P.S.
Ro
682
no.155

ROM
Royal Ontario Museum

LIFE SCIENCES CONTRIBUTIONS

155

ROYAL ONTARIO MUSEUM LIBRARIES

3 1761 04305 1234

Revision of the World Species of *Spalangiopelta*
(Hymenoptera: Chalcidoidea: Pteromalidae: Ceinae)

D. Christopher Darling

ROYAL ONTARIO MUSEUM LIFE SCIENCES PUBLICATIONS INSTRUCTIONS TO AUTHORS

Authors should prepare their manuscripts carefully according to the following instructions; failure to do so will result in the manuscript's being returned to the author for revision. All manuscripts are considered on the understanding that they are not currently offered for publication elsewhere.

1. **General** Papers for publication are accepted from ROM staff members and research associates, and from researchers reporting on work done with ROM collections. Monographs on the flora and/or fauna of Ontario may be considered for publication by authors not affiliated with the ROM. Financial contributions towards publication will be welcome. Authors are expected to write clearly and concisely and to omit any material not essential for an understanding of the main theme of the paper.
2. **Format** Manuscripts (including captions, synonymies, literature cited, and tables) should be typed with double space on 11" × 8½" paper with a 1½" margin on all sides. Three xerox copies should be submitted to the Senior Editor of the Editorial Board; the original should be retained by the author(s). The submission should include a separate sheet giving the author(s) names and affiliations, the title of the publication, the series for which it is submitted, the number of typed pages, the number of tables, and the number of plates or figures. Manuscripts should normally be organized in the following order: Contents, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusions, Summary (if manuscript is long), Acknowledgements, Appendices, and Literature Cited. Authors are encouraged to include foreign-language translations of the Summary, if appropriate. Main headings should be centred; sub-headings should be left-justified to the text margin. The first line of the first paragraph in each new section should not be indented. Literature citations in the text should be in the form "Jones (1972)" or "(Jones, 1972)" or "(Smith, 1960:71–79, fig. 17)".
3. **Standard Sources** The primary authority on questions of format and style is *Guide to Authors*, available from ROM Publication Services. For matters not covered in the Guide, consult *CBE Style Manual* (Fifth Edition). Other standard sources are as follows: for

English spelling, *The Concise Oxford Dictionary*; for Canadian place names and coordinates, *Canada Gazetteer Atlas*; for the spelling of geographic names, *The Times Atlas*.

4. **Abstract** All papers must be preceded by a short, factual abstract, about one per cent of the text in length. The abstract may be followed by four to six key words in parentheses.
5. **Taxonomy** The name of a taxon should be given in full in headings, at the beginnings of paragraphs, and at its first occurrence in the text. Give the authority and date, if appropriate, with the first mention of each taxon, but not thereafter. Taxonomic papers, particularly synonymies, should follow the layout in Life Sciences Contributions beginning with No. 136. International Codes of Biological Nomenclature must be followed.
6. **Literature Cited** A complete list of references, in alphabetical order of authors, must be given at the end of the paper. When two or more works of one author are cited, they should be listed chronologically. The names of journals should not be abbreviated. For correct bibliographic form, see Life Sciences Contributions beginning with No. 136.
7. **Tables** All tables should be typed on separate sheets and numbered consecutively in arabic numerals in the order of their first mention in the text. Mark the location of each table in the margin of the text.
8. **Plates, Figures, and Text-figures** Illustrations may be designated according to the conventions of the author's discipline; in some disciplines grouped photographs of scientific subject matter are commonly termed Plates, while line drawings and locality and other illustrations that occupy a full page or less are Text-figures. Usage must be consistent throughout the paper. A full-page illustration for a Contribution, with its caption, should be sized to fit an area of 17.3 × 22.75 cm; for Occasional Papers, the area is 14.1 × 21.2 cm. If captions are lengthy, they may be placed on the facing page. A scale or magnification factor should be included. Authors are reminded that when illustrations are reduced magnification factors will change, and that they are responsible for the conversion. For details, see *Guide to Authors*.

LIFE SCIENCES CONTRIBUTIONS 155

Revision of the World Species of *Spalangiopelta*
(Hymenoptera: Chalcidoidea: Pteromalidae: Ceinae)

D. Christopher Darling

ROYAL ONTARIO MUSEUM
PUBLICATIONS IN LIFE SCIENCES

The Royal Ontario Museum publishes three series in the Life Sciences:

CONTRIBUTIONS: a numbered series of original scientific publications.

OCCASIONAL PAPERS: a numbered series of original scientific publications, primarily short and of taxonomic significance.

MISCELLANEOUS PUBLICATIONS: an unnumbered series on a variety of subjects.

All manuscripts considered for publication are subject to the scrutiny and editorial policies of the Life Sciences Editorial Board, and to independent refereeing by two or more persons, other than Museum staff, who are authorities in the particular field involved.

LIFE SCIENCES EDITORIAL BOARD

Senior editor: M. D. Engstrom

Editor: D. Collins

Editor: K. Coates

External editor: C. S. Churcher

Manuscript editor: R. W. Murphy

Production editor: K. K. Mototsune

D. Christopher Darling is associate curator in charge, Department of Entomology, Royal Ontario Museum, and assistant professor, Department of Zoology, University of Toronto.

The Royal Ontario Museum is an agency of the Ontario Ministry of Culture and Communications.

Canadian Cataloguing in Publication Data

Darling, D. Christopher (Donald Christopher), 1951–

Revision of the world species of *Spalangiopecta*
(Hymenoptera: Chalcidoidea: Pteromalidae: Ceinae)

(Life sciences contributions ; 155)

Includes bibliographical references.

ISBN 0-88854-395-6

1. *Spalangiopecta*. 2. Pteromalidae. I. Royal
Ontario Museum. II. Title. III. Series.

QL568.P94D37 1991 595.79 C91-094294-3

Publication date: 8 November 1991

ISBN 0-88854-395-6

ISSN 0384-8159

© Royal Ontario Museum, 1991

100 Queen's Park, Toronto, Ontario M5S 2C6

Typesetting by Compeer Typographic Services Limited

Printed and bound in Canada at gagné printing

PS
To
ISS
no. 155

Contents

Abstract	1
Introduction	1
Materials and Methods	2
Comparative Morphology	6
<i>Spalangiopelta</i> Masi	10
Key to Species	11
<i>Spalangiopelta alata</i> Bouček	23
<i>Spalangiopelta albigena</i> Darling sp. nov.	24
<i>Spalangiopelta apotherisma</i> Darling and Hanson	25
<i>Spalangiopelta brachyptera</i> Masi	27
<i>Spalangiopelta canadensis</i> Darling sp. nov.	28
<i>Spalangiopelta ciliata</i> Yoshimoto	29
<i>Spalangiopelta dudichi</i> Erdős	31
<i>Spalangiopelta felonia</i> Darling and Hanson	32
<i>Spalangiopelta laevis</i> Darling sp. nov.	34
<i>Spalangiopelta procera</i> Graham	35
Phylogeny and Biogeography	37
Acknowledgements	41
Literature Cited	42

Digitized by the Internet Archive
in 2011 with funding from
Royal Ontario Museum

<http://www.archive.org/details/revisionofworlds00darl>

Revision of the World Species of *Spalangiopelta* (Hymenoptera: Chalcidoidea: Pteromalidae: Ceinae)

Abstract

Ten species of *Spalangiopelta* are recognized, six from the Nearctic and Neotropical regions and four from the Palearctic. Three new species are described: *S. albigena* sp. nov. (type locality: Dominican Republic, Parque Nacional Armando Bermudez), *S. canadensis* sp. nov. (type locality: Canada, Ontario, Constance Bay), and *S. laevis* (type locality: Costa Rica, Alajuela, Peñas Blancas). Lectotypes are designated for two Palearctic species: *S. brachyptera* and *S. dudichi*. A diagnosis for the subfamily Ceinae is presented and a sister-group relationship is proposed with the subfamily Diparinae based on characters of the forewing and antenna. A revised generic diagnosis and a key to the males and females of *Spalangiopelta* are presented, and information on host associations and geographic distribution is summarized for each species. Intrageneric phylogenetic relationships that support a hypothesis of vicariance in the Holarctic region are discussed.

Introduction

Spalangiopelta Masi and *Cea* Walker comprise the subfamily Ceinae, which is traditionally classified with other groups of uncertain affinity in the Pteromalidae. The Ceinae are generally recognized by the following combination of characters (Bouček, 1952; Graham, 1969; Darling and Hanson, 1986): (1) notauli complete (Figs. 1, 67, but see also Fig. 2); (2) spiracles situated halfway between the front and hind margins of propodeum (Figs. 8, 67, 68); (3) antennal toruli separated from oral fossa by a distance less than diameter of torulus (Fig. 4); (4) antennal formula 11353 (Figs. 5, 37–46, 57–64); (5) marginal vein long (Figs. 25–34, 49–55); and (6) mandibles bidentate (Fig. 3). It is currently impossible to determine which of these characters (if any) are synapomorphies because the phylogenetic relationships between the subfamilies of Pteromalidae are uncertain. Based on the hypothesis that Cleonyminae and Chalcedectinae are plesiomorphic pteromalids (Darling, 1988), characters 2, 3, and 4 would be regarded as synapomorphies of Ceinae. However, character 2 is found in some Colotrechninae (e.g., *Divna*, see Bouček, 1988); character 3 is found in some neodiparines, eunotines, cleonymines (Graham, 1969), and colotrechnines (Bouček, 1988), and may be plesiomorphic for Ceinae; and three annelli are also present in some Pteromalinae (e.g., *Cyclogastrella*) and Miscogasterinae, Pirenini (e.g., *Morodora*). None of the six characters can be regarded with confidence as derived and unique to Ceinae; therefore, there is no unequivocal evidence of the monophyly of Ceinae.

