A Catalog and Review of Immature Apoidea (Hymenoptera)

RONALD J. McGINLEY

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 494

SERIES PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

Emphasis upon publication as a means of "diffusing knowledge" was expressed by the first Secretary of the Smithsonian. In his formal plan for the Institution, Joseph Henry outlined a program that included the following statement: "It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge." This theme of basic research has been adhered to through the years by thousands of titles issued in series publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

Smithsonian Contributions to Anthropology
Smithsonian Contributions to Astrophysics
Smithsonian Contributions to Botany
Smithsonian Contributions to the Earth Sciences
Smithsonian Contributions to the Marine Sciences
Smithsonian Contributions to Paleobiology
Smithsonian Contributions to Zoology
Smithsonian Folklife Studies
Smithsonian Studies in Air and Space
Smithsonian Studies in History and Technology

In these series, the Institution publishes small papers and full-scale monographs that report the research and collections of its various museums and bureaux or of professional colleagues in the world of science and scholarship. The publications are distributed by mailing lists to libraries, universities, and similar institutions throughout the world.

Papers or monographs submitted for series publication are received by the Smithsonian Institution Press, subject to its own review for format and style, only through departments of the various Smithsonian museums or bureaux, where the manuscripts are given substantive review. Press requirements for manuscript and art preparation are outlined on the inside back cover.

Robert McC. Adams
Secretary
Smithsonian Institution

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 494

A Catalog and Review of Immature Apoidea (Hymenoptera)

Ronald J. McGinley

SMITHSONIAN INSTITUTION PRESS
Washington, D.C.
1989

ABSTRACT

McGinley, Ronald J. A Catalog and Review of Immature Apoidea (Hymenoptera). *Smithsonian Contributions to Zoology*, number 494, 24 pages, 2 figures, 1 table, 1989.—The systematic literature covering the larvae and pupae of all bees is reviewed and presented in catalog form. Historical aspects of the study of immature apoids are reviewed with emphasis placed on what yet needs to be accomplished and which taxa should be considered primary targets for collection.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SERIES COVER DESIGN: The coral *Montastrea cavernosa* (Linnaeus).

Library of Congress Cataloging in Publication Data
McGinley, Ronald J.
A catalog and review of immature Apoidea (Hymenoptera).
(Smithsonian contributions to zoology ; no. 494)
Bibliography: p.
Supt. of Docs. no.: SI 1.27:494
1. Bees—Classification. 2. Bees—Development. 3. Bees—Larvae. I. Title. II. Series.
QL1.S54 no. 494 [QL566] 591 s 89-600106 [595.79'9]

Contents

A Catalog and Review of Immature Apoidea (Hymenoptera)

Ronald J. McGinley

Introduction

The immature stages of holometabolous insects provide systematists with character sets that are too often overlooked in taxonomic and phylogenetic studies. The most obvious reason for this neglect is that the immatures of most species are unknown; this because they are often difficult to locate, collect and correctly associate with adults. Another reason for ignoring immature stages is that many systematists are reluctant to utilize character sets that are unfamiliar to them. In the case of apoid "paedophobia," the problem is exacerbated by a seemingly unorganized literature that leaves many workers bewildered. Because the publication of *Immature Insects* (Stehr, 1987) will hopefully stimulate greater interest in larval studies, this seems an appropriate time to summarize the immature-bee literature on a global basis.

The present paper presents a listing of those bee species that are known from the larval and/or pupal stages and provides the associated bibliographic information. It is hoped that this information will encourage bee biologists to preserve immature stages for future study, especially the immatures of those taxa that are unknown or poorly represented in the literature and collections. Immatures should be killed and preserved in alcohol (75 to 80 percent) or Kahle's Solution (a mixture of ethyl alcohol, formaldehyde, glacial acetic acid and water); techniques of specimen preparation and examination are presented in Rozen and McGinley (1974a) and Stephen, Bohart, and Torchio (1969).

ACKNOWLEDGMENTS.—The manuscript was greatly improved by the comments and suggestions provided by Robert W. Brooks, Connal D. Eardley, George C. Eickwort, Oliver S. Flint, Jr., Terry L. Griswold, Terry F. Houston, Wallace E. LaBerge, Charles D. Michener, Beth B. Norden, Frank D. Parker, Yuriy A. Pesenko, Jerome G. Rozen, Jr., Shoichi F. Sakagami, and Philip F. Torchio. Beth Norden also assisted with the literature search and figure lettering, and Philip Torchio kindly provided a prepublication copy of his 1987 paper (with B. Burwell) on colletid pupae. Radclyffe B. Roberts compiled the initial listing of bee taxa that was the basis for the general classification scheme followed herein.

Ronald J. McGinley, Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Historical Review

As mentioned above, our knowledge of apoid diversity is understandably based primarily on studies of adults. The discrepancy in our knowledge of immature forms versus adults is well illustrated by the history of bee taxonomy in the United States and Canada, a fauna of approximately 3,589 species and subspecies (Figure 1). Study of this fauna (based on adults) from 1758 through the 1840s resulted in the description of 90 currently recognized species. During this early period, Thomas Say contributed significantly with descriptions of 33 species. Exploration of the North American bee fauna really began during the 1850–1870 period with the work of F. Smith and E.T. Cresson. T.D.A. Cockerell and P.H. Timberlake contributed most significantly to our knowledge of North American species with descriptions of 1138 and 735 species and subspecies, respectively; nine additional workers, listed in figure 1, have each contributed over 75 species descriptions to the North American fauna. Among these most prolific contributors, only Michener and LaBerge have published descriptions of immature forms and have utilized this information in assessments of phylogenetic relationships and classification. Mature larvae of only 174 (5.0%) of the approximately 3,589 species and subspecies in this area are known.

Among the earliest known larval descriptions of Apoidea are those of *Hoplitis parvula* and *H. tridentata* by Dufour and Perris (1840). Earlier depictions of the honey bee are so generalized as to be virtually useless for comparative purposes. Through the 1940s, several workers contributed scattered larval treatments (most notably F. Claude-Joseph and G. Grandi),

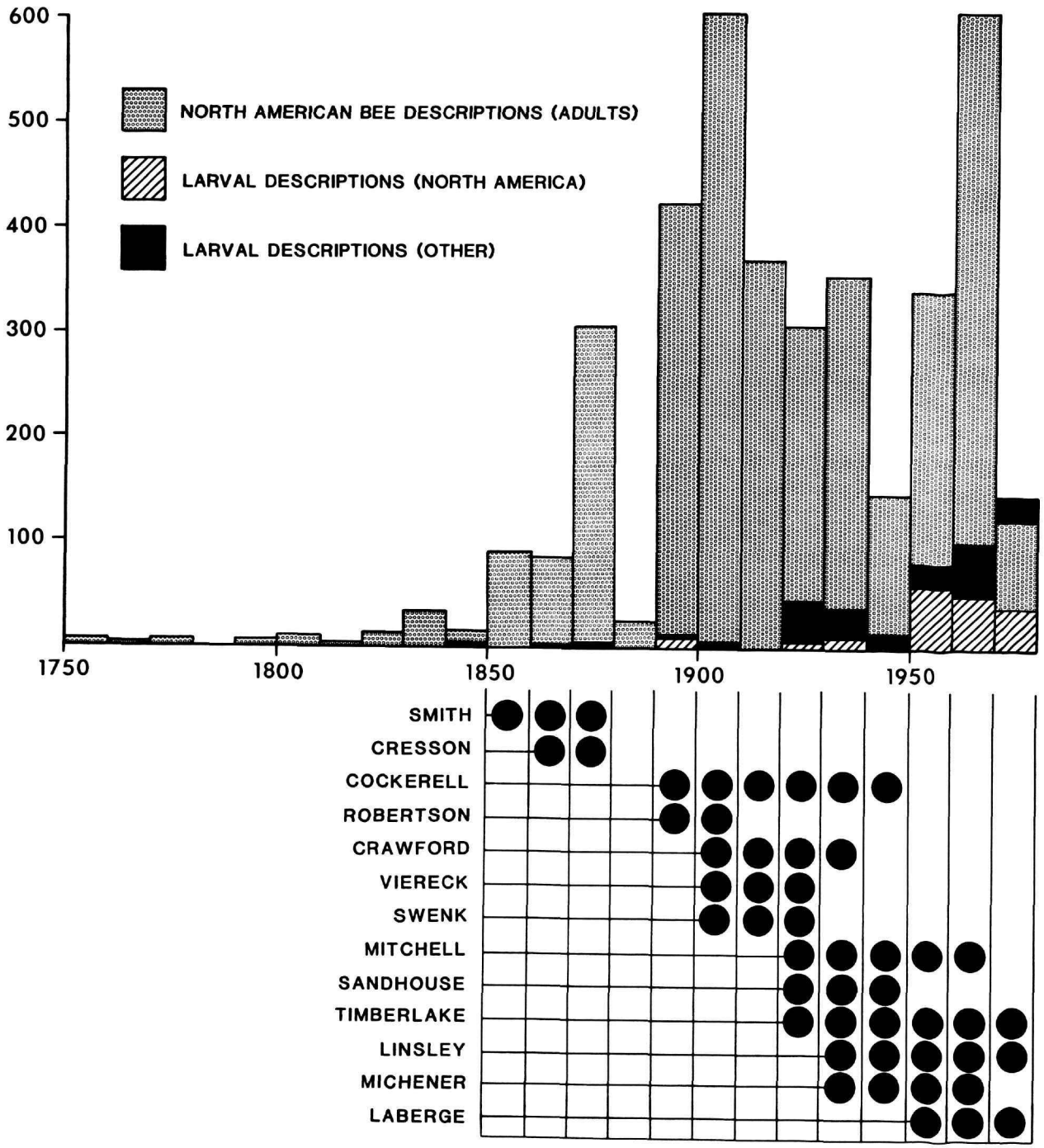

FIGURE 1.—History of the bee fauna in America north of Mexico: number of adult and larval descriptions per decade (including larval treatments outside North America) and associated systematists who have described over 75 species from this area (most adult data from Hurd, 1979).

but it wasn't until Michener's publication in 1953 that the study of larval bees became truly comparative and organized for the first time. In this publication, Michener described or redescribed the larvae of 135 species and subspecies, provided summary descriptions for the bee families based on mature larvae, presented a key to the larvae of the major hymenopteran taxa and discussed evolutionary trends among bee larvae. Michener followed this landmark paper with a similar treatment of apoid pupae in 1954. These papers have done much to stimulate other bee systematists to collect and study immature bees. Most notably, from 1954 to the present, J.G. Rozen, Jr., has contributed a large body of work that has greatly advanced our understanding of the immatures of virtually all bee families and has emphasized their value in phylogenetic considerations (literature cited in bibliography). Also contributing significantly during this period were G.C. Eickwort (primarily halictine immatures), B. Lucas de Oliveira (Neotropical species), W.P. Stephen and T. Koontz (*Bombus* larvae) and P.F. Torchio (various taxa). Stephen et al., (1969) provided an overview of apoid larval and pupal morphology and included an account of preservation and examination techniques. McGinley (1981) published a key to the known mature larvae throughout the Apoidea and described 96 genera in matrix form (126 characters). An illustrated key to North American bee taxa based on mature larvae, family treatments and introduction to the associated literature was published by McGinley, 1987. Torchio and Burwell (1987) have contributed descriptions (in tabular form) of several colletid pupae and discuss some general problems in studying apoid pupae.

Systematic Contribution of Immature Apoid Studies

The few studies published that consider the immature forms of any significant number of congeneric species indicate that larvae and pupae, for some taxa, appear to be of limited value at the alpha-taxonomic level. In his study of adults and larvae of *Nomadopsis*, Rozen (1958) states, "there appears to be no differentiation of the larvae with respect to species groups or subgenera." Eickwort (1981) writes, "I have examined in detail larvae and pupae of 6 species of *Agapostemon* and they are all very similar in even the most minute morphological characters. This suggests that immature stages are unlikely to provide good characters to distinguish closely related halictine species but will prove valuable in generic studies." However, closely related species in other bee taxa can be distinguished by larval characters. For example, Torchio and Torchio (1975) were able to differentiate four closely related species of *Apis* on the basis of larval features and in an unpublished study they found it easy to distinguish the larvae of nine species of *Diadasia* (P.F. Torchio, pers. comm.). Rozen and McGinley (1974a) were able to provide a key to the mature larvae of eight species of *Hesperapis*. In his study of *Perdita*, Eickwort (1977 and pers. comm.) shows that larval characters might be valuable in this taxon at the subgeneric and species group level. As stated by P.F. Torchio (pers. comm.), at the species level "the value of larval characteristics may, therefore, vary from one taxon to another within Apoidea."

