The Zoogeography of Israel: The Distribution and Abundance at a Zoogeographical Crossroad (Monographiae Biologicae, vol. 62)*. Dr. W. Junk Publishers, Dordrecht, the Netherlands, ix+600 pp.
- Latreille, P. A. 1804a. Mémoire sur un Gâteau de Ruche d'une Abeille des Grandes-Indes, et sur les Différences des Abeilles proprement dites, vivant en grande Société, de l'ancien Continent et du nouveau. *Annales du Musée d'Histoire Naturelle* 4: 383-394.
- Latreille, P. A. 1804b. Notice des Espèces d'Abeilles vivant en grande Société, ou Abeilles proprement dites, et Description d'Espèces nouvelles. *Annales du Musée d'Histoire Naturelle* 5: 161-178.

- Latreille, P. A. 1810. *Considérations Générales sur l'Ordre Naturel des Animaux Composant les Classes des Crustacés, des Arachnides, et des Insectes; avec un Tableau Méthodique de leurs Genres, disposés en Familles*. F. Schoell, Paris, France, 444 pp.
- Lavrezhin, F. A. 1935. Contribution to the study of variation of the honey bee. 2. A comparative biometric characteristic of the sexual appendages of the drones belonging to different forms of the genus *Apis*. *Zoologicheskii Zhurnal* 14: 655-663. [In Russian with English summary]
- Lawriochin, F. A. 1960. Über die ersten Versuche zur Einführung der wildlebenden ussurischen Bienen (*Apis indica* F.) in den europäischen Teil der Sowjetunion. XVII Congresso Internazionale degli Apicoltori, Roma, vol. 2 1950: 237-238.
- Lepeletier de Saint Fargeau, A. L. M. 1836. *Histoire Naturelle des Insectes. Suites à Buffon. Hyménoptères*, vol. 1. Roret, Paris, France, 547 pp.
- Linnaeus, C. 1758. *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis*, ed. 10, vol. 1 Reformata. Salviae, Holmiae [Stockholm], Sweden, 824 pp.
- Linnaeus, C. 1761. *Fauna Suecica, Sistens Animalia Sueciae Regni: Mammalia, Aves, Amphibia, Pisces, Insecta, Vermes, Distributa per Classes & Ordines, Genera & Species, cum Differentiis Specierum, Synonymis Auctorum, Nominibus Incolarum, Locis Natalium, Descriptionibus Insectorum*. Salvii, Stockholmiae [Stockholm], Sweden, xlvii+578 pp., 2 pls.
- Linnaeus, C. 1767. *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis*, ed. 12, Reformata, vol. 1, pt. 2. Thomas, Vindobonae [Vienna], Austria, 533-1328+[xxxvii] pp.
- Lord, W. G., and S. K. Nagi. 1987. *Apis florea* discovered in Africa. *Bee World* 68: 39-40.
- Lucas, H. 1882. Communiqué une note relative à un Hyménoptère social. *Bulletin des Séances de la Société entomologique de France* 1882: 42.
- Maa, T. C. 1944. On the classification and phylogeny of the Chinese honeybees. *Entomology Shaowuana* 1: 4-5. [In Chinese: this paper was not seen since no copies of the journal could be traced. I follow Maa's (1953) restatement of its contents.]
- Maa, T. C. 1953. An inquiry into the systematics of the tribus Apidini or honeybees (Hym). *Treubia* 21: 525-640.
- Malaipan, S. 1972. *A Revision of the Genus of Apis of Thailand (Hymenoptera: Apidae)*. M.S. Thesis, Kasetsart University, Bangkok, Thailand, 139 pp.
- McEvoy, M. V., and B. A. Underwood. 1988. The drone and species status of the Himalayan honey bee, *Apis laboriosa* (Hymenoptera: Apidae). *Journal of the Kansas Entomological Society* 61: 246-249.
- Meunier, M. F. 1915. Über einige fossil Insekten aus den Braunkohlenschichten (Aquitaniens) von Rott (Siebengebirge). *Zeitschrift der deutschen geologischen Gesellschaft* 67: 205-217, 219-230.
- Michener, C. D. 1944. Comparative external morphology, phylogeny, and a classification of the bees (Hymenoptera). *Bulletin of the American Museum of Natural History* 82: 151-326.
- Michener, C. D. 1965. A classification of the bees of the Australian and South Pacific regions. *Bulletin of the American Museum of Natural History* 130: 1-362.
- Michener, C. D. 1975. The Brazilian bee problem. *Annual Review of Entomology* 20: 399-416.