Graham (1969) and Darling and Hanson (1986) provided the most recent summaries of information on the Ceinae, for the Palearctic and Nearctic regions respectively. *Cea* is a monotypic genus (type species: *C. pulicaris* Walker) and is most notable for having both long- and short-winged females (Jansson, 1945). *Cea* was considered a strictly Palearctic genus until recently. Males were recently reported from Texas (Darling and Hanson, 1986) and females have recently been collected in Canada and the United States. There is a long series of fully winged females from Prince Edward Island (CNC) and single specimens, all fully winged, from localities in Alaska, Alberta, Ontario, and Quebec (CNC). The specific status of the Nearctic material has yet to be resolved. There are four Palearctic species of *Spalangiopelta*; Graham (1969) summarized the taxonomic and biological information, and presented an identification key. Until recently, *S. ciliata* was the only species recorded for the Nearctic region. This species is very distinctive and easily distinguished from Palearctic species; however, two recently described species from Oregon (Darling and Hanson, 1986) are much more similar to Palearctic species.

This revision was prompted by the discovery of undescribed species from the New World and the possibility of Holarctic species of *Spalangiopelta*. I have examined and compared the primary types of all species except one and herein revise the world species of *Spalangiopelta*. I specifically (1) develop a diagnosis and a modified description of the genus; (2) summarize information concerning

the described species and present illustrations, modified diagnoses, redescrptions, and, where necessary, lectotype designations; (3) describe and illustrate three new species from the New World; (4) present an identification key for

the world species of *Spalangiopelta*; (5) associate males and females for seven species and correct erroneous associations; and (6) discuss the phylogenetic and biogeographic relationships within the genus.

Materials and Methods

There are a number of difficulties encountered in conducting systematic studies of *Spalangiopelta*. Specimens are extremely rare in collections, and only very recently have series of specimens been collected and made available for study. Specialized collecting methods are needed because of the cryptic habits of these wasps. Berlese extraction, Malaise traps (MT), flight intercept traps (FIT), pan traps, and screen-sweeping have resulted in dramatic increases in the number of specimens: in 1977 there were only 5 Nearctic specimens and today there are over 200. However, there are still large areas of Mexico, and Central and South America that are virtually uncollected.

Spalangiopelta adults are extremely small wasps; most are just over 1 mm in total length. Accurate measurements are therefore extremely difficult to make from point- and card-mounted specimens. Parallax problems and rounding errors often can be quite serious when standard descriptive ratios are used. For example, the ratio of ocellar-ocular line to postocellar line, OOL/POL, involves absolute measurements in the range of 50–70 microns. Means and standard deviations could be calculated that would take into account the inaccuracies in the measurements, but this is not possible if only very few specimens are available for study. One possible solution is to base measurements on slide-mounted material, but again this is difficult if few specimens or only the primary types are available for study. The small size of specimens of *Spalangiopelta* also presents problems in basing descriptions and keys on qualitative characters such as surface sculpture. The perception of many of these characters depends on the source and quality of illumination (diffuse versus direct) and on absolute magnification. Most of the comparisons presented herein were made at $\times 160$ magnification with a combination of both reflected light (fiber optics diffused with mylar barrier) and background transmitted light. If ample material is available, scanning electron micrographs (SEMs) can be used to illustrate these features unequivocally, but this still leaves the problem of dealing with type material. In our initial study of the genus (Darling and Hanson, 1986) we were fortunate to have a relatively long type series (35 specimens for *S. felonia*), allowing for dissections, the preparation of slides, and SEMs. Rather subtle differences in wing venation and antenna, evident only in slide-mounted material, were the first indication that two sympa-

tric species were present in Oregon. Characters of the wing venation and antenna have been used extensively in this revision of the world species of *Spalangiopelta*.

TERMS AND ABBREVIATIONS

Morphological terms follow Graham (1969), Richards (1977), and Bouček (1988). “Prepectus” is used instead of “postspiracular sclerite,” and the thorax + propodeum (first true abdominal segment) is referred to as the “mesosoma”; the rest of the abdomen is referred to as the “metasoma.” Metasomal tergites are designated T1, T2, etc. The metasoma consists of two distinct functional units—the “petiole” (T1), and the “gaster.” The antenna consists of the basal scape, the pedicel, three annelli (A1–A3), five funicular segments (F1–F5), and three claval segments (C1–C3) that are referred to collectively as the “club.” Measurements of antennal segments and the club do not include the internal pedunculate processes (Fig. 44, *pp*). Large setae on the undersurface of the forewing, below the marginal vein, are referred to as “admarginal setae” (Figs. 11, 12, 16, 17, 27–30), and the “hyaline break” is a transparent region in the parastigma (Figs. 55–56). Sculpture types follow Harris (1979), and “glabrous” is used to describe smooth and shining surfaces devoid of sculpture.

For measurements, the terms length (L), width (W), and height (H), are maximum values obtained by rotating the specimen. Measurements and abbreviations are as follows: A2, length of second annellus in dorsal view; CL, club length in lateral view; EH, eye height; F1, F2, etc., length of funicle segment 1, 2, etc. in lateral view; HH, head height in frontal view; HL, head length in dorsal view; HW, head width in frontal view; M, length of marginal vein; MN, length of metanotum along midline; MS, length of malar space; MSC, length of mesoscutum along midline; OOL, length of ocular-ocular line; PED, length of pedicel in lateral view; PM, length of postmarginal vein; PN, length of pronotum along midline; POL, length of postocellar line; PROP, length of propodeum along midline; PW, width of pronotal collar; S, length of stigmal vein; SC, length of scutellum along the midline; SL, scape length; SM, length of submarginal vein; TL, total body length (including ovipositor); WL, wing length; and WW, wing width.

FIGS. 1–3. Scanning electron micrographs of *Spalangiopelta* females. 1. *S. felonia*, lateral habitus (mp, mesopleuron). 2, 3. *S. ciliata*: 2. dorsal view of mesoscutum and scutellum; 3. frontal view of head (m, mandible; l, labrum). Scale lines: Fig. 1 = 0.1 mm, Figs. 2–3 = 0.05 mm.

FIGS. 4–7. Scanning electron micrographs of head and antenna of *Spalangiopecta* females. 4, 5. *S. felonia*: 4. frontal view of head; 5. annelli (A1, A2, A3) and funicular segment 1 (F1; ps, papilliform sensillum). 6. *S. ciliata*, apex of club (pls, peglike seta). 7. *S. canadensis*, club and detail (pls, peglike seta). Scale lines: Figs. 4, 6, 7 = 0.05 mm, Fig. 5 = 0.01 mm.

FIGS. 8–10. Scanning electron micrographs of *Spalangiopecta ciliata* male. 8. dorsal view of mesosoma: habitus and detail (mp, mesopleuron; s, spiracle). 9. funicular segments with basal whorl of long setae and papilliform sensillum (ps). 10. papilliform sensillum (ps). Scale lines: Figs. 8, 9 = 0.05 mm, Fig. 10 = 0.01 mm.

DIAGNOSES AND DESCRIPTIONS

The redescription of *Spalangiopelta* summarizes only those features common to the ten species; “diagnostic” characters are species specific and are described in the species accounts. A diagnosis and redescription are presented for previously described species. For new species described herein, more comprehensive descriptions and measurements are provided; comments that pertain to the holotype or lectotype are indicated in square brackets with the notation HT or LT. Table 1 summarizes the metric comparisons. Male descriptions are comparative with the conspecific females, not with males of other species; only characters and measurements that differ from the female are noted. Interspecific comparisons of males are presented in the Key and Diagnosis sections. The complete description for a species consists of the generic and species descriptions with the appropriate values from Table 1.

Comparative Morphology

A number of morphological character systems were examined during the course of these taxonomic and phylogenetic studies of *Spalangiopelta*. By including *Cea* and various representatives of Pteromalidae, the morphological data could provide evidence for the monophyly of Ceinae or indications of possible sister groups of Ceinae. In addition, functional constraints that may be inherent in the various morphological characters of *Spalangiopelta* were considered.

Antenna

Although both *Cea* and *Spalangiopelta* have three annelli and share the same antennal formula, there are important differences in the structure of the antenna that make me question the monophyly of Ceinae. The antenna of *Cea* is characterized by a very long radicle and the lack of a distinct club; F1–F5 and C1–C3 are very similar in size and shape (Fig. 19). In *Spalangiopelta*, the radicle is much smaller and there is a distinct three-segmented club (Figs. 37–46). There is very little sexual dimorphism in the antenna of *Cea*; the radicle is very long in both sexes. The male scape is somewhat shorter and there are long spatulate setae on the apex of C3 (Figs. 18, 20). The antenna is strongly sexually dimorphic in *Spalangiopelta*. In males, F1–F5 are elongate, and there is a whorl of long setae on F1–F5 and C1–C3 (Figs. 57–64).