That larval and pupal characters can be extremely valuable in systematic studies at the generic and higher categorical levels is well illustrated by Rozen's various studies on the Nomadinae (1966c, 1977c), on the Panurginae (1966a, 1968, 1970a, 1971), and the Fideliinae (1970b, 1973b, 1977b) and Lithurginae (1973c). In contrast to the ordinary cell-reared bee larvae, allodapine larvae which do not live in cells have excellent characters at both generic and specific levels. Michener (1977) showed that allodapine larvae were extremely valuable in generic studies; analysis of larval characters alone gave the closest approximation of the topology of a general cladogram based on cladistic analysis of adult, pupal, larval and egg characters.

That apoid larvae do not seem to be highly informative at the higher apoid categorical levels was suggested by Michener and Greenberg (1980). An attempt to illustrate this apparent lack of resolution is presented in Figure 2, where the highest known categorical levels supported by larval synapomorphies are presented (characters listed in Appendix) and contrasted with the greater clustering detected on the basis of adult morphology (Michener and Greenberg, 1980). Among the larger bee families, only the Andrenidae is supported by larval characters alone. This does not argue against the monophyly of the other apoid families (supported by other character sets), but illustrates the lack of phylogenetic resolution detected at this categorical level.

Immature Apoid Collecting/Research Priorities

The primary goal of this paper is not to review what has been accomplished in the study of immature apoids, but rather to identify what still needs to be done. The figures presented in Table 1 review the percentage of genera in each apoid family and subfamily that are known as mature larvae. Of the 480 genera listed in this compilation only 151 (31%) genera are known in the larval stage. The following listing points out the major synthetic papers within each family and emphasizes which taxa might be considered primary targets for future research efforts.

COLLETIDAE.—Although the mature larvae of this family were reviewed by McGinley (1981), only 26 percent of the currently recognized colletid genera are known as larvae. Most work is needed on the many genera of Neotropical and Australasian Paracolletini (Colletinae) and the Australasian Euryglossinae. Of special interest, would be the location of immature representatives of the Neotropical diphaglossine tribe Dissoglottini (*Mydrosoma, Mydrosomella, Ptiloglossidia*). In the United States and neotropics, immature forms of *Eulonchopria* (Paracolletini) remain unknown. Known colletid pupae

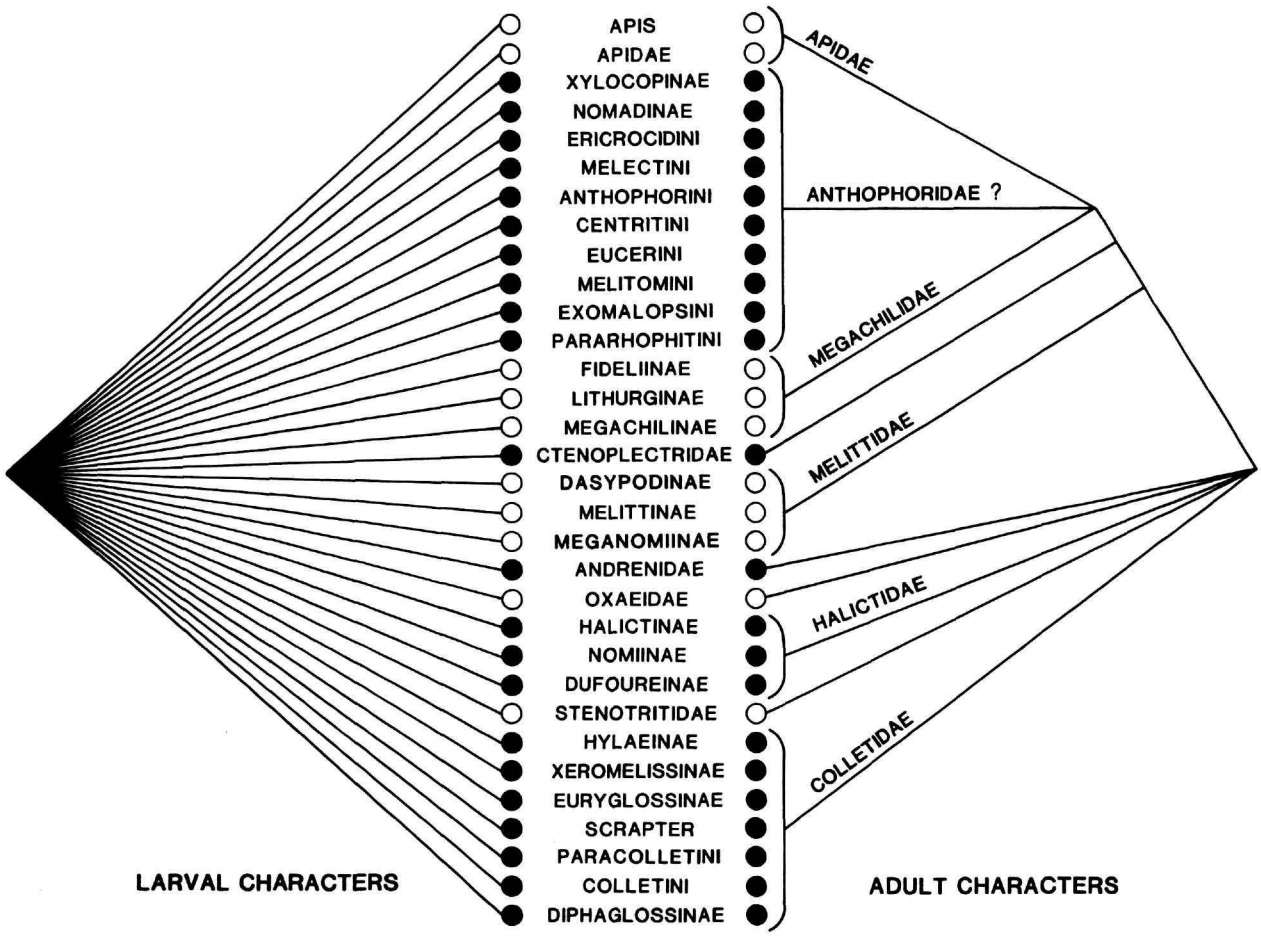

FIGURE 2.—Highest known categorical levels supported by apoid larval synapomorphies (left-hand side) contrasted with higher resolution detected from study of adult characters (Michener and Greenberg, 1980). Apparent larval synapomorphies are listed in Appendix.

TABLE 1.—Percentage of genera known as mature larvae among apoid families and subfamilies.

COLLETIDAE	26.0	ANDRENIDAE	41.0	MEGACHILIDAE	22.0
Colletinae	27.0	Andreninae	17.0	Fideliinae	100.0
Diphaglossinae	44.0	Panurginae	45.0	Lithurginae	66.0
Euryglossinae	11.0			Megachilinae	18.0
Hylaeinae	33.0	OXAEIDAE	50.0		
Xeromelissinae	25.0			ANTHOPHORIDAE	39.0
		MELITTIDAE	28.6	Anthophorinae	38.0
STENOTRITIDAE	50.0	Dasypodinae	38.0	Nomadinae	40.0
		Meganomiinae	25.0	Xylocopinae	74.0
HALICTIDAE	20.0	Melittinae	40.0		
Dufoureinae	15.0			APIDAE	72.0
Halictinae	20.0	CTENOPLECTRIDAE	50.0	Apinae	100.0
Nomiinae	100.0			Bombinae	62.0
				Meliponinae	78.0

have been reviewed by Torchio and Burwell (1987).

STENOTRITIDAE.—Houston (1975) located and described larvae of *Stenotritus pubescens* and has recently collected the larvae of *S. greavesi* and larval representatives of two species of *Ctenocolletes* (McGinley, in prep.).

HALICTIDAE.—Despite the significant contributions by G.C. and K.R. Eickwort (literature cited in bibliography), the larvae and pupae of this family remain virtually unknown with only 20 percent of the recognized genera represented by immatures. Given the high level of diversity exhibited by adult nomiines, the study of additional immatures of this subfamily should prove most valuable. The immatures of Nomioidini (*Ceyalictus, Nomioides*) in the Halictinae are unknown.

ANDRENIDAE.—Among andrenines, immatures of only a few of the numerous *Andrena* subgenera are known; as more representatives become known they may contribute significantly to our understanding of species group relationships. In the United States, immatures of *Ancylandrena* and *Megandrena* are unknown.

Panurgine immatures are relatively well known, largely due the efforts of J.G. Rozen. Rozen (1966a) contributed a synthetic account of panurgine larvae and additional treatments of the immatures of *Meliturgula* (Rozen, 1968), *Hypomacrotera* and *Protandrena* (as *Psaenythia*) (Rozen, 1970a), and *Melitturga* and *Panurgus* (Rozen, 1971). Despite this progress, the immatures of 19 genera of panurgines remain unknown, including *Metapsaenythia* and *Xenopanurgus* from the United States. Yager and Rozen (1966) published a preliminary account of andrenid pupae.

OXAEIDAE.—The known larvae of *Oxaea* (Roberts, 1973) and *Protoxaea* (Rozen, 1964a) are very similar. Immatures of *Mesoxaea* and *Notoxaea* are unknown.

MELITTIDAE.—The known immatures of this family were reviewed by Rozen and McGinley (1974b). Rozen has contributed additional papers on the immatures of *Meganomia* (Rozen, 1977a) and *Macropis* (Rozen and Jacobson, 1980). Among those genera for which immature representatives are unknown, most interesting to locate would be immatures of the dasypodine tribes Promelittini (*Promelitta*) and Sambini (*Samba*).

CTENOPLECTRIDAE.—The mature larva of *Ctenoplectra armata* was described by Rozen (1978). At that time, the Ctenoplectrinae were classified as a melittid subfamily, and Rozen's phylogenetic considerations were made within that context. Larval characters should be reanalyzed in light of recent information presented by Michener and Greenberg (1980) that indicates ctenoplectrids are the sister group of the long-tongued bee families (Figure 2).

MEGACHILIDAE.—In a series of papers, Rozen (1970b, 1973b,c, 1977b) has contributed most significantly to our knowledge of fideliine and lithurgine megachilids. Immature representatives of all genera in these two subfamilies are known, with the exception of pupal *Parafidelia*. This progress contrasts sharply with our understanding of megachiline immatures, which have never been comprehensively reviewed. In the Anthidiini alone, 64 genera remain unknown in immature form.

ANTHOPHORIDAE.—Within the Anthophorinae, Rozen has contributed comprehensive papers on the Eucerini and Centridini (Rozen, 1965b) and the Melectini, Ericrocini, and Rhathymini (Rozen, 1969). Lucas de Oliveira (1962, 1966a) has published preliminary comparative studies of exomalopsine larvae. Within the Anthophorini, Michener (1953) compared a number of *Anthophora* larvae and Torchio and Stephen (1961) described the immatures of *Emphoropsis*. In spite of the above work, our understanding of larval/pupal diversity in this subfamily remains meager, for example, the immatures of 21 genera of Eucerini are unknown including those of *Gaesischia, Martinapis, Melissoptila, Simanthedon,* and *Xenoglossodes*, all of which occur within the United States. The immatures of four anthophorine tribes await discovery: Ancylini (*Ancyla, Tarsalia*), Canephorulini (*Canephorula*), Eucerinodini (*Eucerinoda*), and Tetrapediini (*Tetrapedia*). In the United States, immatures of *Ericrocis*, apparent parasites of *Centris*, should be considered primary targets.

Known mature larvae of the Nomadinae were reviewed by Rozen (1966c, 1977c) and those of the included Ammobatini by Rozen and McGinley (1974b). Because nomadines are cleptoparasitic in the nests of other bees, their immature forms are especially difficult to locate and to correctly associate with adult forms. Most exciting finds would include the discovery of immature Epeoloidini (*Epeoloides;* apparent parasites of *Macropis*) and Townsendiellini (*Townsendiella*, tentatively associated with *Hesperapis*), both of which occur within the United States. Other nomadine tribes unknown as immatures are the Ammobatoidini (*Ammobatoides*), Caenoprosopidini (*Caenoprosopidis*) and Osirini (*Osiris*). Important contributions could be made with the discovery of the many unknown genera of the Ammobatini and the Ericrocidini.