- Michener, C. D. 1990. Classification of the Apidae (Hymenoptera). *University of Kansas Science Bulletin* 54: 75-153.
- Michener, C. D. 1997. Genus-group names of bees and supplemental family-group names. *Scientific Papers, Natural History Museum, University of Kansas* 1: 1-81.
- Mogga, J. B. 1988. *The Taxonomy and Geographical Variability of the Honeybee Apis mellifera L. in Sudan*. M.S. Thesis, University of Khartoum, Khartoum, Sudan.
- Mogga, J. B., and F. Ruttner. 1988. *Apis florea* in Africa: Source of the founder population. *Bee World* 69: 100-103.
- Montagano, J. 1911. Relation sur l'*Apis sicula*. *Proceedings of the International Beekeeping Congress* 5: 26-29.
- Moore, F., F. Walker, and F. Smith. 1871. Descriptions of some new insects collected by Dr. Anderson during the expedition to Yunan. *Proceedings of the Zoological Society of London* 1871: 244-249.
- Morse, R. A., and F. M. Laigo. 1969. *Apis dorsata* in the Philippines (including an annotated bibliography). *Monograph of the Philippine Association of Entomologists* 1: 1-96.
- Muttoo, R. N. 1951. The correct scientific nomenclature for our Indian hive bees. *Indian Bee Journal* 13: 150-153.
- Muttoo, R. N. 1956. Facts about beekeeping in India. *Bee World* 37: 125-133, 154-157.
- Nel, A., X. Martínez-Delclòs, A. Arillo, and E. Peñalver. 1999. A review of the Eurasian fossil species of the bee *Apis*. *Paleontology* 42: 243-285.
- Noll, F. B. 1998. Are behavioral characters informative of phylogenetic relationships among the corbiculate bees (Hymenoptera, Apidae, Apinae). *Proceedings of the 13th International Congress of IUS-SI, Adelaide* 1998: 347.
- Otis, G. W. 1996. Distribution of recently recognized species of honey bees (Hymenoptera: Apidae: Apis). *Journal of the Kansas Entomological Society, supplement* 69: 311-333.
- Peng, Y. S., M. E. Nasr, and S. J. Locke. 1989. Geographical races of *Apis cerana* Fabricius in China and their distribution. Review of recent Chinese

- publications and a preliminary statistical analysis. *Apidologie* 20: 9-20.
- Petrov, P. 1991. Systematics of the Bulgarian bees. *Pchelarstvo* 9: 15-17. [In Russian]
- Petrov, P. 1992. Distribution and phylogenesis of the bee genus *Apis* (Hymenoptera, Apidae). *Uspechi sovremennoi Biologii, Moscow* 112: 359-372. [In Russian]
- Petrov, P. 1993. Man and the honey bee. *Pchelovodstvo* 11/12: 36-37. [In Bulgarian]
- Petrov, P. 1996. Contribution to the taxonomy of the Bulgarian honey bee. *Journal of Animal Science, Agricultural Academy* 33: 58-61. [In Bulgarian with Russian and English summaries]
- Petrov, P. 1997. On the origin of the Bulgarian honey bees (*Apis mellifera rodopica*). *Journal of Animal Science, Agricultural Academy* 34: 88-93.
- Pollmann, A. 1879. *Werth der verschiedenen Bienenrassen und deren Varietäten, bestimmt durch Urtheile namhafter Bienenzüchter*. Voigt, Leipzig, Germany, 69 pp.
- Pollmann, A. 1889. *Werth der verschiedenen Bienenrassen und deren Varietäten, bestimmt durch Urtheile namhafter Bienenzüchter*. Voigt, Leipzig, Germany, viii+100 pp.
- Pongrácz, A. 1931. Bemerkungen über die Insektenfauna von Oeningen nebst Revision der Heer'schen Typen. *Verhandlungen des Naturhistorisch-medizinischen Vereins zu Heidelberg* 17: 104-125.
- Radloff, S. E., and H. R. Hepburn. 1997. Multivariate analysis of honeybees, *Apis mellifera* Linnaeus (Hymenoptera: Apidae), of the Horn of Africa. *African Entomology* 5: 57-64.
- Radoszkowski, O. 1887. Hyménoptères de Korée. *Horræ Societatis Entomologicae Rossicae* 21: 428-436.
- Rafinesque, C. S. 1814. *Principes Fondamentaux de Sociologie*. Impr. de F. Abate aux depens de l'auteur, Palerme [Palermo], Italy, 50+[2] pp.