A more detailed microscopic study of the antenna in these two genera has revealed similarities in sensory structures. There are papilliform sensilla present distad on the dorsal surface of funicular and club segments in males and females of both genera (Figs. 5, 9–10, 21, 48). Most segments have a single sensillum, which is inserted in a

This study is based on over 200 specimens from the following institutions and collections: American Entomological Institute, Gainesville, Florida (AEI); Z. Bouček, personal collection (ZB); British Museum (Natural History), London (BMNH); Canadian National Collection of Insects, Arachnids, and Nematodes (CNC); D. Christopher Darling, personal collection, currently housed at the Royal Ontario Museum, Toronto (DCD); Hungarian Natural History Museum, Budapest; Museum of Zoology and Entomology, Lund University, Lund (LUND); Manchester Museum, Manchester (MANC); Museo Civico di Storia Naturale “Giacomo Doria,” Genova; National Museum of Natural History, Washington D.C. (USNM); Oregon State University, Corvallis (OSU); Royal Ontario Museum, Toronto (ROM); Texas A & M University, College Station (TAM); University Museum, Oxford.

distinct socket formed by an invagination in the cuticle (Figs. 5, 10, 21, 48). Similar sensory structures have been described in Eulophidae. Termed “multiporous pegs,” these structures are distributed randomly on funicular and club segments with as many as 15 on a single segment (Barlin, Vinson, and Piper, 1981, their figs. 1–3, 14–16). These structures are smaller than the papilliform sensilla, do not have the distinct socket that is found in *Spalangiopelta*, and are regarded here as nonhomologous with the papilliform sensilla of Ceinae.

Males ($n = 6$) and females ($n = 19$) of *Spalangiopelta* usually have a single papilliform sensillum on each of F1–F5 and C2; there are papilliform sensilla on the ventral surface in only 4 of 25 antennae (Fig. 10). In males, dorsal sensilla are present on C2 and C3 ($n = 6$). There do not seem to be species-specific differences in the distribution of these sensilla in *Spalangiopelta*. Both males ($n = 2$) and females ($n = 2$) of *Cea* have dorsal and ventral sensilla on the funicular and club segments (Fig. 21); dorsal sensilla are found only on C2 of males, not on C3 as in *Spalangiopelta*.

Exemplars of 15 subfamilies of Pteromalidae were examined (Cleonyminae, Chalcedectinae, Brachyscelidiphaginae, Cerocephalinae, Macromesinae, Spalangiinae, Asaphinae, Miscogasterinae, Pteromalinae, Crataminae, Diparinae, Eutrichosomatinae, Colotrechninae, Eunotinae, Chrysolampinae; see Darling, 1988, table 1 for details), and distal papilliform sensilla with sockets were found only in Diparinae (Fig. 15). These sensilla are present in both sexes (males, 2–4 per funicular and club segment; females, 1–2).

Spalangiopelta and *Cea* females also have peglike sensory structures on the ventral surface of the apical segment

FIGS. 11–15. Photomicrographs of *Lelaps* sp. (Diparinae). 11. male forewing, DCD Slide No. 1217 (ad, admarginal setae). 12. female forewing, DCD Slide No. 1219 (ad, admarginal setae). 13. male antenna, DCD Slide No. 1218. 14. female antenna, DCD Slide No. 1220. 15. male funicular segment, DCD Slide No. 1218 (ps, papilliform sensillum). Scale lines: Figs. 11–14 = 0.5 mm, Fig. 15 = 0.05 mm.

FIGS. 16–21. Photomicrographs of *Cea pulicaris*. 16. male forewing, DCD Slide No. 659 (ad, admarginal setae). 17. female forewing, DCD Slide No. 663 (ad, admarginal setae). 18. male antenna, DCD Slide No. 660 (r, radicle; sas, spatulate apical seta). 19. female antenna, DCD Slide No. 662 (r, radicle). 20, 21. male antenna, DCD Slide No. 380: 20. apical segment of antenna with spatulate apical setae (sas); 21. funicular segment and papilliform sensillum (ps). Scale lines: Figs. 16–19 = 0.5 mm, Figs. 20, 21 = 0.05 mm.

of the antenna (Fig. 47). These pegs are more numerous in *Spalangiopelta*. These structures were not found in any of the other 15 subfamilies of Pteromalidae examined and are regarded here as a synapomorphy of Ceinae. In both genera, there is also an enlarged anteriorly directed seta on the dorsal surface of F1–F5 in females (Figs. 21, 48), but the distribution and homology of this character is more difficult to ascertain.

Pterothorax and Wings

There are two aspects of the morphology of *Spalangiopelta* females that may be related to searching for hosts in leaf litter and duff habitats. There are two configurations of the profile of the mesosoma in lateral view: arched, with the mesonotum and propodeum making an angle of about 135° (Fig. 23); and depressed or flattened, with the mesonotum and propodeum making an angle of about 150°–160° (Figs. 1, 24). Both configurations are found in *S. felonia*, suggesting that the mesosoma may be flexible and may permit the relative movement of sclerites (Figs. 23, 24). The unique structure of the mesosoma in *Spalangiopelta*, with the mesopleuron projecting rooflike over the metapleuron (Figs. 1, 8, 65–68), would allow changes in the shape of the mesosoma if the mesopleuron and metapleuron had a flexible articulation. The metapleuron would shift under the mesopleuron, lowering the propodeum and resulting in a more arched profile. The two configurations of the mesosoma in *S. felonia* do not appear to be related to either the degree of wing development or the contraction of the antagonistic indirect flight muscles. The arched profile is found in both short- and long-winged specimens, and also in specimens with the wings resting both above and below the level of the tegula (i.e., after the upstroke and downstroke, respectively).

There are two interesting morphological features of the forewing of *Spalangiopelta*. Species may have either a hyaline break or admarginal setae. The hyaline break is an example of a fenestra or bulla, a weakened area of a vein that usually marks an area where a fold or flexion line crosses the vein (Gauld and Bolton, 1988). The distribution of these structures in Chalcidoidea has not been determined, but they are also present in some Encyrtidae (Noyes, 1980), some Eulophidae (Bouček, 1988), and various subfamilies of Pteromalidae (Darling, unpublished). In *Spalangiopelta*, the hyaline break is associated with sensilla (Figs. 35, 56), the function of which are unknown. One hypothesis is that the hyaline break in *Spalangiopelta* allows the forewings to be folded back over the mesosoma; the sensilla may be proprioceptors that provide information on the orientation of the forewings. Wing folding would facilitate movement in a restricted subterranean habitat by allowing females to reverse direction without turning around. Consistent with this view is the absence of the hyaline break in females with shortened forewings

(e.g., *S. felonia* and *S. brachyptera*). The large, ventrally directed admarginal setae might hold the forewings tightly over the body and function to restrict the movement of the wings, thus preventing either abrasion of the wings or hindrance of movement.

Admarginal setae also occur in other subfamilies of Pteromalidae (see illustrations in Graham, 1969) including Diparinae (Figs. 11–12), and many genera of Eulophidae (Eulophinae and Euderinae). Extant members of these eulophid subfamilies do not all search for hosts in restricted habitats, suggesting that the hypothesis presented above concerning the adaptive significance of admarginal setae is either not general or false, or suggesting that natural selection is not the only factor explaining the distribution of admarginal setae in Chalcidoidea.

The hyaline break and the admarginal setae may be viewed as alternative solutions to movement in a restricted habitat. A hyaline break could allow the wings to fold and the admarginal setae could prevent the wings from becoming entangled. Clearly, these putative adaptations are mutually exclusive, and consistent with this scenario is the absence of both structures in any single species. *Spalangiopelta ciliata* is the only species without either a hyaline break or admarginal setae, suggesting that females of this species may not locate their hosts in confined habitats such as leaf litter. More females of this species have been collected than of all other species combined, often in Malaise and flight intercept traps, which is consistent with the females searching for hosts above ground.

Laboratory studies are necessary to evaluate these hypotheses concerning the possible functional correlates of the various morphological characters in *Spalangiopelta*. Given the rarity and lack of economic importance of these wasps, such studies are unlikely to be conducted in the near future, but the possibility of functional constraints should be kept in mind when morphological features are used for phylogenetic studies. Many aspects of morphology may be functionally correlated, and therefore cannot be used as independent evidence of relationships.

PHYLOGENETIC IMPLICATIONS

The presence of distal papilliform sensilla may be a synapomorphy that indicates a close phylogenetic or sister-group relationship between Ceinae and Diparinae. These sensilla are more numerous in the Diparinae, and a reduced number of papilliform sensilla may be a synapomorphy of Ceinae. A more comprehensive study is necessary to determine the distribution of the various types of sensory structures on the antennae of Pteromalidae. Additional support for the hypothesis of a sister-group relationship between Ceinae and Diparinae may be provided by the sexual dimorphism of the male antennae. The males of *Spalangiopelta* and Diparinae have elongate funicular and club

segments with long, laterally projecting setae (Figs. 13, 57–64). It should be noted that these setae are not present in *Cea* (Fig. 18), which implies that the loss of sexual dimorphism is an autapomorphy of *Cea* (i.e., the common ancestor of *Cea* + *Spalangiopelta* had sexually dimorphic male antennae), or that *Cea* and *Spalangiopelta* do not form a monophyletic group; i.e., *Spalangiopelta* may be more closely related to taxa now referred to the Diparinae. The presence of admarginal setae is also consistent with a sister-group relationship between *Cea* + *Spalangiopelta* and Diparinae. These setae are present in both *Cea* and *Spalangiopelta* (Figs. 16, 17, 27–30, 50–52) and in Diparinae (Figs. 11, 12). As noted above, these setae are found in other subfamilies of Pteromalidae, but not in the exemplars

of the other 14 subfamilies of Pteromalidae examined (see Darling, 1988, table 1 for details). Admarginal setae may be plesiomorphic in Ceinae and Diparinae, and thus may provide no phylogenetic evidence. Clearly, more broadly based comparative morphological studies are necessary to evaluate both the monophyly of *Cea* + *Spalangiopelta* and the relationships of these genera with Diparinae. For the purposes of providing a preliminary analysis of the phylogenetic relationships of the species of *Spalangiopelta*, I regard the Ceinae as monophyletic based on two putative synapomorphies: viz. peglike sensory structures on the ventral surface of the apical segment of the antenna, and a reduced number of papilliform sensilla.