Within the Xylocopinae, study of immature allodapines include the early efforts of Rayment (1949a,b, 1951) and Syed (1963). This group, which exhibits the greatest morphological diversity known among apoid larvae, was the focus of a series of comprehensive papers by Michener (1964, 1975, 1976, 1977). The known immatures of *Xylocopa* have been studied by Lucas de Oliveira (1974). Immatures of *Lestis*, and *Proxylocopa* have not been treated in the literature.

APIDAE.—The known larvae of *Apis* were thoroughly studied by Torchio and Torchio (1975). Their study is especially notable for documenting considerable levels of intraspecific morphological variability which should be considered in future larval work. Larval Bombini were subject to early study by Ritcher (1933) and more recently by Stephen and Koontz (1973). Surprisingly, immatures of only two genera of the popularly studied Euglossini are known; immatures of *Eufriesea, Exaerete*, and *Aglae* remain unknown and should be considered primary targets. What we know about the immatures of the Meliponinae comes mostly from the

contributions of Lucas de Oliveira (1958, 1960, 1965, 1966a, 1968, 1970). Many more larval/pupal representatives of this subfamily need to be collected; immatures of *Dactylurina* and *Meliponula* are unknown.

Catalog of Immature Apoidea

The information presented below was obtained from a personal card catalog maintained since 1977. A computer search of the literature was carried out in August 1988; the data bases searched were the Biosis Previews Database (1969–1988), the Zoological Record Database (1978–1983) and the Life Sciences Collection Database (1978–1985). Only systematic treatments of immatures are listed; a large body of literature dealing with immature development, physiology and biology exists but is not included here (see for example the paper on embryogenesis by Torchio and Trostle, 1986). Some larvae are known to have been collected but as of yet have not been treated in the literature; these are herein listed as being unknown.

The classification utilized largely follows an unpublished listing of bee taxa at and above the subgeneric level compiled by Radclyffe B. Roberts; this listing is not intended to be exhaustive, especially for Old World taxa, but is most adequate for cataloging immature studies.

Papers dealing only with larvae are cited without annotation; papers treating both larvae and pupae are cited with the annotation "[+ PUPA]"; citations followed by "[PUPA]" indicate that only pupae were treated. The numbers in parentheses after the higher categories indicate the percentage of bee genera in that taxon known as mature larvae. Taxa enclosed by brackets are known to have been collected, but as yet have not been treated taxonomically (listed depositories are: the University of Kansas (KU), the Bee Biology and Systematics Laboratory, Utah State University (UTAH), and the Smithsonian Institution (USNM; Karl V. Krombein trap-nesting material). The American Museum of Natural History, New York, is a major depository for immature apoids and houses many unstudied specimens not listed herein; interested biologists should contact Jerome G. Rozen, Jr., for information concerning loan and deposition policies.

COLLETIDAE (26%)

COLLETINAE (27%)

COLLETINI (25%)

Colletes araucariae Friese.—Claude-Joseph, 1926; Michener, 1953; McGinley, 1981.

Colletes ciliatoides Stephen.—Nielsen and Bohart, 1967 [sex characters]; Torchio and Burwell, 1987 [PUPA].

Colletes ciliatus Friese.—Claude-Joseph, 1926; Michener, 1953.

Colletes cognatus Spinola.—Torchio and Burwell, 1987 [PUPA].

Colletes daviesanus Smith.—Semichon, 1936.

Colletes fulgidus Swenk.—Michener, 1953, 1954 [PUPA]; McGinley, 1981.

Colletes kincaidii Cockerell.—Torchio and Burwell, 1987 [PUPA].

Colletes laticeps Friese.—Claude-Joseph, 1926; Michener, 1953; McGinley, 1981.

Colletes michenerianus Moure.—McGinley, 1981.

Colletes succinctus (Linnaeus).—Mayet, 1875 [+ PUPA]; Michener, 1953.

Colletes thoracicus Smith.—McGinley, 1981.

Colletes validus Cresson.—Rajotte, 1979.

Unknown: *Hemicotelles, Mourecotelles, Xanthocotelles.*

PARACOLLETINI (27%)

Callomelitta species A.—McGinley, 1981.

Leioproctus cingulatus (Moure).—McGinley, 1981.

Leioproctus zonalis (Reed).—Claude-Joseph, 1926 [as *Lonchopria marginata*]; Michener, 1953; McGinley, 1981.

Leioproctus zonatus (Moure).—McGinley, 1981.

Leioproctus species near *semipurpureus* (Cockerell).—McGinley, 1981.

Scrapter longula (Friese).—McGinley, 1981.

Unknown: *Anthoglossa, Eulonchopria, Hesperocolletes, Hexantheda, Neopasiphae, Paracolletes, Tetraglossula, Trichocolletes.*

DIPHAGLOSSINAE (44%)

CAUPOLICANINI (100%)

Caupolicana gayi Spinola.—Claude-Joseph, 1926; Michener, 1953; McGinley, 1981.

Crawfordapis luctuosa (Smith).—Otis et al., 1982; Roubik and Michener, 1985 [PUPA]; Torchio and Burwell, 1987 [PUPA].

Ptiloglossa fulvopilosa (Cameron).—McGinley, 1981.

Ptiloglossa species A.—McGinley, 1981.

Ptiloglossa species B.—McGinley, 1981.

DIPHAGLOSSINI (33%)

Cadeguala occidentalis (Haliday).—Claude-Joseph, 1926 [as *Policana occidentalis*]; Michener, 1953; McGinley, 1981; Torchio and Burwell, 1987 [PUPA].

Cadeguala albopilosa (Spinola).—Claude-Joseph, 1926; Michener, 1953, 1954 [PUPA]; McGinley, 1981 [all above as *Policana herbsti*]; Torchio and Burwell, 1987 [PUPA].

Unknown: *Cadegualina, Diphaglossa.*

DISSOGLOTTINI (0)

Unknown: *Mydrosoma, Mydrosomella, Ptiloglossidia.*

EURYGLOSSINAE (11%)

Euryglossa fasciatella Cockerell.—Michener, 1953.
Euryglossa subsericea Cockerell.—McGinley, 1981.
Euryglossa species A.—McGinley, 1981.
Pachyprosopis angophorae Cockerell.—McGinley, 1981.
Pachyprosopis indicans (Cockerell).—McGinley, 1981.
Unknown: *Argohesma, Brachyhesma, Dasyhesma, Euryglossina, Euryglossella, Euryglossula, Heterohesma, Hyphesma, Melittosmithia, Parapachyprosopis, Quasihesma, Sericogaster, Stenohesma, Stilpnosoma, Turnerella, Xanthesma.*

HYLAEINAE (33%)

Amphylaeus morosus (Smith).—McGinley, 1981.
Hylaeus alcyoneus (Erichson).—McGinley, 1981.
Hylaeus asininus (Cockerell and Casad).—McGinley, 1981.
Hylaeus bisinuatus Forster.—Torchio and Burwell, 1987 [PUPA].
Hylaeus brevicornis (Nylander).—Danks, 1970.
Hylaeus cressoni (Cockerell).—Nielsen and Bohart, 1967 [sex characters].
Hylaeus modestus Say.—McGinley, 1981.
Hylaeus nigritus Fabricius.—Janvier, 1969.
Hylaeus parvulus Janvier.—Janvier, 1972.
Hylaeus perhumilis (Cockerell).—McGinley, 1981.
Hylaeus pictus Smith.—Janvier, 1969.
Hylaeus pubescens (Perkins).—Daly and Coville, 1982.
Hylaeus variegata (Fabricius).—Stockhert, 1922; Michener, 1953.
Hylaeus species—Michener, 1953.
[*Hylaeus* species, UTAH.]
Hyleoides concinna (Fabricius).—McGinley, 1981.
Meroglossa species A, near *torrida* (Smith).—McGinley, 1981.
[*Palaeorhiza gratiosa* Cheesman; Y. Hirashima material, on loan to R.J. McGinley.]
[*Palaeorhiza gressittorum* Hirashima; Y. Hirashima material, on loan to R.J. McGinley.]
Unknown: *Agogenohylaeus, Gephyrohylaeus, Hemirhiza, Heterapoides, Hylaeorhiza, Nothylaeus, Pharohylaeus.*

XEROMELISSINAE (25%)

Chilicola ashmeadi (Crawford).—Eickwort, 1967 [+ PUPA]; McGinley, 1981; Torchio and Burwell, 1987 [PUPA].
Chilicola friesei Herbst.—Claude-Joseph, 1926; Michener, 1953.
Chilicola inermis Friese.—Claude-Joseph, 1926; Michener, 1953.
Xeromelissine species A.—McGinley, 1981.
Unknown: *Chilimelissa, Xenochilicola, Xeromelissa.*

STENOTRITIDAE (50%)

[*Stenotritus greavesi* (Rayment); T.F. Houston material, on loan to R.J. McGinley.]
Stenotritus pubescens (Smith).—Houston, 1975; McGinley, 1981.
[*Ctenocolletes nicholsoni* (Cockerell); T.F. Houston material, on loan to R.J. McGinley.]
[*Ctenocolletes ordensis* Michener; T.F. Houston material, on loan to R.J. McGinley.]

HALICTIDAE (20%)

DUFOUREINAE (15%)

Dufourea mulleri (Cockerell).—Torchio et al., 1967 [partial description]; McGinley, 1981.
Dufourea novaeangliae (Robertson).—Eickwort et al., 1986.
Rophitoides canus (Eversm.).—Enslin, 1921 [as *Rhophites canus*].
[*Systropha punjabensis* Batra and Michener.—Batra and Michener, 1966 (immature larva)].
Unknown: *Conanthalictus, Michenerula, Micralictoides, Morawitzia, Morawitzeiella, Penapis, Protodufourea, Rophites, Sphecodosoma,* [*Systropha,* UTAH], *Xeralictus.*

HALICTINAE (20%)

AUGOCHLORINI (17%)

Augochlora cordiaefloris Cockerell.—Eickwort and Eickwort, 1972a [+ PUPA].
Augochlora hallinani Michener.—Eickwort and Eickwort, 1973a [+ PUPA].
Augochlora nominata Michener.—Eickwort and Eickwort, 1972a [+ PUPA].
Augochlora pura (Say).—Michener, 1953, 1954 [PUPA]; McGinley, 1981.
Augochlora sidaefoliae Cockerell.—Eickwort and Eickwort, 1973a [+ PUPA].
Corynura chloris (Spinola).—Claude-Joseph, 1926 [as *Halictus chloris*].
Corynura cristata (Smith).—Claude-Joseph, 1926 [as *Halictus cristatus*].
Neocorynura colombiana Eickwort.—Eickwort, 1979 [+ PUPA].
[*Neocorynura* species, KU.]
Pereirapis edentata Michener.—Eickwort and Eickwort, 1973b [+ PUPA, as *Augochlorella*]; McGinley, 1981.
Unknown: *Andinaugochlora, Ariphanarthra, Augochlorella, Augochlorodes,* [*Augochloropsis,* KU], *Caenaugochlora, Ceratalictus, Chlerogas, Chlerogella, Corynurella, Halictillus, Megalopta, Megaloptidia, Megommation, Paroxystoglossa,* [*Pseudaugochloropsis,* KU], *Rhectomia, Rhinocorynura, Temnosoma, Thectochlora.*

HALICTINI (24%)