- Rafinesque, C. S. 1815. *Analyse de la Nature; ou Tableau de l'Univers et des corps Organisés*. Impr. de F. Abate aux depens de l'auteur, Palerme [Palermo], Italy, 224 pp.
- Ransome, H. M. 1937. *The Sacred Bee in Ancient Times and Folklore*. Houghton Mifflin Company, New York, United States, 308 pp.
- Rashad, S. E., and M. S. A. El-Sarrag. 1978. Beekeeping in Sudan. *Bee World* 59: 105-111.
- Ray, J. 1710. *Historia Insectorum*. A. and J. Churchill, London, United Kingdom, xv+400 pp.
- Rayment, T. 1925. A new species of honey-bee. *Australasian Beekeeper* 27: 67-69.
- Rayment, T. 1935. *A Cluster of Bees. Sixty Essays on the Life-Histories of Australian Bees, with Specific Descriptions of over 100 New Species, and an Introduction by Professor F. F. Phillips*. Endeavour Press, Sydney, Australia, 752 pp.
- Ráha, P. 1973. *Synapis petrefacta* sp. n., eine neue Bienenart aus dem Tertiär des Böhmisches Mittelgebirges. *Věstník Ústředního ústavu geologického* 48: 217-220.
- Roubik, D. W., S. F. Sakagami, and I. Kudo. 1985. A note on distribution and nesting of the Himalayan honey bee *Apis laboriosa* Smith (Hymenoptera: Apidae). *Journal of the Kansas Entomological Society* 58: 746-749.
- Roussy, L. 1960. Insectes et abeilles fossiles de l'ambre de Sicile. Migrations, localisations, peuplement du Nouveau Monde, de l'Australie, de la Nouvelle Zélande. *La Gazette Apicole, Montfavet* 635: 5-8.
- Ruttner, F. 1968. Les races d'abeilles. Pages 27-44, in R. Chauvin (ed.) *Traité de Biologie de l'Abeille*, vol. 1. Masson et Cie, Paris, France, xii+547 pp.
- Ruttner, F. 1975. Die kretische Biene, *Apis mellifera adami*. *Allgemeine deutsche Imkerzeitung* 9: 271-272.
- Ruttner, F. 1976a. Les races d'abeilles de l'Afrique. XXV Congrès International d'Apiculture, Grenoble 1976: 347-367.
- Ruttner, F. 1976b. Isolated populations of honeybees in Australia. *Journal of Apicultural Research* 15: 97-104.
- Ruttner, F. 1977. The problem of the Cape bee (*Apis mellifera capensis* Escholtz [sic]): parthenogenesis, size of population, evolution. *Apidologie* 8: 281-294.
- Ruttner, F. 1980. *Apis mellifera adami* (n. ssp.), die Kretische Biene. *Apidologie* 11: 385-400.
- Ruttner, F. 1988. *Biogeography and Taxonomy of Honeybees*. Springer Verlag, Berlin, Germany, xxii+284 pp.
- Ruttner, F. 1992. *Naturgeschichte der Honigbienen*. Ehrenwirth, Munich, Germany, 357 pp.
- Ruttner, F., D. Kauhausen, and N. Koeniger. 1989. Position of the red honey bee, *Apis koschewnikovi* (Buttel-Reepen 1906), within the genus *Apis*. *Apidologie* 20: 395-404.
- Sakagami, S. F., T. Matsumura, and K. Ito. 1980. *Apis laboriosa* in Himalaya, the little known world largest honeybee (Hymenoptera: Apidae). *Insecta Matsumurana* 19: 47-77.
- Santiago, E., J. Albornoz, A. Dominguez, and J. I. Inquierdo. 1986. Etude biométrique des populations d'abeilles (*Apis mellifera*) du nord-ouest de l'Espagne. *Apidologie* 16: 71-92.
- Schrank, F., von Paula. 1798. *Fauna Boica: Durchgedachte Geschichte der in Baiern einheimischen und zahmen Thiere*. Stein'schen Buchhandlung, Nürnberg, Germany.
- Schultz, T. R., M. S. Engel, and M. Prentice. 1999. Resolving conflict between morphological and molecular evidence for the origin of eusociality in the "corbiculate" bees (Hymenoptera: Apidae): A hypothesis-testing approach. *The University of*

- Kansas Natural History Museum Special Publication 24: 110-123.
- Scopoli, J. A. 1770. *Annus Historico Naturalis. Annus IV. Hilscher, Lipsiae* [Leipzig], Germany, 150 pp., 2 pls.