Spalangiopelta Masi

Spalangiopelta Masi, 1922:169. Type species: *S. brachyptera* Masi, by monotypy.

Both males and females are characterized by an apomorphic configuration of the mesosoma; the hind margin of the mesopleuron partly overlaps the metapleuron (Figs. 1, 8, 65–68).

FEMALE

Head. In frontal view subquadrate, maximum width 1.0–1.2 times height (Fig. 4), narrower than mesosoma; MS/EH and OOL/POL diagnostic; clypeus small, transverse; antennal toruli separated from oral fossa by less than diameter of torulus (Fig. 4); scrobal cavity deep with high triangular interantennal callus (Fig. 4); eyes with minute setae. Antenna (Figs. 4–7, 37–48): radicle small; scape length approximately equal to eye height, SL/EH = 0.8–1.1; size and shape of scape diagnostic; pedicel elongate, length twice maximum width, longer than F1; with three annelli, combined length less than F1; A1 and A2 transverse, length one-third width, A3 longer than A1 and A2, size and shape diagnostic; five funicular segments, size and shape diagnostic; club three-segmented; papilliform sensillum (Fig. 5) and enlarged, anteriorly directed seta (Fig. 48) present on dorsal surface of F1–F5 and C2; apex and ventral surface of C3 with erect peglike sensilla. Mandibles bidentate (Fig. 3).

Mesosoma. Pronotum campanulate, wider than long, without a distinct collar; apex of scutellum broadly rounded (Figs. 67, 68); posterior margin of mesopleuron projected

rooflike over metapleuron, leaving a distinct space (Figs. 1, 65–68); spiracle situated halfway between the front and hind margin of propodeum (Figs. 65–68), with long seta present beneath spiracle (Figs. 68–73). Forewing and hindwing diagnostic.

Metasoma. Hypopygium extended beyond middle of gaster (Fig. 1); cerci elongate.

MALE

More slender in habitus; eyes smaller, SL/EH approximately 1.3. Antenna (Figs. 9–10, 57–64): pedicel more quadrate, shorter than F1; A1–A3 transverse, subequal in length, combined length less than one-half F1; funicular segments elongate, at least twice as long as wide, each with a basal whorl of long setae; club with three whorls of setae, length diagnostic; ventral surface of C3 without peglike sensilla; C3 with paired digitate apical setae. Hindwing much narrower. Metasoma ovate, T1–T3 subequal in length, laterotergite indistinct.

DISTRIBUTION

Spalangiopelta is a Holarctic genus which extends southward in the New World into South America. *Spalangiopelta* is more broadly distributed in the Neotropical region than indicated in Figures 74 and 75, based on unassociated males from Brazil (Nova Teutonia and San Jose Barreiro, CNC). These specimens probably represent undescribed species, but formal description must await the discovery of females.

Key to Species

Note: Males are not known for three Palearctic species (*S. brachyptera*, *S. dudichi*, *S. procera*) and are only tentatively associated for two Nearctic species (cf. *S. felonia* and *S. laevis*). There is also an apparently undescribed species from Sweden based on a single damaged female specimen in the personal collection of Karl-Johan Hedqvist, "Upl. [Uppsalla] Vallentuna, 27/5 1977, K-J Hedqvist," "D. Chris Darling Slide No. 1422–23, forewing, antenna." The specimen is fully winged with admarginal setae but unfortunately the apex of the metasoma and the ovipositor are destroyed (cf. couplet 7). In coloration, the specimen is similar to *S. brachyptera*: the legs are light in colour, white and yellow, and are strongly contrasted with the iridescent blue-green mesosoma. However, the structure of the antenna differs from *S. brachyptera*, which is only known from short-winged specimens.

- 1** Females: antenna evenly covered with short setae (Figs. 37–46) **2**
- 1'** Males: antenna with basal whorl of long setae on F1–F5 and C1–C3 (Figs. 57–64) **11**
- 2(1)** Petiole elongate, length about twice maximum width (Fig. 22); midlobe of mesoscutum with longitudinal striations (Fig. 2) [eastern North America, south to Texas] ***S. ciliata*, p. 29**
- 2'(1)** Petiole transverse, length less than maximum width (Figs. 1, 65, 66, 68); midlobe of mesoscutum either imbricate (Fig. 67) or with transverse costulae (Fig. 69) **3**
- 3(2')** General body colour light brown, with distinct iridescent violet-green reflections; head bicoloured, with white maculation on gena; scape expanded in lateral view (Figs. 43, 44) **4**
- 3'(2')** General body colour dark violet-blue to black, without strong iridescent reflections; head concolorous, without white maculation on gena; scape linear in lateral view (Figs. 38–42, 45, 46) **5**
- 4(3)** Midlobe of mesoscutum with transverse costulae (Fig. 69); mesosoma with white maculations on pleuron, legs primarily white in colour; forewing with asetose region along hind margin (Fig. 26); scape in lateral view with forward-projecting lamina (Fig. 44, *lm*) [circum-Caribbean] ***S. albigena* sp. nov., p. 24**
- 4'(3)** Midlobe of mesoscutum weakly imbricate (as in Fig. 67); mesosoma concolorous, without white maculations on pleuron, legs primarily

brown in colour; forewing evenly covered with setae, without asetose region along hind margin (Fig. 25); scape expanded in lateral view, but without forward-projecting lamina (Fig. 43) [Mexico and Central America]

- ***S. laevis* sp. nov., p. 34**
- 5(3')** Forewing without admarginal setae, parastigma with hyaline break (Figs. 32, 33) **6**
- 5'(3')** Forewing with 4–10 admarginal setae, parastigma without hyaline break (Figs. 27–30) **7**
- 6(5)** Notauli distinct and linear (Fig. 66); dorsellum about one-third length of scutellum along midline (Fig. 68); antenna with club noticeably wider than funicle, F1 shorter than F2 (Fig. 46) [North America] ***S. canadensis* sp. nov., p. 28**
- 6'(5)** Notauli indicated along scutellum as broad pit-shaped depressions; dorsellum massive, one-half length of scutellum along midline; antenna with club not noticeably wider than funicle, F1 subequal in length to F2 (Fig. 45) [Europe] ***S. alata*, p. 23**
- 7(5')** Ovipositor long, sheaths extended beyond apex of metasoma by at least one-half length of hind tibia; head subequal in width to mesosoma (MSOW/HW = 0.9); pronotum elongate, subequal in length to mesoscutum **8**
- 7'(5')** Ovipositor short, sheaths only slightly extended beyond apex of metasoma by about one-third length of hind tibia; head wider than maximum width of mesosoma (MSOW/HW = 0.7); pronotum about one-half length of mesoscutum **10**
- 8(7)** Robust in habitus, mesosoma length only about 1.5 times maximum width; gena imbricate, malar sulcus indistinct and integrated with sculpture; dorsellum transverse, subequal in length to frenum (Fig. 70) **9**
- 8'(7)** Slender in habitus, mesosoma about twice as long as wide; gena shining with effaced sculpture, with distinct malar sulcus; dorsellum quadrate, longer than frenum (Fig. 73) [Europe] ***S. procera*, p. 35**

- 9(8) Metasoma black, concolorous with head and mesosoma; F1 quadrate, length 0.9-1.0 times width, shorter than F2 (Figs. 39, 40) [North America] *S. apotherisma*, p. 25
- 9'(8) Metasoma dark chestnut brown in colour, contrasted with black head and mesosoma; F1 elongate, length about 1.4 times width, subequal in length or longer than F2 (Fig. 38) [Europe] *S. dudichi*, p. 31
- 10(7') Antenna and legs bright yellow, contrasted with iridescent blue-green general body colour; brachypterous, forewing not extended past propodeum (WL/TL = 0.09-0.11) [Europe] *S. brachyptera*, p. 27
- 10'(7') Antenna and legs brown, similar to general body colour; forewing length variable but always extended past propodeum (WL/TL = 0.14-0.67) [western North America] *S. felonia*, p. 32
- 11(1') Short-winged, forewing only extended to base of metasoma; venation reduced (as in Fig. 27b) *cf. S. felonia*, p. 32
- 11'(1') Long-winged, forewing extended past apex of metasoma; venation complete (Figs. 49-55) 12
- 12(11') Petiole elongate, length greater than maximum width (Fig. 8); forecoxa, hindcoxa, and petiole white, strongly contrasted with mesosoma and gaster (brown in colour); scape white, club much longer than scape (Figs. 57, 59) 13
- 12'(11') Petiole conical, length not greater than maximum width; forecoxa, hindcoxa, and petiole concolorous with mesosoma and gaster (brown in colour); scape brown, club subequal in length to scape (Figs. 60-64) 14
- 13(12) Mesoscutum with longitudinally striate sculpture, propodeum finely areolate (Fig. 8) [eastern North America, south to Texas] *S. ciliata*, p. 29
- 13'(12) Mesoscutum with effaced imbricate sculpture, propodeum glabrous (as in Fig. 72) *cf. S. laevis* sp. nov., p. 34
- 14(12') Midlobe of mesoscutum with iridescent violet-green reflections; scape and gena yellow, lighter in colour than rest of head; forewing with asetose region along hind margin (Fig. 52) [circum-Caribbean] *S. albigena* sp. nov., p. 24
- 14'(12') Midlobe of mesoscutum without iridescent reflections; head and scape concolorous, brown to black; forewing evenly covered with setae, without asetose region along hind margin (Figs. 49-51, 53-55) 15
- 15(14') Forewing rounded, hind margin distinctly expanded, with 4-6 admarginal setae, parastigma without hyaline break (Fig. 50) [North America] *S. apotherisma*, p. 25
- 15'(14') Forewing linear, front and hind margins parallel from midpoint of marginal vein to end of postmarginal vein, without admarginal setae (Figs. 53-55), parastigma with hyaline break (Fig. 56) 16
- 16(15') Notauli distinct and linear (as in Fig. 66); dorsellum about one-third length of scutellum along midline [North America] *S. canadensis* sp. nov., p. 28
- 16'(15') Notauli indicated along scutellum as broad pit-like depressions; dorsellum massive, one-half length of scutellum along midline [Europe] *S. alata*, p. 23

FIGS. 22–24. Lateral view of mesosoma of *Spalangiopelta* females. 22. *S. ciliata*. 23, 24. Intraspecific variation in *S. felonia*, see text for discussion: 23. arched; 24. depressed or flattened. Scale lines = 0.1 mm.