Agapostemon angelicus Cockerell.—Eickwort, 1981 [+ PUPA].
Agapostemon cockerelli Crawford.—Eickwort, 1981 [+ PUPA].
Agapostemon nasutus Smith.—Eickwort and Eickwort, 1969 [+ PUPA].
Agapostemon sericeus (Forster).—LaBerge and Ribble, 1966a [as *A. radiatus*]; Eickwort, 1981 [+ PUPA]; McGinley, 1981 [as *A. radiatus*].
Agapostemon texanus Cresson.—Eickwort, 1981 [+ PUPA].
Agapostemon virescens (Fabricius).—Abrams and Eickwort, 1980 [+ PUPA].
[*Halictus (Halictus) farinosus* Smith, UTAH.]
Halictus (Halictus) ligatus Say.—Packard, 1897; Michener, 1953; McGinley, 1981.
Halictus (Halictus) parallelus Say.—Packard, 1897; Michener, 1953.
Halictus (Halictus) scabiosae Rossi.—Grandi, 1954, 1961.
Halictus (Halictus) sexcinctus (Fabricius).—Grandi, 1937, 1961; Michener, 1953.
Halictus (Seladonia) tripartitus Cockerell.—Michener, 1953, 1954 [PUPA].
Lasioglossum (Dialictus) spinolae (Friese).—Claude-Joseph, 1926.
Lasioglossum (Ctenonomia) albescens sepulchralis Cameron.—Sakagami, 1968 [+ PUPA].
Lasioglossum (Evylaeus) duplex Dalla Torre.—Sakagami and Hayashida, 1960 [+ PUPA].
Lasioglossum (Dialictus) herbstiellum (Friese).—Claude-Joseph, 1926 [as *Halictus herbstiellus*].
Lasioglossum (Dialictus) imitatum (Smith).—Michener, 1953 [as *L. sparsum*], 1954 [PUPA, as *L. sparsum*].
Lasioglossum (Evylaeus) kincaidii (Cockerell).—Michener, 1953, 1954 [PUPA].
Lasioglossum (Hemihalictus) lustrans (Cockerell).—Daly, 1961.
Lasioglossum (Evylaeus) malachurum (Kirby).—Soika, 1934 [+PUPA]; Michener, 1953.
Lasioglossum (Evylaeus) ohei Hirashima and Sakagami.—Sakagami, Hirashima, and Ohe, 1966.
Lasioglossum (Dialictus) umbripenne (Ellis).—Eickwort and Eickwort, 1971 [+ PUPA].
Lasioglossum (Dialictus) zephyrum (Smith).—(McGinley, 1981).
Lasioglossum (Dialictus) species.—Michener, 1953.
Microsphecodes kathleenae Eickwort.—Eickwort and Eickwort, 1972b [+ PUPA].
Ruizantheda (Ruizanthedella) mutabilis (Spinola).—Claude-Joseph, 1926 [as *Halictus mutabilis*].
Sphecodes albilabris (Kirby).—Rozen, 1965a [+ PUPA]; McGinley, 1981.
Sphecodes species.—Michener, 1953, 1954 [+ PUPA; reported as *Neopasites* species?].
Sphecodes species, near *fragariae* Cockerell.—Torchio, 1975 [+ PUPA].
Unknown: *Archihalictus*, [*Caenoha lic tus*, KU], *Dinagapostemon*, *Echthralictus*, *Eupetersia*, [*Habralictus*, KU], *Homalictus*, *Madagalictus*, *Mexalictus*, *Pachyhalictus*, *Paragapostemon*, *Parathrincostoma*, *Patellapis*, [*Pseudagapostemon*, KU], *Ptilocleptis*, *Rhinetula*, *Thrincohalictus*, *Thrinchostoma*, *Zonalictus*.

NOMIOIDINI (0)

Unknown: *Ceyalictus*, *Nomioides*.

NOMIINAE (100%)

(Many taxa in this group have variously been treated as genera or subgenera; undoubtedly, there are several valid nomiine genera but the following conservative scheme, i.e., *Nomia* (s.l.), is used here to avoid additional confusion).

Nomia australica Smith.—Rayment, 1957.
Nomia esakii Hirashima.—Hirashima, 1961 [as *Rhopalomelissa*].
[*Nomia heteropoda* Say, UTAH.]
Nomia melanderi Cockerell.—Michener, 1953, 1954 [PUPA]; Nielsen and Bohart, 1967 [sex characters]; McGinley, 1981.
Nomia n. nevadensis Cresson.—Michener, 1953; Nielsen and Bohart, 1967 [sex characters].
Nomia punctulata Dalla Torre.—Masuda, 1943; Hirashima, 1961.
Nomia ruficornis Spinola.—Soika, 1932; Michener, 1953.
Nomia triangulifera Vachal.—Nielsen and Bohart, 1967 [sex characters].
Nomia yasumatsui Hirashima.—Hirashima, 1961 [as *Rhopalomelissa*].
Nomia species.—LaBerge and Ribble, 1966a [as *Agapostemon splendens*].

ANDRENIDAE (41%)

ANDRENINAE (17%)

Andrena (Callandrena) accepta Viereck.—Rozen, 1973a; McGinley, 1981.
Andrena (Leucandrena) barbilabris (Kirby).—Thorp and Stage, 1968 [+ PUPA; as *A. placida* Smith].
Andrena (Thysandrena) bisalicis Viereck.—Yager and Rozen, 1966 [PUPA]; Rozen, 1973a.
Andrena (Euandrena) caerulea Smith.—Michener, 1953 [as *A. complexa* Viereck].
Andrena (Thysandrena) candida Smith.—Youssef and Bohart, 1968 [+ PUPA].
Andrena (Melandrena) carlini Cockerell.—Schrader and LaBerge, 1978.
Andrena (Diandrena) chalybaea (Cresson).—Thorp, 1969.
Andrena (Melandrena) dunningi Cockerell.—Johnson, 1981.
Andrena (Ptilandrena) erigeniae Robertson.—Davis and LaBerge, 1975.

Andrena (Leucandrena) erythronii Robertson.—Michener, 1953; Yager and Rozen, 1966 [PUPA].
Andrena (Scrapteropsis) imitatrix Cresson.—Yager and Rozen, 1966 [PUPA]; Rozen, 1973a.
Andrena (Larandrena) miserabilis Cresson.—Norden and Scarbrough, 1979.
Andrena (Scrapteropsis) morrisonella Viereck.—Rozen, 1973a.
Andrena (Tylandrena) perplexa Smith.—Stephen, 1966 [+ PUPA; as *A. viburnella*].
Andrena (Melandrena) regularis Malloch.—Schrader and LaBerge, 1978.
Andrena (Melandrena) vicina Smith.—Packard, 1897 [+ PUPA]; Michener, 1953.
Andrena species.—Michener, 1953.
Unknown: *Alocandrena, Ancylandrena, Euherbstia, Megandrena, Orphana.*

PANURGINAE (45%)

Acamptopoeum submettallicum (Spinola).—Claude-Joseph, 1926 [as *Camptopaeum*]; Michener, 1953.
Calliopsis andreniformis Smith.—Michener, 1953; Rozen, 1966a; Yager and Rozen, 1966 [PUPA].
Calliopsis crypta Shinn.—Rozen, 1966a; McGinley, 1981.
Calliopsis rozeni Shinn.—Rozen, 1966a.
Camptopoeum bakeri Rozen.—Rozen, 1988.
Heterosarus boylei (Cockerell).—Rozen, 1966a; McGinley, 1981.
Hypomacrotera callops callops Cockerell and Porter.—Rozen, 1970a [+ PUPA]; McGinley, 1981.
Melitturga caudata Perez.—Rozen, 1971.
Melitturga clavicornis (Latreille).—Rozen, 1965a; Yager and Rozen, 1966 [PUPA]; McGinley, 1981.
Meliturgula braunsi Friese.—Rozen, 1968 [+ PUPA]; McGinley, 1981.
Nomadopsis anthidia anthidia (Fowler).—Rozen, 1958; Yager and Rozen, 1966 [PUPA]; Nielsen and Bohart, 1967 [sex characters].
Nomadopsis anthidia lutea Rozen.—Rozen, 1958.
Nomadopsis australior (Cockerell).—Custer, 1929; Michener, 1953; Rozen, 1958.
Nomadopsis barbata Timberlake.—Rozen, 1958.
Nomadopsis boharti Rozen.—Rozen, 1958; Yager and Rozen, 1966 [PUPA].
Nomadopsis comptula (Cockerell).—Rozen, 1958.
Nomadopsis edwardsii (Cresson).—Rozen, 1958.
Nomadopsis filiorum Rozen.—Rozen, 1963.
Nomadopsis fracta Rozen.—Michener, 1953; Rozen, 1958.
Nomadopsis helianthi (Swenk and Cockerell).—Michener, 1953, 1954 [PUPA, described as *N. euphorbiae* (Cockerell)]; Rozen, 1958; Yager and Rozen, 1966 [PUPA].
Nomadopsis hesperia equina (Cockerell).—Rozen, 1958; Yager and Rozen, 1966 [PUPA].
Nomadopsis linsleyi Rozen.—Rozen, 1958.
Nomadopsis micheneri Rozen.—Rozen, 1958.
Nomadopsis personata (Cockerell).—Yager and Rozen, 1966 [PUPA].
Nomadopsis puellae (Cockerell).—Rozen, 1958; Yager and Rozen, 1966 [PUPA]; McGinley, 1981.
Nomadopsis scitula (Cresson).—Yager and Rozen, 1966 [PUPA].
Nomadopsis scutellaris scutellaris (Fowler).—Rozen, 1958; Yager and Rozen, 1966 [PUPA]; Nielsen and Bohart, 1967 [sex characters].
Nomadopsis trifolii Timberlake.—Rozen, 1958.
Nomadopsis zonalis sierrae Rozen.—Rozen, 1963; Yager and Rozen, 1966 [PUPA].
Panurginus albopilosus Lucas.—Rozen, 1971 [+ PUPA].
Panurginus atriceps (Cresson).—Rust, 1976.
Panurginus melanocephalus (Cockerell).—Michener, 1953; Rozen, 1966a.
Panurginus potentillae (Crawford).—Rozen, 1966a; McGinley, 1981.
Panurginus species A.—Rozen, 1966a; Yager and Rozen, 1966 [PUPA].
Panurgus banksianus (Kirby).—Micheli, 1931; Michener, 1953.
Panurgus calcaratus Scopoli.—Micheli, 1936; Michener, 1953.
Panurgus dentipes Latreille.—Rozen and Rozen, 1966; McGinley, 1981.
Panurgus intermedius Rozen.—Rozen, 1971 [+ PUPA].
Panurgus oraniensis Perez.—Rozen, 1971 [+ PUPA].
Panurgus podagricus Perez.—Rozen, 1971.
[*Perdita (Cockerellia) albipennis* Cresson, UTAH.]
[*Perdita (Perdita) bohartorum* Timberlake, UTAH.]
Perdita (Perdita) confusa Timberlake.—Rozen, 1966a.
Perdita (Perdita) halictoides Smith.—Eickwort, 1977 [+ PUPA].
Perdita (Perdita) lenis Timberlake.—Rozen, 1966a.
Perdita (Cockerellia) lingualis Cockerell.—Michener, 1963 [+ PUPA]; Rozen, 1966a; Yager and Rozen, 1966 [PUPA]; McGinley, 1981.
Perdita (Perdita) maculigera maculipennis Graenicher.—Michener and Ordway, 1963 [+ PUPA]; Rozen, 1966a; Yager and Rozen, 1966 [PUPA].
Perdita (Perdita) nuda Cockerell.—Torchio, 1975 [+ PUPA].
Perdita (Perdita) octomaculata (Say).—Eickwort, 1977 [+ PUPA].
Perdita (Cockerellula) opuntiae Cockerell.—Custer, 1929; Michener, 1953.
Perdita (Perdita) sexmaculata Cockerell.—Rozen, 1966a.
Perdita (Perdita) zebrata zebrata Cresson.—Custer, 1929; Michener, 1953; Rozen, 1966a.
Protandrena bicolor (Timberlake).—Rozen, 1970 [+ PUPA]; McGinley, 1981.
Pseudopanurgus aethiops (Cresson).—Rozen, 1966a.