- Seeley, T. D. 1985. *Honeybee Ecology: A Study of Adaptation in Social Life*. Princeton University Press, Princeton, New Jersey, United States, x + 201 pp.
- Seeley, T. D. 1995. *The Wisdom of the Hive: The Social Physiology of Honey Bee Colonies*. Harvard University Press, Cambridge, Massachusetts, United States, xiv + 295 pp.
- Sheppard, W. S., M. C. Arias, A. Grech, and M. D. Meixner. 1997 [1998]. *Apis mellifera ruthieri*, a new honey bee subspecies from Malta. *Apidologie* 28: 287-293.
- Skorikov, A. S. 1929a. Beiträge zur Kenntnis der kaukasischen Honigbienenrassen, I-V. *Reports on Applied Entomology, Leningrad* 4: 1-60. [In Russian with German summary]
- Skorikov, A. S. 1929b. Eine neue Basis für eine Revision der Gattung *Apis* L. *Reports on Applied Entomology, Leningrad* 4: 249-270. [In Russian with German summary]
- Smith, D. R. 1991a. *Diversity in the Genus Apis*. Westview Press, Boulder, Colorado, United States, xiv + 265 pp.
- Smith, D. R. 1991b. Mitochondrial DNA and honey bee biogeography. Pages 131-176, in D. R. Smith (ed.) *Diversity in the Genus Apis*. Westview Press, Boulder, Colorado, United States, xiv + 265 pp.
- Smith, D. R., and T. C. Glenn. 1995. Allozyme polymorphisms in Spanish honeybees (*Apis mellifera iberica*). *Journal of Heredity* 86: 12-16.
- Smith, D. R., and R. H. Hagen. 1996. The biogeography of *Apis cerana* as revealed by mitochondrial DNA sequence data. *Journal of the Kansas Entomological Society, supplement* 69: 294-310.
- Smith, D. R., M. F. Palopoli, B. R. Taylor, J. M. Cornuet, L. Garnery, M. Solignac, and W. M. Brown. 1991. Geographical overlap of two mitochondrial genomes in the Spanish honey bees, *Apis mellifera iberica*. *Journal of Heredity* 82: 96-100.
- Smith, F. 1854. *Catalogue of Hymenopterous Insects in the Collection of the British Museum, Part 2, Apidae*. British Museum, London, United Kingdom, 199-465 pp., vii-xii pls.
- Smith, F. 1858. Catalogue of the hymenopterous insects collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore, by A. R. Wallace. *Proceedings of the Linnean Society, London* 2: 42-130.
- Smith, F. 1859. Catalogue of hymenopterous insects collected at Celebes by Mr. A. R. Wallace. *Proceedings of the Linnean Society, London* 3: 4-27.
- Smith, F. 1861a. Descriptions of new species of hymenopterous insects collected by Mr. A. R. Wallace at Celebes. *Proceedings of the Linnean Society, London* 5: 57-93.
- Smith, F. 1861b. [Untitled]. *Proceedings of the Entomological Society of London* 7: 14.
- Smith, F. 1865. On the species and varieties of the honey-bees belonging to the genus *Apis*. *Annals and Magazine of Natural History, series* 3, 15: 372-380.
- Smith, F. 1871. A catalogue of the aculeate Hymenoptera and Ichneumonidae of India and the eastern Archipelago. *Journal of the Linnean Society* 11: 285-415.
- Smith, F. G. 1961a. The races of honeybees in Africa. *Bee World* 42: 255-260.
- Smith, F. G. 1961b. Races of honeybees in Africa. 18th Congreso Internacional de Apicultura, Madrid 1961: 148.
- Snodgrass, R. E. 1956. *Anatomy of the Honey Bee*. Cornell University Press, Ithaca, New York, United States, xiv + 334 pp.
- Spinola, M. 1806. *Insectorum Liguria Species Novae aut Rariores, Quas in Agro Ligustico nuper Detexit, Descripsit, et Iconibus Illustravit Maximilianus Spinola, adjecto Catalogo Specierum Auctoribus jam Enumeratarum, Quae in Eadem Regione Passim Occurrunt, vol. 1. Gravier, Genuae* [Genoa], Italy, xvii + 159 + [1] pp., 2 pls.
- Spivak, M., D. J. C. Fletcher, and M. D. Breed. 1991. *The "African" Honey Bee*. Westview Press, Boulder, Colorado, United States, [ii] + 435 pp.
- Starr, C. K., P. J. Schmidt, and J. O. Schmidt. 1987. Nest-site preferences of the giant honey bee, *Apis dorsata* (Hymenoptera: Apidae), in Borneo. *Pan-Pacific Entomologist* 63: 37-42.