FIGS. 25–30. Photomicrographs of forewings of *Spalangiopecta* females. 25. *S. laevis*, Holotype, DCD Slide No. 1215. 26. *S. albigena*, Paratype, DCD Slide No. 888 (hb, hyaline break). 27. *S. felonia*, Paratypes: *a*, fully winged, DCD Slide No. 353; *b*, short-winged, DCD Slide No. 359. 28. *S. procera*, drawing of Holotype. 29. *S. apotherisma*, Paratype, DCD Slide No. 378 (ad, admarginal setae). 30. *S. dudichi*, Paralectotype, DCD Slide No. 907. Scale lines = 0.5 mm.

FIGS. 31–36. Photomicrographs of forewings of *Spalangiopecta* females. 31. *S. ciliata*, DCD Slide No. 884. 32. *S. alata*, DCD Slide No. 891. 33. *S. canadensis*, British Columbia, DCD Slide No. 1200. 34. *S. canadensis*, Paratype, DCD Slide No. 886. 35, 36. Parastigma: 35. *S. canadensis*, DCD Slide No. 1198, with paired sensilla (s) and hyaline break (hb); 36. *S. apotherisma*, DCD Slide No. 893, without hyaline break. Scale lines: Figs. 31–35 = 0.5 mm, Fig. 36 = 0.05 mm.

FIGS. 37–42. Photomicrographs of antennae of *Spalangiopelta* females. 37. *S. ciliata*, DCD Slide No. 885. 38. *S. dudichi*, Paralectotype, DCD Slide No. 908. 39. *S. apotherisma*, Alberta, DCD Slide No. 894. 40. *S. apotherisma*, Ontario, DCD Slide No. 898. 41. *S. felonia*, Paratype, DCD Slide No. 329. 42. *S. brachyptera*, Paralectotype, DCD Slide No. 909. Scale lines = 0.1 mm.

FIGS. 43–48. Photomicrographs of antennae of *Spalangiopecta* females. 43. *S. laevis*, Holotype, DCD Slide No. 1216. 44. *S. albigena*, Paratype, DCD Slide No. 889 (lm, lamina; pp, pedunculate process). 45. *S. alata*, DCD Slide No. 892. 46. *S. canadensis*, Paratype, DCD Slide No. 887. 47, 48. *S. apotherisma*, DCD Slide No. 898: 47. club with peglike seta (pls) on ventral surface of apical segment; 48. funicular segment with papilliform sensillum (ps) and enlarged anteriorly directed seta (s). Scale lines: Figs. 43–47 = 0.1 mm, Fig. 48 = 0.05 mm.

FIGS. 49–56. Photomicrographs of forewings of *Spalangiopecta* males. 49. *S. ciliata*, DCD Slide No. 1191. 50. *S. apotherisma*, Paratype, DCD Slide No. 376 (ad, admarginal setae). 51. cf. *S. laevis*, DCD Slide No. 1350. 52. *S. albigena*, Paratype, DCD Slide No. 1206 (hb, hyaline break). 53. *S. alata*, DCD Slide No. 1196. 54. *S. canadensis*, British Columbia, DCD Slide No. 1204. 55, 56. *S. canadensis*, Paratype, DCD Slide No. 1194: 56. parastigma with hyaline break (hb). Scale lines: Figs. 49–55 = 0.5 mm, Fig. 56 = 0.05 mm.

FIGS. 57-64. Photomicrographs of antennae of *Spalangiopecta* males. 57. *S. ciliata*, DCD Slide No. 1192. 58. cf. *S. felonia*, DCD Slide No. 1193. 59. cf. *S. laevis*, DCD Slide No. 1351 [scape rotated 180°]. 60. *S. apotherisma*, Paratype, DCD Slide No. 377. 61. *S. albigena*, Paratype, DCD Slide No. 1207. 62. *S. alata*, DCD Slide No. 1197. 63. *S. canadensis*, British Columbia, DCD Slide No. 1205. 64. *S. canadensis*, Paratype, DCD Slide No. 1195. Scale lines = 0.1 mm.

FIGS. 65–68. Scanning electron micrographs of *Spalangiopecta* females. 65. *S. apotherisma*, lateral view of mesosoma and petiole (lc, longitudinal costae on petiole). 66. *S. canadensis*, lateral view of mesosoma and petiole. 67. *S. felonia*, dorsal view of mesonotum and propodeum. 68. *S. canadensis*, dorsal view of mesonotum and propodeum. Scale lines = 0.05 mm.

FIGS. 69–73. Dorsal view of mesosoma of *Spalangiopelta* females (f, frenum; d, dorsellum). 69. *S. albigena*, Paratype. 70–73. Propodea: 70. *S. dudichi*, Paralectotype; 71. *S. brachyptera*, Holotype; 72. *S. laevis*, Holotype; 73. *S. procera*, Holotype. Scale lines = 0.05 mm, Figs. 70–73 drawn to same scale.

TABLE 1. Metric descriptors for female exemplars of previously described and new species of *Spalangiopecta*. Diagnostic ratios are indicated by an asterisk (*), and superscripts (' , " , ''') designate ratios that are considered similar in the species descriptions.

	<i>felonia</i> (Holotype)	<i>brachyptera</i> (Lectotype)	<i>apotherisma</i> (Holotype)	<i>dudichi</i> (Lectotype)	<i>procera</i> (Holotype)	<i>alata</i> (det Bouček)	<i>ciliata</i> (Homotopotype)	<i>canadensis</i> (n = 4)	<i>albigena</i> (n = 4)	<i>laevis</i> (n = 1)
*HW/HL	1.6'	1.6'	1.8	1.9	1.7	1.7	1.6'	1.70–1.83	1.66–1.85	1.57'
HW/HH	1.1	1.1	1.2	1.2	1.1	1.2	1.0	1.10–1.18	0.96–1.12	1.23
*MS/EH	0.5	0.4	0.5	0.4	0.6'	0.5	0.4	0.37–0.41	0.35–0.38	0.46
OOL/POL	0.4	0.8	0.7	0.6	0.7	0.7	0.65	0.66–0.80	0.90–0.92	0.57
SL/EH	1.0	0.8	1.0	1.0	1.1	0.95	1.0	0.94–1.05	0.86–0.95	1.1
*SL/SW	7	6	7	6	7	7	7	7–8	9'' (n = 2)	4.8'
*MSOL/W	2.2	2.2	1.4'	1.6'	2.1	1.6'	1.9	1.50–1.67'	1.75–1.95	1.58'
MSOW/HW	0.7	0.7	0.9	0.9	0.9	0.9	0.8	0.79–0.86	0.74–0.84	0.83
*PN/MS	0.9'	1.0'	0.6	0.6	0.5	0.65	0.5	0.81–0.86'	0.48–0.50	0.64
*SC/MS	1.2	0.8'	1.0	1.1	1.1	1.0	0.7'	0.92–1.0	0.68–0.71'	1.34''
*SC/PROP	1.3'	1.0'	1.5	1.5	1.7	1.3'	0.9'	1.53–1.63	1.70–2.20''	2.68'''
*MN/SC	0.3	0.3	0.3	0.3	0.3	0.5'	0.3	0.27–0.31	0.38–0.45'	0.37'
*O/HT	0.4	0.3	0.7'	0.7'	0.5''	0.3	0.5''	0.34–0.39	0.39–0.46''	0.48''
*FWL/FWW	3.7'	–	3.1	3.0	3.0	3.6'	3.7'	4.2–4.6'	3.5–4.4'	3.6'
*HWL/HWW	7.6	–	4.6'	4.5'	5.6	5.7	6.5	6.1–6.8	7.7–7.9''	6.6
*SM/M	1.1	–	1.1	1.1	1.1	0.9	0.8'	0.77–0.87'	0.67–0.72'	0.83'
*M/PM	1.7	–	2.0	2.5	2.3	2.0	5.2'	2.1–2.4	2.2–2.7	3.2
*PM/S	2.9'	–	2.0	2.0	1.8	2.8'	1.8	2.7–3.5'	2.1–2.5	1.5''

***Spalangiopelta alata* Bouček**

Figs. 32, 45, 53, 62

Spalangiopelta alata Bouček, 1952:160, figs. 2, 3 [♀ antenna, ♀ habitus].