Pseudopanurgus verticalis Timberlake.—Rozen, 1966a.
Pterosarus occidus (Timberlake).—Rozen, 1966a.
Spinoliella herbsti (Friese).—Claude-Joseph, 1926 [as *Camptopaeum*]; Michener, 1953.
Spinoliella maculata (Spinola).—Claude-Joseph, 1926 [as *Camptopaeum*]; Michener, 1953.
Unknown: *Anthemurgus, Anthrenoides, Austropanurgus, Callonychium, Cephalurgus, Epimethea, Liopoeum, Liphanthus, Mermiglossa, Metapsaenythia, Parafriesea, Parapsaenythia, Plesiopanurgus, Poecilomelitta, Protomeliturga, Pseudosarus, Rhophitulus, Xenopanurgus.*

OXAEIDAE (50%)

Oxaea flavescens Klug.—Roberts, 1973 [+ PUPA]; Torchio and Burwell, 1987 [PUPA].
Protoxaea gloriosa (Fox).—Rozen, 1964a; McGinley, 1981.
Unknown: *Mesoxaea, Notoxaea.*

MELITTIDAE (29%)

DASYPODINAE (38%)

DASYPODINI (60%)

Capicola braunsiana Friese.—Rozen and McGinley, 1974a; McGinley, 1981.
Dasypoda plumipes Panzer.—Rozen and McGinley, 1974a; McGinley, 1981.
Hesperapis carinata Stevens.—Rozen and McGinley, 1974a.
Hesperapis ilicifoliae (Cockerell).—Rozen and McGinley, 1974a.
Hesperapis nitidula Cockerell.—Rozen and McGinley, 1974a.
Hesperapis pellucida Cockerell.—Rozen and McGinley, 1974a.
Hesperapis regularis (Cresson).—Burdick and Torchio, 1959; Rozen and McGinley, 1974a.
Hesperapis rufipes (Ashmead).—Michener, 1953; Rozen and McGinley, 1974a.
Hesperapis trochanterata Snelling.—Rozen, 1987a.
Hesperapis species A.—Rozen and McGinley, 1974a.
Hesperapis species B.—Rozen and McGinley, 1974a.
Unknown: *Eremaphanta, Xeralictoides.*

PROMELITTINI (0)

Unknown: *Promelitta.*

SAMBINI (0)

Unknown: *Haplomelitta, Samba.*

MEGANOMIINAE (25%)

Meganomia gigas Michener.—Rozen, 1977a [+ PUPA; as *M. binghami* (Cockerell)]; McGinley, 1981.
Unknown: *Agemmonia, Ceratomonia, Uromonia.*

MELITTINAE (40%)

Macropis europaea Warncke.—Rozen and McGinley, 1974a [+PUPA]; McGinley, 1981.
Macropis nuda (Provancher).—Rozen and Jacobson, 1980 [+ PUPA].
Melitta leporina (Panzer).—Rozen and McGinley, 1974a [+ PUPA]; McGinley, 1981.
Unknown: *Dolichochile, Rediviva, Redivivoides.*

CTENOPLECTRIDAE (50%)

Ctenoplectra armata Magretti.—Rozen, 1978; McGinley, 1981.
Unknown: *Ctenoplectrina.*

MEGACHILIDAE (22%)

FIDELIINAE (100%)

Fidelia villosa Brauns.—Rozen, 1970b [+ PUPA]; McGinley, 1981.
Neofidelia profuga Moure and Michener.—Rozen, 1973b [+ PUPA]; McGinley, 1981.
Parafidelia pallidula Cockerell.—Rozen, 1977b; McGinley, 1981.

LITHURGINAE (66%)

Lithurge apicalis (Cresson).—Rozen, 1973c.
Lithurge atratiformis Cockerell.—Rozen, 1973c; McGinley, 1981.
Lithurge chrysurus Fonscolombe.—Roberts, 1978 [+ PUPA].
Lithurge echinocacti (Cockerell).—Rozen, 1973c [compared to *L. apicalis*].
Trichothurgus dubius (Herbst).—Claude-Joseph, 1926 [as *Lithurge*]; Michener, 1953; Rozen, 1973c [+ PUPA].
Trichothurgus echinocacti (Cockerell).—Rozen, 1973c [as *Lithurge*].
Trichothurgus species—Rozen, 1973c [as *Lithurge*].
Unknown: *Microthurge.*

MEGACHILINAE (18%)

ANTHIDIINI (12%)

Anthidium chilense Spinola.—Claude-Joseph, 1926; Michener, 1953.
Anthidium oblongatum Latreille.—Xambeu, 1896; Maneval, 1937; Michener, 1953.
Anthidium 7-dentatum Lepeletier.—Grandi, 1961.
Anthidium species—McGinley, 1981.
Anthidiellum ehrhorni (Cockerell).—Michener, 1953 [as *Anthidium ehrhorni*].
Anthidiellum perplexum (Smith).—Baker et al., 1985 [PUPA].
Anthidiellum notatum robertsoni (Cockerell).—Michener, 1953.

Dianthidium curvatum sayi Cockerell.—Michener, 1953.
Dianthidium heterulkei heterulkei Schwarz.—Clement, 1976.
Dianthidium species—Michener, 1953; McGinley, 1981.
[*Dianthidium* spp., UTAH.]
Heterostelis hurdi Thorp.—Thorp, 1966 [+ PUPA].
Odontostelis bilineolata (Spinola).—Rozen, 1966b [+ PUPA; as *Stelis*]; McGinley, 1981.
Paranthidiellum lituratum (Panzer).—Enslin, 1923; Micheli, 1934; Michener, 1953.
Paranthidium caturigense (Giraud).—Micheli, 1935; Maneval, 1936; Michener, 1953.
Paranthidium septemdentatum (Latreille).—Xambeu, 1896; Grandi, 1934; Michener, 1953.
Stelis chlorocyanea (Cockerell).—Rust and Thorp, 1973 [+ PUPA].
Stelis elongativentris Parker.—Rozen, 1987b.
Stelis lateralis Cresson.—Michener, 1953; Rozen, 1966b.
Stelis minuta Lepeletier.—Enslin, 1925; Michener, 1953.
Stelis nasuta (Latreille).—Maneval, 1937; Michener, 1953.
Stelis ornatula Nylander.—Micheli, 1935; Michener, 1953.
[*Stelis* spp., UTAH.]
Trachusa perdita Cockerell.—Michener, 1953; McGinley, 1981.
Unknown: *Adanthidium, Afranthidium, Allanthidium, Anthidioma, Anthodioctes, Apianthidium, Archianthidium, Asianthidium, Aspidosmia, Atropium, Ausanthidium, Axillanthidium, Aztecanthidium, Bathanthidium, Bellanthidium, Benanthis, Branthidium, Bothranthidium,* [*Callanthidium,* UTAH], *Capanthidium, Carinanthidium, Cyphanthidium,* [*Dolichostelis,* UTAH], *Domanthidium, Doxanthidium, Epanthidium, Euaspis, Exanthidium, Gnathanthidium, Heteranthidium, Honanthidium, Hypanthidioides, Hypanthidium, Icteranthidium, Immanthidium, Malanthidium, Manthidium, Meganthidium, Melanthidium, Mesanthidiellum, Mesanthidium, Nananthidium, Neanthidium, Nigranthidium, Notanthidium, Oranthidium, Oxyanthidium, Pachyanthidium, Paraanthidium,* [*Parevaspis,* UTAH], *Plesianthidium, Pseudoanthidium, Pyctanthidium, Reanthidium, Rhodanthidium, Royanthidium, Serapista, Spinanthidium, Trianthidiellum, Trianthidium, Trichanthidium, Tuberanthidium, Ulanthidium, Xenanthidium.*

DIOXINI (100%)

Dioxys cincta (Jurine).— Micheli, 1936; Michener, 1953.
Dioxys pomonae pomonae Cockerell.—Rozen, 1967 [+ PUPA]; McGinley, 1981.
Dioxys productus productus (Cresson).—Rozen, 1967.

MEGACHILINI (75%)

Chalicodoma (Chelostomoides) campanulae campanulae (Robertson).—Baker, Kuhn, and Bambara, 1985.
Chalichodoma (Pseudomegachile) flavipes Spinola.—Moustafa and Mazeed, 1977 [+ PUPA].
Chalicodoma (Callomegachile) mystaceana Michener.—King, 1984 [+ PUPA].
Chalicodoma (Chelostomoides) species.—Michener, 1953, 1954 [PUPA].
[*Chalicodoma* spp., UTAH.]
Coelioxys elongata Lepeletier.—Iwata, 1939.
[*Coelioxys funeraria* Smith, UTAH.]
Coelioxys modesta Smith.—Baker et al., 1985 [additional material in USNM].
Coelioxys octodentata Say.—Michener, 1953; Baker, 1971.
Coelioxys sayi Robertson.—Baker, 1971; Baker et al., 1985 [PUPA]; [first instar in USNM].
Coelioxys species.—McGinley, 1981.
Megachile albisecta Klug.—Grandi, 1931; Michener, 1953; Grandi, 1961.
Megachile argentata Fabricius.—Grandi, 1931; Michener, 1953; Grandi, 1961.
Megachile brevis Say.—Michener, 1953, 1954 [PUPA]; McGinley, 1981.
Megachile buyssonii Perez.—Buysson, 1902; Michener, 1953.
Megachile centuncularis (Linnaeus).—Packard, 1897; Buysson, 1902; Grandi, 1934; Michener, 1953; Grandi, 1961; Romasenko, 1983b.
Megachile euzona Perez.—Claude-Joseph, 1926; Michener, 1953.
Megachile lagopoda (Linnaeus).—Buysson, 1902; Michener, 1953; Marikovskaja, 1984.
Megachile ligniseca Kirby.—Romasenko, 1983a.
Megachile maculatis Dalla Torre.—King, 1984.
Megachile maritima (Kirby).—Buysson, 1902; Michener, 1953.
Megachile mendica Cresson.—Baker et al., 1985 [+ PUPA].
Megachile montivaga Cresson.—Baker et al., 1985.
Megachile muraria Fabricius.—Grandi, 1934; Michener, 1953; Grandi, 1961.
Megachile nigriventris Schenck.—Micheli, 1937; Michener, 1953.
Megachile policaris Say.—Baker et al., 1985 [+ PUPA; as *Eumegachile*].
Megachile pollinosa Spinola.—Claude-Joseph, 1926; Michener, 1953.
Megachile pyrenaica pyrenaica Lepeletier.—Buysson, 1902; Michener, 1953.
Megachile pyrenaica alpina Morawitz.—Micheli, 1935; Michener, 1953.
Megachile rancaguensis Friese.—Claude-Joseph, 1926; Michener, 1953.
Megachile rotundata (Fabricius).—Nielsen and Bohart, 1967 [sex characters].
Megachile saulcyi Guerin-Meneville.—Claude-Joseph, 1926; Michener, 1953.
Megachile versicolor Smith.—Danks, 1970.
Megachile species.—King, 1984.

Megachile species.—Michener, 1953.
[*Megachile* spp., USNM.]
Unknown: *Creightoniella.*

OSMIINI (23%)

Many unstudied taxa, including nearly all species of *Ashmeadiella,* are in the collections of the Bee Biology and Systematics Laboratory, Utah State University and the Smithsonian Institution.