- Statz, G. 1931. Eine neue Bienenart aus Rott am Siebengebirge. Ein Beitrag zur Kenntnis der fossilen Honigbienen. *Wissenschaftlichen Mitteilungen des Vereins für Natur- und Heimatkunde, Köln* 1: 39-60.
- Taylor, O. R., Jr. 1977. The past and possible future spread of Africanized honeybees in the Americas. *Bee World* 58: 19-30.
- Taylor, O. R., Jr. 1985. African bees: Potential impact in the United States. *Bulletin of the Entomological Society of America* 31: 14-24.
- Tegetmeier, W. B. 1859. [Untitled]. *Proceedings of the Entomological Society of London* 5: 88.
- Tegetmeier, W. B. 1860. [Untitled]. *Proceedings of the Entomological Society of London* 6: 126.
- Théobald, N. 1937. *Les Insectes Fossiles des Terrains Oligocènes de France*. George Thomas, Nancy, France, 473 pp., 29 pls.
- Tingek, S., M. Mardan, T. E. Rinderer, N. Koeniger, and G. Koeniger. 1988. Rediscovery of *Apis cecili* (Maa, 1953): The Saban honey bee. *Apidologie* 19: 97-102.
- Tingek, S., G. Koeniger, and N. Koeniger. 1996 [1997]. Description of a new cavity nesting species of *Apis* (*Apis nuluensis* n. sp.) from Sabah, Borneo.

- with notes on its occurrence and reproductive biology. *Senckenbergiana biologica* 76: 115-119.
- Underwood, B. A. 1990a. Seasonal nesting cycle and migration patterns of the Himalayan honey bee *Apis laboriosa*. *National Geographic Research* 6: 276-290.
- Underwood, B. A. 1990b. Time of drone flight of *Apis laboriosa* Smith in Nepal. *Apidologie* 21: 501-504.
- Villers, C., de. 1789. *Caroli Linnaei Entomologia, Faunae Suecicae Descriptionibus Aucta*, D.D. Scopoli, Geoffroy, de Geer, Fabricii, Schrank, &c., *Speciebus vel in Systemate non Enumeratis, vel Nuperrime Detectis, vel Speciebus Galliae Australis Locupletata, Generu Specierumque Rariorum Iconibus Ornata; Curante et Augente Carolo de Villers*, vol. 3. Piestre et Delamollere, Lugduni [Lyon], France, 657 pp., 4 pls.
- Willis, L. G., M. L. Winston, and B. M. Honda. 1992. Phylogenetic relationships in the honeybee (genus *Apis*) as determined by the sequence of the cytochrome oxidase II region of mitochondrial DNA. *Molecular Phylogenetics and Evolution* 1: 169-178.
- Wilson, E. O., and W. L. Brown, Jr. 1953. The subspecies concept and its taxonomic application. *Systematic Zoology* 2: 97-111.
- Winston, M. L. 1987. *The Biology of the Honey Bee*. Harvard University Press, Cambridge, Massachusetts, United States, viii+281 pp.
- Wongsiri, S., K. Limbipichai, P. Tanganasing, M. Mardan, T. E. Rinderer, H. A. Sylvester, G. Koeniger, and G. W. Otis. 1989. Evidence of reproductive isolation confirms that *Apis andreniformis* (Smith, 1858) is a separate species from sympatric *Apis florea* (Fabricius, 1787). *Apidologie* 21: 47-52.
- Wu, Y., and B. Kuang. 1986. A study of the genus *Micrapis* (Apidae). *Zoological Research* 7: 99-102. [In Chinese]
- Wu, Y., and B. Kuang. 1987. Two species of small honeybee—a study of the genus *Micrapis*. *Bee World* 68: 153-155.
- Zeuner, F. E. 1931. Die Insektenfauna des Böttinger Marmors. *Fortschritte der Geologie und Palaeontologie* 9: 247-406.
- Zeuner, F. E., and F. J. Manning. 1976. A monograph on fossil bees (Hymenoptera: Apoidea). *Bulletin of the British Museum (Natural History), Geology* 27: 149-268.
- Zhang, F. J. 1989. *Fossil Insects from Shanwang, Shandong, China*. Science and Technology Publishing House, Jinan, China, 459 pp., 92 pls. [In Chinese with English summary]
- Zhang, F. J. 1990. New fossil species of Apoidea (Insecta: Hymenoptera). *Acta Zootaxonomica Sinica* 15: 83-91. [In Chinese with English summary]