Spalangiopelta alata—Kerrich, 1957:276.

Spalangiopelta alata—Bouček, 1961:56, figs. 1, 2 [♂ antenna, ♂ wing].

Spalangiopelta sp.—Askew, 1965:142.

Spalangiopelta alata—Graham, 1966:188.

Spalangiopelta alata—Graham, 1969:47.

Spalangiopelta alata—Darling and Hanson, 1986:155.

TYPE LOCALITY

Northeastern Bohemia.

TYPE MATERIAL

Holotype (♀, not examined): Tyniste nad Orlici, in forest humus, November 5, 1943, Bouček leg.

TYPE REPOSITORY

National Museum, Prague, Czechoslovakia.

MATERIAL EXAMINED

England (1 ♀, 3 ♂♂)—CHESHIRE: Delamere, Abbots Moss (VII.23; 1 ♂; MANC; DCD Slide Nos. 1196 [forewing], 1197 [antenna]); Jatton Park (?) (IX.20; 1 ♂; BMNH). EAST SUSSEX: Ashdown Forest (VIII.8; 1 ♀; BMNH; DCD Slide Nos. 891 [forewing], 892 [antenna]). WEST CHESHIRE: Austwick Moss (IX.27; 1 ♂; MANC). France (1 ♂)—DORDOGNE: Monestier, Ste. Foy (VII.17; 1 ♂; MANC). Sweden (2 ♀♀, 1 ♂)—GOTLAND: Gottska Sandon (VII.7; 1 ♂; LUND). NARKE: Orebro, Lillan (V.24; 1 ♀; LUND). VARMLAND: Lundsberg (1 ♀; LUND).

DIAGNOSIS

Spalangiopelta alata is characterized by having a very large (see Table 1) and coarsely sculptured metanotum. The female is black without iridescent reflections and the forewing is infusate beyond the basal vein (Fig. 32). The only other species with an enlarged metanotum is *S. laevis*, but in this species the general body colour is light brown with iridescent reflections, the forewing is hyaline (Fig. 25), and the metanotum is finely imbricate. *Spalangiopelta alata* is the only fully winged species recorded from the Palearctic that lacks admarginal setae and has a hyaline break in the parastigma (Figs. 32, 53). In these regards this species is very similar to *S. canadensis*, but both sexes of *S. alata* can be distinguished from *S. canadensis* by the structure of the mesoscutum. The notauli of *S. alata* are indicated as rather deep and broad pitlike depressions; in *S. canadensis* the notauli are linear and typical for the genus, without distinct pitlike depressions (Fig. 66). There are four additional characters to distinguish females of *S. alata* and

S. canadensis: (1) shape of forewing, hind margin rounded versus parallel to front margin (Fig. 32 cf. Figs. 33, 34); (2) colour of mesosoma, black without iridescent reflections versus dark blue-violet with weak iridescent reflections; (3) colour of metasoma, black versus dark brown; and (4) structure of antenna, club narrow and F1 subequal to F2 versus club expanded and F1 shorter than F2 (Fig. 45 cf. Fig. 46). I am unable to reliably separate the males of these two species on the basis of the forewing (Fig. 53 cf. Figs. 54, 55) or antenna (Fig. 62 cf. Figs. 63, 64).

DISTRIBUTION

England, Sweden, France, Germany, Czechoslovakia, Moldavian S.S.R.

HOST

Reared from leaf mine of *Scaptomyza flaveola* Mg. (Diptera: Drosophilidae) on *Cakile maritima* Scop (Cruciferae, see Bouček, 1961:56).

REMARKS

The specimen from Varmland, Lundsberg, is referred to this species with a query. It has the characteristic wing venation of *Spalangiopelta alata* but differs in a number of important characters: the petiole is larger than in *S. alata* and *S. canadensis*, similar in size and sculpture to *S. dudichi*; and the structure of the metanotum and the shape of the forewing are similar to *S. canadensis*. This may represent a distinct species of *Spalangiopelta*, but additional material is needed from Europe to evaluate the status of this specimen.

FEMALE

Length about 1.5 mm, robust in habitus, mesosoma about 1.6 times as long as wide. Head, mesosoma, and metasoma black, without iridescent reflections on head and mesosoma; legs black except tibia brown to yellow distad, concolorous with basal tarsomeres, and distal tarsomeres brown; antenna uniformly brown. Forewing long, extended beyond apex of metasoma, 0.8 body length, infusate beyond basal vein (Fig. 32).

Head. In dorsal view transverse, HW/HL = 1.7–2.0; sculpture distinctly imbricate, except effaced in malar region, scrobal cavity glabrous; MS/EH = 0.5; malar sulcus indistinct, integrated with sculpture, and only clearly indicated at eye margin. Antenna (Fig. 45): scape spindle-shaped; A3 elongate, almost as long as wide, length subequal to A1+A2; F1 elongate, length 1.5 times width, wider than annelli; F2–F5 longer than F1, elongate, length twice width; clava elongate, subequal in length to F3–F5, C2 and C3 equal in length to F5, C1 shorter, segments conical, equal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum arched in lateral view, mesonotum and propodeum making an angle of about 135° (as in Fig.

23); with coarse imbricate sculpture, except where noted; pronotum about one-half length of mesoscutum; notauli indicated as broad pit-shaped depressions at scutellum; pronotum transverse, about one-half length of mesoscutum; scutellum subequal in length to mesoscutum; axillula without longitudinal costae, frenum delimited by slight change of sculpture, with groove indicated laterad; metanotum massive, one-half SC, reticulate with glabrous region laterad along propodeum, dorsellum not distinctly delimited laterad, quadrate and almost twice length of frenum; propodeum large, subequal in length to scutellum, distinctly alveolate, with nuchal concavity clearly indicated, with incomplete median carinae, foveae laterad along metanotum and beneath spiracle; prepectus alveolate, broadly triangular, with rounded flange at upper posterior corner; mesopleuron imbricate. Forewing (Fig. 32) narrow, length about 4 times maximum width, rounded, hind margin expanded, apical setae longer than length of stigmal vein; without admarginal setae; parastigma with hyaline break and two sensilla; submarginal vein subequal in length to marginal vein; marginal vein of uniform thickness, length 2–3 times postmarginal; postmarginal vein long, about 3 times stigmal; stigmal vein slender and linear, stigma only slightly enlarged, uncus long with four sensilla. Hindwing narrow, length about 6 times maximum width, with setae on apical and posterior margins shorter than width of hindwing.

Metasoma. Petiole transverse and inconspicuous; gaster smooth and shining with sparse white setae; T2 longer than following four tergites combined, laterotergite large, more than one-half height of gaster, imbricate; ovipositor short, sheaths only slightly extended beyond apex of metasoma, protruded distance about one-third length of hind tibia.

MALE

Length 0.9–1.2 mm. Metasoma brown, antenna yellow. Head: malar region imbricate. Antenna (Fig. 62): scape shorter, length about 3 times pedicel length; F1 longer than pedicel; F1–F5 subequal in length; club subequal in length to scape. Forewing (Fig. 53) not as distinctly infuscate; hind margin not rounded; apical setae longer; stigmal vein thicker and angulate. Petiole conical, wider along gaster. Hindwing length about 8 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing. Genitalia not examined.

Spalangiopelta albigena Darling sp. nov.

Figs. 26, 44, 52, 61, 69, 75

TYPE LOCALITY

Dominican Republic, Parque Nacional Armando Bermudez

TYPE MATERIAL

Holotype (♀). “DOMINICAN REPUBLIC: Parque Nacional Armando Bermudez, Cord. Central, 1,000 m, I.12–22.1989 L. Masner,” “FIT (mod.) broadleaf forest.” Paratypes (12 ♀♀, 1 ♂). Dominican Republic—Pedernales, 25 km N. Cabo Rojo (I.17–20; 1 ♀; S. A. Marshall; CNC; pan trap). Mexico—JALISCO: 8.3 mi S Autlan (VII.8.1984; 2 ♀♀; J. B. Woolley; TAM, ROM). PUEBLA: 5 mi SE Izucar de Matamoras (VII.20; 1 ♀; J. B. Woolley; TAM). Suriname—BROKOPONDO: Brownsberg (I.12–18.1985; 1 ♀; Finnamore, Thormin; CNC). U.S.A.—FLORIDA: Levy Co., Manatee Springs St. Pk. (VI.3–5.1978; 1 ♀; N. F. Johnson; DCD; pan trap in hardwood forest); Monroe Co., Fat Deer Key (VI.4–VIII.28.1986; 1 ♀; S. & J. Peck; ROM; MT-FIT, hammock forest; DCD Slide Nos. 888 [forewing], 889 [antenna]), (31.VIII–15.12.86 (?); 1 ♀; S. & J. Peck; CNC; MT-FIT, hammock forest). NORTH CAROLINA: Northhampton Co., 7 km S Jackson (VII.1–7; 1 ♀; CNC; bald cypress swamp). SOUTH CAROLINA: Anderson Co., Pendleton 250 m (VI.1987; 1 ♀; BRC HYM TEAM; CNC; FIT, mature hardwood forest), (V.13–19.1987; 1 ♂; BRC HYM TEAM; CNC; FIT, mature hardwood forest; DCD Slide Nos. 1206 [forewing], 1207 [antenna]). TEXAS: Kerr Co., Center Point (VII.31–VIII.6.1987; 1 ♀; R. Wharton; TAM); Harris Co., Jacinto St. Pk. (IX.3; 1 ♀; C. M. Yoshimoto; CNC).