Ashmeadiella species.—Michener, 1953; McGinley, 1981.
Heriades carinatus Cresson.—Matthews, 1965.
Heriades crenulatus Nylander.—Grandi, 1934; Grandi, 1961; Michener, 1953.
Hoplitis adunca (Panzer).—Grandi, 1935 [as *Osmia*]; Michener, 1953; Grandi, 1961 [as *Osmia*].
Hoplitis anthocopoides (Schenck).—Eickwort, 1973 [+ PUPA].
Hoplitis cylindrica (Cresson).—Baker, Kuhn, and Bambara, 1985.
Hoplitis lepeletieri (Perez).—Micheli, 1933; Michener, 1953.
Hoplitis leucomelanena (Kirby).—Enslin, 1925; Micheli, 1930; Michener, 1953.
Hoplitis loti (Morawitz).—Micheli, 1931; Michener, 1953.
Hoplitis parvula (Dufour and Perris).—Dufour and Perris, 1840; Michener, 1953.
Hoplitis tridentata (Dufour and Perris).—Dufour and Perris, 1840; Michener, 1953.
Hoplitis species—Michener, 1953; McGinley, 1981.
Osmia aurulenta (Panzer).—Marechal, 1926; Michener, 1953.
Osmia lignaria lignaria Say.—Baker, Kuhn, and Bambara, 1985.
Osmia lignaria propinqua Cresson.—Michener, 1953; McGinley, 1981.
Osmia rufa (Linnaeus).—Losinski, 1911; Michener, 1953.
Osmia submicans (Morawitz).—Maneval, 1939; Michener, 1953; Wafa and El Berry, 1972 [+ PUPA]; Moustafa and El Berry, 1976 [+ PUPA].
Proteriades bunocephala (Michener).—Thorp, 1968.
Proteriades xerophila (Cockerell).—Michener, 1953.
Unknown: *Archeriades, Bytinskia,* [*Chelostoma,* UTAH], *Hofferia, Jaxartinula, Kumobia, Megaloheriades, Metallinella, Noteriades, Ochreriades, Othinosmia,* [*Prochelostoma,* USNM], [*Protosmia,* UTAH], *Pseudoheriades, Stenosmia, Wainia, Xeroheriades.*

ANTHOPHORIDAE (39%)

ANTHOPHORINAE (38%)

ANCYLINI (0)

Unknown: *Ancyla, Tarsalia.*

ANTHOPHORINI (33%)

Amegilla crinipes (Smith).—Radovic and Krunic, 1977.
Amegilla parietina fulvocinerea (Dours).—Radovic and Krunic, 1977.
Amegilla pulchra (Smith).—Cardale, 1968 [+ PUPA].
Amegilla species .—Cardale, 1968 [+ PUPA].
Anthophora abrupta Say.—Michener, 1953; Norden, 1984 [+ PUPA].
Anthophora bomboides stanfordiana Cockerell.—Michener, 1953 [as *A. stanfordiana*]; McGinley, 1981; Brooks, 1983 [PUPA].
Anthophora borealis Morawitz.—Popova, 1984.
Anthophora edwardsii Cresson.—Michener, 1953.
Anthophora furcata syringae (Cockerell).—Michener, 1953, 1954 [+ PUPA].
Anthophora incerta Spinola.—Claude-Joseph, 1926 [as *Podalirius*]; Michener, 1953.
Anthophora linsleyi Timberlake.—Michener, 1953, 1954 [+ PUPA].
Anthophora occidentalis Cresson.—Nielsen and Bohart, 1967 [sex characters].
Anthophora personata (Illiger).—Semichon, 1922 [+ PUPA]; Michener, 1953, 1954 [PUPA].
Anthophora urbana Cresson.—Michener, 1953.
Anthophora villosula Smith.—Torikata, 1931; Michener, 1953.
Emphoropsis miserabilis (Cresson).—Torchio and Stephen, 1961 [+ PUPA]; McGinley, 1981.
Unknown: *Deltoptila, Elaphropoda, Habrophorula, Habropoda, Heliophila, Pachymelus.*

CANEPHORULINI (0)

Unknown: *Canephorula.*

CENTRIDINI (66%)

Centris aenea Lepeletier.—Rozen, 1965b.
Centris cineraria (Smith).—Claude-Joseph, 1926; Michener, 1953.
Centris derasa Lepeletier.—Rozen, 1965b.
Centris lanipes (Fabricius).—Rozen, 1965b; McGinley, 1981.
Centris rufosuffusa Cockerell.—Rozen, 1965b.
[*Centris* spp., UTAH.]
Epicharis fasciata Lepeletier and Serville.—Rozen, 1965b; McGinley, 1981.
Epicharis rustica (Olivier).—Rozen, 1965b.
Epicharis rustica flava (Olivier).—Camargo, Zucchi, and Sakagami, 1975 [+ PUPA].
Unknown: *Ptilotopus.*

ERICROCIDINI (15%)

Acanthopus splendidus urichi Cockerell.—Rozen, 1969; McGinley, 1981.
Mesoplia rufipes (Perty).—Rozen, 1969.
Unknown: *Abromelissa, Aglaomelissa, Ctenioschelus, Cyphomelissa, Epiclopus, Ericrocis, Eurytis, Hopliphora, Mesocheira, Mesonychium, Oxynedys.*

EUCERINI (31%)

Alloscirtetica gayi (Spinola).—Claude-Joseph, 1926 [as *Tetralonia chilensis* Herbst]; Michener, 1953.
Alloscirtetica tristrigata (Spinola).—Claude-Joseph, 1926 [as *Tetralonia*]; Michener, 1953.
Eucera sociabilis Smith.—Masuda, 1946 [+ PUPA; as *E. difficilis* Perez].
Florilegus condignus (Cresson).—LaBerge and Ribble, 1966b.
[*Melissodes agilis* Cresson, UTAH.]
Melissodes pallidisignata Cockerell.—Rozen, 1965b; McGinley, 1981.
Melissodes persimilis Cockerell.—Buchmann and Jones, 1980.
Melissodes robustior Cockerell.—Rozen, 1965b.
Melissodes rustica (Say).—Clement, 1973.
Melissodes species.—Michener, 1953.
Peponapis fervens (Smith).—Rozen, 1965b; McGinley, 1981.
Svastra obliqua obliqua (Say).—Rozen, 1964b; McGinley, 1981.
Svastrides melanura (Spinola).—Claude-Joseph, 1926; Michener, 1953.
Tetralonia hamata Bradley.—Miliczky, 1985.
Tetralonia lanuginosa Klug.—Mohamed, 1974 [+ PUPA].
Tetralonia malvae Rossi.—Grandi, 1954, 1961.
Thygater species.—Packer, 1987.
Xenoglossa angustior Cockerell.—Rozen, 1965b; McGinley, 1981.
Xenoglossa fulva Smith.—Rozen, 1965b.
Xenoglossa strenua (Cresson).—Bohart, 1964; Rozen, 1965b.
Unknown: *Anthedonia, Cemolobus, Dithygater, Eucara, Gaesischia, Gaesochira, Lophothygater, Loxoptilus, Martinapis, Melissina, Melissoptila, Megascirtetica, Micronychapis, Pachysvastra, Pectenapis, Simanthedon, Svastrina, Syntrichalonia, Tetraloniella, Thygatina, Trichocerapis, Xenoglossodes.*

EUCERINODINI (0)

Unknown: *Eucerinoda.*

EXOMALOPSINI (40%)

Exomalopsis caerulea Friese.—Claude-Joseph, 1926; Michener, 1953; Rozen, 1957.
Exomalopsis chionura Cockerell.—Rozen, 1957; McGinley, 1981.
Lanthanomelissa species—Lucas de Oliveira, 1966a.
Paratetrapedia gigantea (Schrottky).—Lucas de Oliveira, 1962.
[*Paratetrapedia swainsonae* (Cockerell), KU.]
Tapinotaspis caerulea (Friese).—Lucas de Oliveira, 1962.
Unknown: [*Ancyloscelis*, UTAH], *Caenonomada, Chalepogenus, Chilimalopsis*, [*Eremapis*, UTAH], *Monoeca.*

MELECTINI (57%)

Melecta armata Panzer.—Semichon, 1922 [+ PUPA]; Michener, 1953, 1954 [PUPA].
Melecta luctuosa Sopoli.—Soika, 1936 [first instar].
Melecta pacifica Cresson.—Torchio and Youssef, 1968.
Melecta separata callura (Cockerell).—Rozen, 1969; McGinley, 1981.
Thyreus caeruleopunctatus (Blanchard).—Cardale, 1968 [PUPA].
Thyreus lieftincki Rozen.—Rozen, 1969; McGinley, 1981.
Thyreus lugubrus (Smith).—Cardale, 1968.
Thyreus species—Rozen, 1969.
Xeromelecta californica (Cresson).—Michener, 1953, 1954 [PUPA]; Rozen, 1969.
Zacosmia maculata (Cresson).—Torchio and Youssef, 1968 [+ PUPA]; Rozen, 1969; McGinley, 1981.
Unknown: *Brachymelecta, Nesomelecta, Tetralonoidiella.*

MELITOMINI (100%)

Diadasia chilensis Spinola.—Claude-Joseph, 1926 [as *Melitoma*]; Michener, 1953.
[*Diadasia consociata* Timberlake, UTAH.]
Diadasia diminuta (Cresson).—McGinley, 1981.
Diadasia enevata (Cresson).—Michener, 1953, 1954 [+ PUPA]; Nielsen and Bohart, 1967 [sex characters].
Melitoma euglossoides Lepeletier and Serville.—McGinley, 1981.
Ptilothrix bombiformis (Cresson).—Michener, 1953 [as *Emphor bombiformis*], 1954 [+ PUPA].

PARARHOPHITINI (100%)

Pararhophites orobinus (Morawitz).—McGinley and Rozen, 1987.

RHATHYMINI (100%)

Rhathymus bicolor Lepeletier.—Rozen, 1969; McGinley, 1981.
Rhathymus trinitatis Cockerell.—Rozen, 1969.
Rhathymus species—Camargo, Zucchi, and Sakagami, 1975 [+ PUPA].

TETRAPEDIINI (0)

[*Tetrapedia*, UTAH.]

NOMADINAE (40%)

AMMOBATINI (33%)

Ammobates carinatus Morawitz.—Rozen and McGinley, 1974b; McGinley, 1981.
Morgania histrio transvaalensis Bischoff.—Rozen and McGinley, 1974b [+ PUPA]; McGinley, 1981.

Oreopasites vanduzeei Cockerell.—Rozen, 1954, 1966c; Rozen and McGinley, 1974b [+ PUPA]; McGinley, 1981.
Pseudodichroa fumipennis Bischoff.—Rozen and McGinley, 1974b; McGinley, 1981.
Unknown: *Caesarea, Melanempis, Omachthes, Parammobatodes, Pasites, Pasitomachthes, Pseudopasites, Sphecodopsis.*

AMMOBATOIDINI (0)

Unknown: *Ammobatoides.*

BIASTINI (50%)

Neopasites cressoni Crawford.—Rozen, 1966c; McGinley, 1981.
Unknown: [*Biastes*, UTAH].

CAENOPROSOPIDINI (0)

Unknown: *Caenoprosopidis.*

EPEOLINI (66%)

Doeringiella gayi (Spinola).—Claude-Joseph, 1926 [as *Epeolus*]; Michener, 1953.
Epeolus pusillus Cresson.—Rozen, 1966c.
Epeolus tristis Smith.—Mayet, 1875 [+ PUPA]; Michener, 1953.
Epeolus species A.—Michener, 1953; Rozen, 1966c; McGinley, 1981.
Odyneropsis apicalis Ducke.—Rozen, 1966c.
Triepeolus dacotensis (Stevens).—Nielsen and Bohart, 1967 [sex characters].
[*Triepeolus helianthi* (Robertson), UTAH.]
Triepeolus mesillae Cockerell.—Rozen, 1966c.
Triepeolus remigatus (Fabricius).—Rozen, 1966c.
Triepeolus species A.—Rozen, 1966c; McGinley, 1981.
Triepeolus species B.—Rozen, 1966c.
Triepeolus species C.—Michener, 1953; Rozen, 1966c.
Unknown: *Thalestria, Trophocleptria.*

EPEOLOIDINI (0)

Unknown: *Epeoloides.*

HOLCOPASITINI (50%)

Holcopasites calliopsidis (Linsley).—Rozen, 1966c.
Holcopasites insoletus (Linsley).—Rozen, 1966c; McGinley, 1981.
Holcopasites species A.—Rozen, 1966c.
Unknown: *Schmiedeknechtia.*

ISEPEOLINI (100%)

Isepeolus luctuosus (Spinola).—Claude-Joseph, 1926; Michener, 1953.
Isepeolus viperinus (Holmberg).—Michener, 1957; Rozen, 1966c; Lucas de Oliveira, 1966b; McGinley, 1981.

NEOLARRINI (100%)

Neolarra pruinosa Ashmead.—Rozen, 1966c; McGinley, 1981.