TYPE REPOSITORY

Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada; CNC Type No. 20913.

ETYMOLOGY

A reference to the white coloration on the gena that is characteristic of this species.

DIAGNOSIS

Spalangiopelta albigena is the only species with distinct iridescent violet-green reflections on the mesoscutum and an asetose region along the hind margin of the forewing (Figs. 26, 52). The structure of the forewing will distinguish both males and females from all other described species. In females, the forewing is very narrow, with the apical setae one-half the maximum width of the forewing (Fig. 26). In males, the forewing is broadened and truncate toward the apex (Fig. 52). Females can also be immediately recognized by the white colour on the posterior of the gena and along the pleuron, anteriorly directed laminae on the scape (Fig. 44, *lm*), and transverse costulae on the midlobe of the mesoscutum (Fig. 69).

DISTRIBUTION

Circum-Caribbean: southeastern U.S.A. to Texas, Florida Keys, Greater Antilles, northern South America.

HOST

Unknown.

FEMALE

Length 1.1–1.3 mm, slender in habitus, mesosoma about twice as long as wide. Head, mesosoma, and metasoma brown in lateral view, with brilliant blue-violet iridescent reflections on dorsum of head and mesosoma, except head with interantennal process, posterior malar region, gena, outer orbit, and region below antennal toruli white and with white maculations on pleuron; legs white, except forecoxa brown behind; antenna brown, annelli lighter in colour. Forewing extended to apex of metasoma, 0.7–0.8 body length; with median longitudinal infusate band and asetose region along the hind margin (Fig. 26).

Head. In dorsal view transverse, HW/HL = 1.7–1.8; vertex and ocular-ocular region with transverse costulae; MS/EH = 0.4; malar sulcus indistinct and located more posterior than in other species. Antenna (Fig. 44): scape expanded in lateral view, spindle-shaped, with anteriorly directed lamina (*lm*) on mesal margin; A3 transverse, length about one-quarter width, shorter than A1+A2; F1 transverse, length about one-half width, wider than annelli; F2–F5 longer than F1, quadrate, length subequal to width; clava expanded and extremely large, length subequal to F1–F5, segments conical, equal in length on dorsal and ventral surfaces.

Mesosoma (Fig. 69). Dorsum depressed in lateral view, mesonotum and propodeum making an angle of about 150°; midlobe of mesoscutum with transverse costulae; pleuron with imbricate sculpture; pronotum about one-half length of mesoscutum; notauli distinct; pronotum transverse, about one-half length of mesoscutum; scutellum shorter than mesoscutum; axillula with longitudinal costae, frenum distinct; metanotum large, about 0.4 SC, with glabrous triangular region laterad, dorsellum imbricate, distinctly delimited laterad, quadrate, longer than frenum; propodeum 1.7–2.2 times length of scutellum, glabrous, without nuchal concavity, carinae and foveae absent, with narrow rim along posterior margin (Fig. 69); prepectus imbricate, broadly triangular, without rounded flange at upper posterior corner. Forewing (Fig. 26) very narrow, length about 4 times maximum width, front and hind margins parallel from marginal vein to end of postmarginal vein, apical setae longer than stigmal vein, one-half maximum width of forewing; admarginal setae absent; parastigma with hyaline break and two sensilla; submarginal vein shorter than marginal vein, SM/M = 0.67–0.72; marginal vein of uniform thickness, length 2–3 times postmarginal; postmarginal vein about twice stigmal; stigmal vein linear, stigma slightly enlarged, uncus long with four sensilla. Hindwing very narrow, length about 8 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing.

Metasoma. Petiole transverse and inconspicuous; gaster smooth and shining with long setae; T2 subequal in length to following two tergites combined, laterotergite large, more than one-half height of gaster, imbricate; ovipositor sheaths extended beyond apex of metasoma, protruded distance about one-half length of hind tibia.

MALE

Length 0.9 mm. Head, mesosoma, and metasoma uniformly brown in lateral view, antenna light brown except A1 and A2 yellow, longitudinal infusate band on forewing very faint (Fig. 52). Malar sulcus distinct. Antenna (Fig. 61): scape narrower, with much smaller anteriorly directed lamina, length about 2.5 times pedicel length; A3 more quadrate than A1 and A2; F1 longer than pedicel; F1–F5 subequal in length; club slightly longer than scape, CL/SL = 1.1. Mesosoma arched in lateral view. Forewing (Fig. 52) extended beyond apex of metasoma, 0.9 body length; broadened and truncate toward apex, hind margin expanded, front and hind margins not parallel, apical setae less than one-half maximum width of forewing; SM/M = 0.85; marginal vein 1.7 times postmarginal. Hindwing length about 9 times maximum width, setae on apical and posterior margins longer than width of hindwing. Metasoma: petiole conical, wider along gaster. Genitalia not examined.

Spalangiopelta apotherisma Darling and Hanson

Figs. 29, 36, 39, 40, 47, 48, 50, 60, 65, 75

Spalangiopelta apotherisma Darling and Hanson, 1986:160, figs. 7, 8 [♀ antenna], 9–10 [♂ antenna], 17–18 [♀ wings], 19–20 [♂ wings], 22 [habitus], 24 [prepectus].

TYPE LOCALITY

U.S.A., Oregon, Benton Co.

TYPE MATERIAL

Holotype (♀, examined). “OR: Benton Co. 3 mi NW Corvallis McDonald Forest,” “14 April 1985, D Chris Darling,” “sweeping open Douglas fir forest,” “Holotype ♀ *Spalangiopelta apotherisma* D. C. Darling & P. E. Hanson 1985.” Paratypes (2 ♀♀, 1 ♂). 1 ♀, same data as holotype, DCD Slide Nos. 378 [wings], 379 [antenna]. OREGON: Benton Co., 5 mi WNW Corvallis (IX.15–X.1.1985; 1 ♂; D. C. Darling; DCD; DCD Slide Nos. 376 [wings], 377 [antenna]). Canada—ONTARIO: Nepean, Slack Road (VI.17–24.1985; 1 ♀; L. Masner; CNC; pan trap).

TYPE REPOSITORY

Royal Ontario Museum, Toronto, Canada.

ADDITIONAL MATERIAL EXAMINED

Canada (16 ♀♀, 5 ♂♂)—ALBERTA: Cypress Hills Prov. Park (VIII.14; 2 ♀♀, 1 ♂; CNC, ROM; DCD Slide Nos. 895 [wings], 896 [antenna]); Onefour (VIII.2; 1 ♀; CNC); Writing-on-Stone Prov. Pk. (VI.22–27, IX.19; 5 ♀♀, 2 ♂♂; CNC, ROM; DCD Slide Nos. 893 [♀ wings], 894 [♀ antenna], 924 [♂ antenna], 925 [♀ antenna], 1210 [♀ forewing], 1211 [♀ hindwing]). NOVA SCOTIA: Cape Breton Highlands Nat. Pk. (VII.1; 1 ♀; CNC). ONTARIO: Lanark Co., 7 km SW Carleton Place (V.17; 2 ♀♀; CNC, ROM; DCD Slide No. 898 [antenna]); Russell Co., Mer Bleue (VIII.14–28; 2 ♀♀; CNC). QUEBEC: Gatineau Co., Luskville Falls (VI.17–24, VII.8–15; 2 ♀♀; CNC, ROM); Vaudreuil Co., Rigaud (VII.9; 1 ♀; CNC); Soulanges Co., St. Clet (VII.20; 1 ♂; labelled as allotype *S. ciliata*, CNC Type No. 14079; whole slide mount), (XI.9; 1 ♂; CNC; labelled as paratype *S. ciliata*, CNC Slide No. 75-12-12-2). U.S.A. (3 ♀♀)—MISSOURI: Wayne Co., Williamsville (VI; 1 ♀; CNC). OREGON: Lane Co., H. J. Andrews Exp. For., 11 mi NE Blue River (X.19; 1 ♀; OSU). VIRGINIA: Shenandoah Co., Shenandoah Nat. Park, Big Meadows, 1300 m (VII.8–VIII.20; 1 ♀; CNC).

DIAGNOSIS

Spalangiopecta apotherisma and *S. felonia* are the only Nearctic species with admarginal setae. The females of these two species can be distinguished by these characters: the length of the ovipositor, long, 0.7 length of hind tibia versus shorter, less than 0.33 length of hind tibia; and the shape of the forewing, hind margin expanded versus parallel to front margin (Fig. 29 cf. Fig. 27). Males of *S. apotherisma* have distinct admarginal setae (Fig. 50). The male of *S. felonia* is only tentatively associated and therefore all males with admarginal setae in North America are here referred to *S. apotherisma*. *Spalangiopecta apotherisma* is morphologically very similar to the Palearctic species *S. dudichi*. In addition to sharing the above characters, females of both species have a distinct transverse petiole with longitudinal costae (Fig. 65), and essentially identical wing venation (Fig. 29 cf. Fig. 30). *Spalangiopecta apotherisma* and *S. dudichi* females can be distinguished by these characters: general body colour, black versus chestnut brown; and the structure of the antenna, F1 quadrate and subequal to F2 versus F1 elongate and longer than F2 (Figs. 39, 40 cf. Fig. 38). The male of *S. dudichi* is unknown.

DISTRIBUTION

Transcontinental in North America, between about 36° and 47° north latitude.

HOST

Unknown.

REMARKS

The lighter colour of the antenna in *Spalangiopecta dudichi* (Fig. 38), as compared to *S. apotherisma* (Figs. 39, 40), is an artifact of the preparation of a Canada Balsam slide.