NOMADINI (71%)

Kelita tuberculata Ehrenfeld and Rozen.—Ehrenfeld and Rozen, 1977.
Melanomada sidaefloris (Cockerell).—Rozen, 1977c [+ PUPA]; McGinley, 1981.
Melanomada annectens Snelling and Rozen.—Snelling and Rozen, 1987.
Nomada obscurella Fowler.—Michener, 1953 [as *N. fowleri*]; Rozen, 1966c; McGinley, 1981.
Nomada imbricata Smith.—Packard, 1897 [+ PUPA]; Michener, 1953.
Nomada japonica Smith.—Masuda, 1946 [+ PUPA].
Nomada suavis Cresson.—Rozen, 1966c.
Nomada species A.—Rozen, 1966c.
Nomada species B.—Rozen, 1966c.
Nomada species C.—Rozen, 1966c.
Paranomada velutina Linsley.—Rozen, 1977c [+ PUPA]; McGinley, 1981.
Triopasites penniger (Cockerell).—Rozen, 1977c.
Unknown: *Brachynomada, Hexepeolus.*

OSIRINI (0)

Unknown: *Osiris.*

PROTEPEOLINI (50%)

Protepeolus singularis Linsley and Michener.—Rozen, Eickwort, and Eickwort, 1978 [+ PUPA]; McGinley, 1981.
Unknown: *Leiopodus.*

TOWNSENDIELLINI (0)

Unknown: *Townsendiella.*

XYLOCOPINAE (74%)

CERATININI (81%)

Allodape ceratinoides Gribodo.—Brauns, 1926; Michener, 1953, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape collaris Vachal.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape dapa Strand.—Michener, 1975.
Allodape exoloma Strand.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape friesei Strand.—Michener, 1975; Michener and

Scheiring, 1976 [PUPA].
Allodape interrupta Vachal.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape mucronata Smith.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape panurgoides Smith.—Michener, 1975; McGinley, 1981 [as *A. crinita* Brauns MS].
Allodape pernix (Bingham).—Michener, 1975.
Allodape pictifrons Smith.—Michener, 1975.
Allodape quadrilineata (Cameron).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape rufogastra Lepeletier and Serville.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape stellarum Cockerell.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodape species.—Friese, 1914; Brauns, 1926; Michener, 1953.
Allodapula acutigera Cockerell.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodapula dichroa (Strand).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodapula hessei Michener.—Michener, 1975.
Allodapula melanopus (Cameron).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Allodapula ornaticeps Michener.—Michener, 1975.
Allodapula rozeni Michener.—Michener, 1975.
Allodapula variegata (Smith).—Brauns, 1926 [as *Allodape pringlei*]; Michener, 1953, 1975; Michener and Scheiring, 1976 [PUPA].
Allodapula xerica Michetner.—Michenesr, 1975.
Braunsapis acuticauda Michener.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapins albitarsis (Friese).—Michener, 1975.
Braunsapis bouyssoui (Vachal).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis draconis Michener.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis elizabethana (Strand).—Michener, 1975.
Braunsapis facialis (Gerstaecker).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis foveata (Smith).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis ghanae Michener.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis gorillarum (Cockerell).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis iwatai (Sakagami and Yoshikawa).—Sakagami and Yoshikawa, 1961 [as *Allodape iwatai*].
Braunsapis leptozonia (Vachal).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis luapulana (Cockerell).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis natalica Michener.—Michener, 1975.
Braunsapis nitida (Smith).—Michener and Syed, 1962 [as *Allodapula*].
Braunsapis pallida Michener.—Michener, 1975.
Braunsapis paradoxa (Strand).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis perkinsiella (Michener and Syed).—Michener and Syed, 1962 [as *Allodapula*].
Braunsapis plebeia (Cockerell).—Michener and Syed, 1962 [as *Allodapula*].
Braunsapis rhodesi (Cockerell).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis rolini (Vachal).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis sauteriella Cockerell.—Yasumatsu, 1938 [as *Allodape marginata* Cockerell]; Michener, 1953 [as *A. marginata*]; Sakagami and Yoshikawa, 1961 [as *Allodape sauteriella*].
Braunsapis simillima (Smith).—Michener and Syed, 1962 [as *Allodapula*].
Braunsapis simplicipes Michener.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis strandi (Masi).—Masi, 1930 [as *Allodape*]; Michener, 1953.
Braunsapis stuckenbergorum Michener.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis trochanterata (Gerstaecker).—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Braunsapis unicolor (Smith).—Michener and Syed, 1962 [as *Allodapula*]; Michener, 1962 [+ PUPA].
Braunsapis vitrea (Vachal).—Michener, 1975.
Ceratina callosa (Fabricius).—Micheli, 1936; Michener, 1953.
Ceratina chalcites Latreille.—Grandi, 1957.
Ceratina cucurbitina (Rossi).—Grandi, 1935; Michener, 1953.
Ceratina dupla Say.—Packard, 1897; Michener, 1953.
Ceratina species.—McGinley, 1981.
[*Ceratina* spp., UTAH.]
Compsomelissa stigmoides (Michener).—Michener, 1976; Michener and Scheiring, 1976 [PUPA].
Eucondylops konowi Brauns.—Michener, 1975.
Eucondylops reducta Michener.—Michener and Scheiring, 1976 [PUPA].
Exoneura apposita Rayment.—Rayment, 1949b; Michener, 1953.
Exoneura concava Rayment.—Rayment, 1949b; Michener, 1953.
Exoneura concinnula Cockerell.—Syed, 1963; Michener and Scheiring, 1976 [PUPA].
Exoneura frogattii Cockerell.—Rayment, 1949a; Michener, 1953.
Exoneura fultoni Cockerell.—Rayment, 1949a; Michener, 1953.
Exoneura hamulata Cockerell.—Rayment, 1951; Michener, 1953; Syed, 1963; Michener and Scheiring, 1976 [PUPA].
Exoneura illustris Erickson and Rayment.—Erickson and Rayment, 1951; Michener, 1953.

Exoneura montana Rayment.—Rayment, 1949b; Michener, 1953.
Exoneura obliterata Cockerell.—Rayment, 1949a; Michener, 1953.
Exoneura obscuripes Michener.—Syed, 1963.
Exoneura pictifrons Alfken.—Erickson and Rayment, 1951; Michener, 1953.
Exoneura richardsoni Rayment.—Rayment, 1951; Michener, 1953.
Exoneura roddi Rayment.—Rayment, 1949b; Michener, 1953.
Exoneura rufitarsis Rayment.—Rayment, 1951 [+ PUPA]; Michener, 1953.
Exoneura setosa Houston.—Houston, 1976 [+ PUPA].
Exoneura simillima Rayment.—Rayment, 1949a; Michener, 1953.
Exoneura subbaculifera Rayment.—Rayment, 1951; Michener, 1953; Syed, 1963.
Exoneura subholmesi Rayment.—Rayment, 1949b; Michener, 1953.
Exoneura variabilis Rayment.—Rayment, 1949b; Michener, 1953; Syed, 1963; Michener and Scheiring, 1976 [PUPA].
Exoneurella eremophila (Houston).—Houston, 1976 [+ PUPA; as *Exoneura*].
Exoneurella lawsoni (Rayment).—Syed, 1963 [this and following citations as *Exoneura*]; Michener, 1964; Michener and Scheiring, 1976 [PUPA].
Exoneurella tridentata (Houston).—Houston, 1976 [+ PUPA; as *Exoneura*].
Halterapis angustula (Cockerell).—Michener, 1976; Michener and Scheiring, 1976 [PUPA].
Halterapis nigrinervis (Cameron).—Michener, 1976; Michener and Scheiring, 1976 [PUPA].
Inquilina excavata (Cockerell).—Rayment, 1949b [also included as *Exoneura concava*]; Michener, 1953 [also as *E. concava*]; Syed, 1963; Michener and Scheiring, 1976 [PUPA].
Macrogalea candida (Smith).—Michener, 1976; Michener and Scheiring, 1976 [PUPA].
Manuelia gayatina (Spinola).—Claude-Joseph, 1926; Michener, 1953.
Nasutapis straussorum Michener.—Michener, 1975; Michener and Scheiring, 1976 [PUPA].
Unknown: *Effractapis, Exoneuridia, Pithitis.*

XYLOCOPINI (33%)

Xylocopa aestuans (Linnaeus).—Dover, 1924 [+ PUPA]; Michener, 1953.
Xylocopa augusti Lepeletier.—Lucas de Oliveira, 1974.
Xylocopa brasilianorum Linnaeus.—Lucas de Oliveira, 1974.
Xylocopa ciliata Burmaister.—Lucas de Oliveira, 1974.
Xylocopa frontalis Oliver.—Lucas de Oliveira, 1974; McGinley, 1981.
Xylocopa hirsutissima Maidl.—Lucas de Oliveira, 1974.
Xylocopa iris Christ.—Grandi, 1957, 1961.
Xylocopa macrops Lepeletier.—Lucas de Oliveira, 1974.
Xylocopa mordax Smith.—Lucas de Oliveira, 1974.
Xylocopa nogueirai Hurd and Moure.—Lucas de Oliveira, 1974.
Xylocopa subcyanea Perez.—Lucas de Oliveira, 1974.
Xylocopa submordax Cockerell.—Lucas de Oliveira, 1974.
Xylocopa violacea (Linnaeus).—Lucas, 1868, 1888; Grandi, 1934; Michener, 1953; Janvier, 1977.
Xylocopa virecens Lepeletier.—Lucas de Oliveira, 1974.
Xylocopa virginica (Linnaeus).—Packard, 1897; Michener, 1953, 1954 [PUPA].
Unknown: *Lestis, Proxylocopa.*

APIDAE (72%)

APINAE (100%)

Apis cerana Fabricius.—Torchio and Torchio, 1975.
Apis dorsata Fabricius.—Torchio and Torchio, 1975.
Apis florea Fabricius.—Torchio and Torchio, 1975.
Apis mellifera Linnaeus.—Nelson, 1924; Grandi, 1934; Michener, 1953, 1954 [PUPA]; Grandi, 1961; Dade, 1962; Nielsen and Bohart, 1967 [sex characters]; Torchio and Torchio, 1975; McGinley, 1981.

BOMBINAE (62%)

BOMBINI (100%)

Bombus agrorum (Fabricius).—Stephen and Koontz, 1973; Cumber, 1949.
Bombus agrorum pascuorum Scopoli.—Grandi, 1937; Michener, 1953.
Bombus appositus Cresson.—Stephen and Koontz, 1973.
Bombus atratus Franklin.—Lucas de Oliveira, 1979 [+ PUPA].
Bombus bimaculatus Cresson.—Ritcher, 1933; Michener, 1953.
Bombus brasiliensis Lepeletier.—Lucas de Oliveira, 1979 [+ PUPA].
Bombus californicus Smith.—Stephen and Koontz, 1973.
Bombus caliginosus (Frison).—Stephen and Koontz, 1973.
Bombus crotchii Cresson.—Stephen and Koontz, 1973.
Bombus deuteronynus Schulz.—Sakagami, 1951 [as *B. senilis* Smith]; Michener, 1953 [as *B. senilis*].
Bombus fervidus (Fabricius).—Packard, 1866, 1897; Ritcher, 1933; Michener, 1953.
Bombus griseocollis (Degeer).—Ritcher, 1933; Michener, 1953; Stephen and Koontz, 1973.
Bombus hortorum (Linnaeus).—Cumber, 1949.
Bombus hypnorum (Linnaeus).—Stephen and Koontz, 1973.
Bombus hyperboreus Schonherr.—Stephen and Koontz, 1973.
Bombus impatiens Cresson.—Ritcher, 1933; Michener, 1953; Stephen and Koontz, 1973.
Bombus lapidarius (Linnaeus).—Cumber, 1949.

Bombus lucorum (Linnaeus).—Cumber, 1949.
Bombus mastrucatus Gerstaecker.—Moczar, 1938; Michener, 1953.
Bombus morio (Swederus).—Lucas de Oliveira, 1979.
Bombus morrisoni Cresson.—Stephen and Koontz, 1973.
Bombus nevadensis Cresson.—Stephen and Koontz, 1973.
Bombus nevadensis auricomus (Robertson).—Ritcher, 1933; Michener, 1953; Stephen and Koontz, 1973.
Bombus pennsylvanicus (Degeer).—Ritcher, 1933; Michener, 1953, 1954 [PUPA; as *B. americanorum*]; Stephen and Koontz, 1973; McGinley, 1981.
Bombus pennsylvanicus sonorus Say.—Stephen and Koontz, 1973.
Bombus perplexus Cresson.—Ritcher, 1933; Michener, 1953.
Bombus pratorum (Linnaeus).—Cumber, 1949.
Bombus ruderarius (Muller).—Cumber, 1949.
Bombus silvarum Linnaeus.—Grandi, 1934; Michener, 1953.
Bombus sylvicola Kirby.—Stephen and Koontz, 1973.
Bombus terrestris (Linnaeus).—Cumber, 1949.
Bombus terricola Kirby.—Ritcher, 1933; Michener, 1953; Stephen and Koontz, 1973.
Bombus terricola occidentalis Greene.—Stephen and Koontz, 1973.
Bombus vagans Smith.—Ritcher, 1933; Michener, 1953.
Bombus vandykei (Frison).—Stephen and Koontz, 1973.
Bombus vosnesenskii Radoszkowski.—Ritcher, 1933; Michener, 1953, 1954 [PUPA]; Stephen and Koontz, 1973.
Psithyrus rupestris (Fabricius).—Cumber, 1949.
Psithyrus variabilis (Cresson).—Ritcher, 1933; Michener, 1953.
[*Psithyrus suckleyi* (Greene), UTAH.]

EUGLOSSINI (50%)

Euglossa intersecta Latreille.—Zucchi, de Oliveira, and de Camargo, 1969 [+ PUPA].
Euglossa imperialis Cockerell.—Roberts and Dodson, 1967.
Eulaema nigrita Lepeletier.—Zucchi, Sakagami, and de Camargo, 1970.
Euplusia violacea (Blanchard).—Michener, 1953 [as *Centris (Euplusia) violacea*].
Unknown: *Eufriesea*, [*Exaerete*, UTAH], *Aglae*.

MELIPONINAE (78%)

Hypotrigona muelleri (Friese).—Lucas de Oliveira, 1970.
Lestrimelitta ehrhardti Friese.—Lucas de Oliveira, 1968 [+ PUPA].
Lestrimelitta limao (Smith).—Lucas de Oliveira, 1968 [+ PUPA].
Melipona fasciata trinitatis Cockerell.—McGinley, 1981.
Melipona marginata Lepeletier.—Michener, 1953.
Melipona nigra schencki Gribodo.—Lucas de Oliveira, 1960.
Melipona quadrifasciata quadrifasciata Lepeletier.—Michener, 1953.
Melipona variegatipes Gribodo.—Michener, 1953.
Nannotrigona postica (Latreille).—Lucas, 1958.
Partamona cupira Smith.—Michener, 1953 [as *Trigona*], 1954 [PUPA].
Partamona testacea (Klug).—McGinley, 1981 [as *Trigona*].
Plebeia droryana (Friese).—Lucas de Oliveira, 1965.
Trigona corvina Cockerell.—Michener, 1953.
Unknown: *Dactylurina*, *Meliponula*.

Appendix

This section lists the apparent larval synapomorphies supporting the taxa listed in Figure 2 (in upper case, below). Many of these taxa, while clearly defined by adult characters, are only tenuously supported by presumed larval synapomorphies; below, these characters are followed by a question mark. Future research may result in greater resolution based on larval features; this treatment should be considered preliminary.

COLLETIDAE.—DIPHAGLOSSINAE: elongate, cylindrical salivary lips (McGinley, 1981, figs. 2, 17); COLLETINI: extremely broad, unproduced spiracular atria? (McGinley, 1981, fig. 63); PARACOLLETINI: maxilla greatly exceeding labium in lateral view (McGinley, 1981, figs. 29, 33, 38, 45); *Scrapter:* genal area conspicuously expanded (McGinley, 1981, fig. 51); EURYGLOSSINAE: labiomaxillary region strongly recessed? (McGinley, 1981, figs. 66, 74); XEROMELISSINAE: frontal swellings above antennae present, maxillary palpi enlarged (McGinley, 1981, fig. 80); HYLAEINAE: salivary lips absent with labiomaxillary region produced? (McGinley, 1981, figs. 86, 87).

STENOTRITIDAE.—Mandibular apex obliquely truncate? (Houston, 1975, fig. 15).

HALICTIDAE.—DUFOUREINAE: venter of abdominal segment IX strongly protuberant (Eickwort et al., 1986, fig. 10); NOMIINAE: dorsal tubercles well developed, conical (Michener, 1953, fig. 68), mandibular apex usually bifid? (Michener, 1953, fig. 71; Hirashima, 1961, figs. 61–66); HALICTINAE: maxillary palpi apparently absent (Michener, 1953, fig. 51).

OXAEIDAE.—Primary tracheal opening slit-like, not circular (Rozen, 1964a, fig. 6), labral apex cleft (Rozen, 1964a, fig. 2).

ANDRENIDAE.—Salivary opening appearing U-shaped in frontal view (Rozen, 1966a, fig. 5; Rozen, 1973a, fig. 5; see Torchio (1975) for discussion).

MELITTIDAE.—MEGANOMIINAE: area immediately behind posterior mandibular articulation projecting (Rozen, 1977a, figs. 18, 19), spiracular subatrial wall spinose (Rozen, 1977a, fig. 20); MELITTINAE: salivary plate present (Rozen and McGinley, 1974a, figs. 10, 21); DASYPODINAE: salivary lips absent? (Rozen and McGinley, 1974a, figs. 29, 35, 46).

CTENOPLECTRIDAE.—Monophyly based on larval characters alone is questionable (see Rozen, 1978).

MEGACHILIDAE.—MEGACHILINAE: conspicuous body setae present? (see Rozen, 1978:644); LITHURGINAE: large, conspicuous tooth at the base of the apical mandibular concavity (Rozen, 1973c, figs. 7, 19, 21); FIDELIINAE: monophyly based on larval characters alone is questionable (two of three known generic representatives share with the Lithurginae a conspicuous, adoral tooth; see Rozen, 1977b).

ANTHOPHORIDAE.—PARARHOPHITINI: the traditional classification of this taxon as an anthophorid is probably incorrect; more likely associated with the megachiloid lineage (McGinley and Rozen, 1987). EXOMALOPSINI: body slender, venter of abdominal segment IX protuberant? (Rozen, 1957, fig. 4), maxillary apices not bent mesiad? (Rozen, 1957, fig. 1); MELITOMINI: body extremely slender, venter of abdominal segment IX protuberant (Michener, 1953, figs. 206, 213), maxillary apices strongly bent mesiad (Michener, 1953, figs. 208, 215; most likely plesiomorphic); at present, this tribe is difficult to differentiate from the Exomalopsini on the basis of larval synapomorphies. EUCERINI: larvae extremely uniform but difficult to define cladistically? (see Rozen, 1965b); CENTRITINI: anus situated dorsally on segement X, mandibular concavity extremely broad and scoop-shaped? (Rozen, 1965b); ANTHOPHORINI: monophyly based on larval characters questionable? (salivary lips absent, mandibular concavity scoop-shaped, Michener, 1953, figs. 220, 223); MELECTINI: labiomaxillary region recessed (Rozen, 1969, figs. 4, 12, 26); ERICROCIDINI and RATHYMINI: labiomaxillary region greatly enlarged (Rozen, 1969, figs. 33, 40, 47); NOMADINAE: position of posterior tentorial pits and/or posterior arms modified, mandibles with simple apex and reduced cusp (Rozen et al., 1978); XYLOCOPINAE: salivary opening on dorsal surface of labium (hidden from view, Michener, 1953, figs. 177, 178).

APIDAE.—APINAE (except *Apis*): conical, often highly sclerotic and darkly pigmented, dorsal papillae on thorax (Michener, 1953, figs. 248, 266).

REQUIREMENTS FOR SMITHSONIAN SERIES PUBLICATION

Manuscripts intended for series publication receive substantive review (conducted by their originating Smithsonian museums or offices) and are submitted to the Smithsonian Institution Press with Form SI-36, which must show the approval of the appropriate authority designated by the sponsoring organizational unit. Requests for special treatment—use of color, foldouts, case-bound covers, etc.—require, on the same form, the added approval of the sponsoring authority.

Review of manuscripts and art by the Press for requirements of series format and style, completeness and clarity of copy, and arrangement of all material, as outlined below, will govern, within the judgment of the Press, acceptance or rejection of manuscripts and art.

Copy must be prepared on typewriter or word processor, double-spaced, on one side of standard white bond paper (not erasable), with 1¼″ margins, submitted as ribbon copy (not carbon or xerox), in loose sheets (not stapled or bound), and accompanied by original art. Minimum acceptable length is 30 pages.

Front matter (preceding the text) should include: **title page** with only title and author and no other information, **abstract** page with author, title, series, etc., following the established format; table of **contents** with indents reflecting the hierarchy of heads in the paper; also, **foreword** and/or **preface**, if appropriate.

First page of text should carry the title and author at the top of the page; **second page** should have only the author's name and professional mailing address, to be used as an unnumbered footnote on the first page of printed text.

Center heads of whatever level should be typed with initial caps of major words, with extra space above and below the head, but no other preparation (such as all caps or underline, except for the underline necessary for generic and specific epithets). Run-in paragraph heads should use period/dashes or colons as necessary.

Tabulations within text (lists of data, often in parallel columns) can be typed on the text page where they occur, but they should not contain rules or numbered table captions.

Formal tables (numbered, with captions, boxheads, stubs, rules) should be submitted as carefully typed, double-spaced copy separate from the text; they will be typeset unless otherwise requested. If camera-copy use is anticipated, do not draw rules on manuscript copy.

Taxonomic keys in natural history papers should use the aligned-couplet form for zoology and may use the multi-level indent form for botany. If cross referencing is required between key and text, do not include page references within the key, but number the keyed-out taxa, using the same numbers with their corresponding heads in the text.

Synonymy in zoology must use the short form (taxon, author, year:page), with full reference at the end of the paper under "Literature Cited." For botany, the long form (taxon, author, abbreviated journal or book title, volume, page, year, with no reference in "Literature Cited") is optional.

Text-reference system (author, year:page used within the text, with full citation in "Literature Cited" at the end of the text) must be used in place of bibliographic footnotes in all Contributions Series and is strongly recommended in the Studies Series: "(Jones, 1910:122)" or ". . . Jones (1910:122)." If bibliographic footnotes are required, use the short form (author, brief title, page) with the full citation in the bibliography.

Footnotes, when few in number, whether annotative or bibliographic, should be typed on separate sheets and inserted immediately after the text pages on which the references occur. Extensive notes must be gathered together and placed at the end of the text in a notes section.

Bibliography, depending upon use, is termed "Literature Cited," "References," or "Bibliography." Spell out titles of books, articles, journals, and monographic series. For book and article titles use sentence-style capitalization according to the rules of the language employed (exception: capitalize all major words in English). For journal and series titles, capitalize the initial word and all subsequent words except articles, conjunctions, and prepositions. Transliterate languages that use a non-Roman alphabet according to the Library of Congress system. Underline (for italics) titles of journals and series and titles of books that are not part of a series. Use the parentheses/colon system for volume (number): pagination: "10(2):5–9." For alignment and arrangement of elements, follow the format of recent publications in the series for which the manuscript is intended. Guidelines for preparing bibliography may be secured from Series Section, SI Press.

Legends for illustrations must be submitted at the end of the manuscript, with as many legends typed, double-spaced, to a page as convenient.

Illustrations must be submitted as original art (not copies) accompanying, but separate from, the manuscript. Guidelines for preparing art may be secured from Series Section, SI Press. All types of illustrations (photographs, line drawings, maps, etc.) may be intermixed throughout the printed text. They should be termed **Figures** and should be numbered consecutively as they will appear in the monograph. If several illustrations are treated as components of a single composite figure, they should be designated by lowercase italic letters on the illustration; also, in the legend and in text references the italic letters (underlined in copy) should be used: "Figure 9b." Illustrations that are intended to follow the printed text may be termed **Plates**, and any components should be similarly lettered and referenced: "Plate 9b." Keys to any symbols within an illustration should appear on the art rather than in the legend.

Some points of style: Do not use periods after such abbreviations as "mm, ft, USNM, NNE." Spell out numbers "one" through "nine" in expository text, but use digits in all other cases if possible. Use of the metric system of measurement is preferable; where use of the English system is unavoidable, supply metric equivalents in parentheses. Use the decimal system for precise measurements and relationships, common fractions for approximations. Use day/month/year sequence for dates: "9 April 1976." For months in tabular listings or data sections, use three-letter abbreviations with no periods: "Jan, Mar, Jun," etc. Omit space between initials of a personal name: "J.B. Jones."

Arrange and paginate sequentially every sheet of manuscript in the following order: (1) title page, (2) abstract, (3) contents, (4) foreword and/or preface, (5) text, (6) appendixes, (7) notes section, (8) glossary, (9) bibliography, (10) legends, (11) tables. Index copy may be submitted at page proof stage, but plans for an index should be indicated when manuscript is submitted.