FEMALE

Length about 1.5 mm, robust in habitus, mesosoma about 1.5 times as long as wide. Head and mesosoma black, metasoma chestnut brown, without iridescent reflections; legs brown except tibia and basal tarsomeres yellow, distal tarsomeres brown; antenna brown except anterior surface of scape yellow. Forewing long, extended beyond apex of metasoma, 0.6 body length; lightly infusate beyond basal vein (Fig. 29).

Head. In dorsal view transverse, HW/HL = 1.7–2.0; sculpture imbricate, except scrobes glabrous; MS/EH = 0.5; malar sulcus indistinct. Antenna (Figs. 39, 40): scape narrowly linear; A3 trapezoidal, same shape as A1 and A2, length subequal to A1 and A2; F1 quadrate, length 0.93–1.1 times width ($n = 5$), wider than annelli; F2–F5 longer than F1, quadrate, length less than 1.5 times width; clava elongate, slightly shorter than F2–F5, claval segments longer distad, $C3 > C2 > C1$, C2 subequal in length to F5, segments conical, subequal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum arched in lateral view, mesonotum and propodeum making an angle of about 135° (Fig. 65); with imbricate sculpture, effaced on disk of scutellum; notauli distinct; pronotum transverse, about one-half length of mesoscutum; scutellum subequal in length to mesoscutum; axillula with longitudinal costae, frenum distinct, alveolate; metanotum one-third SC, dorsellum distinctly delimited laterad by punctate (anterior) and glabrous (posterior) areas, transverse, subequal in length to frenum; propodeum shorter than scutellum, distinctly alveolate, with nuchal concavity clearly indicated, with incomplete median and submedian carinae, distinct foveae laterad along metanotum and laterad of submedian carinae beneath spiracle; prepectus imbricate, narrowly triangular, with rounded flange at upper posterior corner (Fig. 65); mesopleuron imbricate to alveolate ventrad. Forewing (Fig. 29) broad, length about 3 times maximum width, apical setae shorter than stigmal vein; with 7–9 admarginal setae; parastigma without hyaline break, with two sensilla (Fig. 36); submarginal vein subequal in length to marginal vein; marginal vein of uniform thickness, length 2–3 times postmarginal; postmarginal vein about twice stigmal; stigmal vein slender and curved, stigma not enlarged, uncus long with four sensilla. Hindwing broad, length less than 5 times maximum width, with setae on apical and posterior margins distinctly shorter than one-half width of hindwing.

Metasoma. Petiole transverse, with longitudinal costae (Fig. 65); gaster smooth and shining with sparse white setae; T2 longer than following three tergites combined,

laterotergite large, more than one-half height of gaster, weakly imbricate; ovipositor long, sheaths distinctly extended beyond apex of metasoma, protruded distance about 0.7 length of hind tibia.

MALE

Length about 1.5 mm, antenna uniform brown in colour. Antenna (Fig. 60): scape narrower, length about 3 times pedicel length; F1 shorter than pedicel; F1–F5 subequal in length; club shorter than scape. Forewing (Fig. 50): apical setae longer, length subequal to stigmal vein; with fewer admarginal setae (3–5); stigmal vein angulate, stigma slightly enlarged. Hindwing length 6–7 times maximum width, with setae on apical and posterior margins longer than one-half width of hindwing. Genitalia not examined.

Spalangiopelta brachyptera Masi

Figs. 42, 71

Spalangiopelta brachyptera Masi, 1922:170, figs. 7, 8 [habitus; legs, head, antenna].

Spalangiopelta brachyptera—Bouček, 1952:160, fig. 1 [antenna].

Spalangiopelta brachyptera—Bouček, 1961:57.

Spalangiopelta brachyptera—Graham, 1969:47.

Spalangiopelta brachyptera—Darling and Hanson, 1986:155.

TYPE LOCALITY

Italy, Isle of Giglio.

TYPE MATERIAL

Lectotype (♀, **here designated**). “Is. Giglio III. 1902 G. Doria,” “*Spalangiopelta brachyptera* Ms. ♀ cotypus!” Paralectotype (♀). “Vallo Lucano VI. 1904 Solari,” “*Spalangiopelta brachyptera* Ms. ♀ cotypus!” “D. Chris Darling Slide No. 909 antenna.” Both specimens are card-mounted and in excellent condition, and have been labelled by me as lectotype and paralectotype.

TYPE REPOSITORY

Museo Civico di Storia Naturale “Giacomo Doria,” Genova, Italy.

DIAGNOSIS

Spalangiopelta brachyptera is known only from females and is the only species with extremely reduced forewings and vestigial hindwings: the forewing extends only to the middle of the propodeum. The only other species with reduced forewings is the Nearctic species *S. felonia*, but in all specimens of this species the forewing extends to the metasoma. The coloration of *S. brachyptera* is also distinctive: the antenna and legs (including the coxae) are bright

yellow and strongly contrast with the iridescent blue-green body colour. This coloration pattern should allow the association of longer-winged females, if wing length variation occurs, and perhaps of males.

DISTRIBUTION

Italy, southern France, Hungary, Rumania.

HOST

Unknown.

FEMALE

Length 1.2–1.3 mm [LT], slender in habitus, mesosoma about twice as long as wide. Head, mesosoma, and metasoma dark brown with blue-green iridescent reflections, especially prominent on pronotum and propodeum; legs, including coxae, bright yellow and contrasted with general body colour. Antenna tricoloured in pinned specimens, scape and pedicel yellow, annelli white, funicle and club light brown. Forewing very short, reaching only the middle of propodeum, 0.09–0.11 [LT] body length, hindwing very reduced.

Head. In dorsal view subquadrate, HW/HL = 1.6; sculpture weakly imbricate, except vertex and ocular-ocellar areas glabrous; MS/EH = 0.4; malar sulcus absent. Antenna (Fig. 42): scape arched; A3 subquadrate, length about 0.6 width, length equal to A1+A2; F1 quadrate, length subequal to width, wider than annelli; F2–F5 longer than F1, elongate, length twice width; clava extremely elongate, longer than F2–F5, claval segments longer distad, C1 subequal to F5, C3>C2>C1 [LT = 15:20:27], segments conical, subequal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum depressed in lateral view, mesonotum and propodeum making an angle of about 150° (as in Fig. 1); with imbricate sculpture, except midlobe of mesoscutum and scutellum glabrous along midline; notauli indistinct; pronotum elongate, length subequal to mesoscutum; scutellum shorter than mesoscutum; axillula with longitudinal costae, frenum distinct; metanotum one-third SC, dorsellum defined laterad, subequal to frenum; propodeum large (Fig. 71), subequal in length to scutellum, alveolate, convex, with slight indication of nuchal concavity, acarinate with weak foveae indicated along metanotum; prepectus alveolate, broadly triangular; mesepimeron alveolate ventrad, rest of mesopleuron imbricate.

Metasoma. Petiole transverse with longitudinal costae; gaster smooth and shining with sparse white setae; T2 longer than following four tergites combined, laterotergite small, less than one-half height of gaster, glabrous; ovipositor short, sheaths only slightly extended beyond apex of metasoma, protruded distance about one-third length of hind tibia.

MALE

Unknown.

Spalangiopelta canadensis Darling sp. nov.

Figs. 7, 33–35, 46, 54–56, 63, 64, 66, 68, 75

TYPE LOCALITY

Canada, Ontario, Constance Bay.

TYPE MATERIAL

Holotype (♀). “Canada: Ontario, Constance Bay, VII.10–23. 1983, Mike Sanborne.” Paratypes (12 ♀♀, 4 ♂♂; CNC, ROM). 6 ♀♀, 1 ♂, same data as holotype, DCD Slide Nos. 388 [♀ antenna], 886 [♀ forewing], 887 [♀ antenna], 897 [♀ hindwing], 382–87 [complete ♀ specimen], 1194 [♂ forewing], 1195 [♂ antenna], 1198 [♀ forewing]. ONTARIO: Grenville Co., Spencerville (IV.19–V.7; 1 ♀; L. Masner; CNC); Grenville Co., Flint Hill nr. Kempville (VI.12–19; 1 ♂; L. Dumouchel, J. Perking; CNC); Hamilton-Wentworth Reg. Mun., Hamilton (VIII.6, VIII.14–22; 1 ♀, 1 ♂; M. Sanborne; DCD); Lanark Co., 3 km N Almonte (VII.1–8; 1 ♀; Denis, Dumouchel; CNC; pan trap); Lanark Co., 5 km NW Almonte (V.12–15; 1 ♀; H. Goulet; CNC; pan trap); Lanark Co., 7 km SW Carleton Place (VII; 1 ♂; S. Miller; ZB); Prescott Co., Alfred Bog (VIII.12; 1 ♀; M. Sanborne; CNC). QUEBEC: Gatineau Co., Gatineau Park (IX; 1 ♀; C. Yoshimoto; CNC).

TYPE REPOSITORY

Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada; CNC Type No. 20914.

ETYMOLOGY

A reference to the country of origin of the type material.

ADDITIONAL MATERIAL EXAMINED

Canada (11 ♀♀, 9 ♂♂)—ALBERTA: Aden (VI.28; 1 ♀; CNC); Elkwater Lake (VII.21; 1 ♀; CNC; DCD Slide No. 1199 [antenna]). BRITISH COLUMBIA: Blind Bay nr. Sorrento (IV.4–15, IX.10–23; 8 ♀♀, 9 ♂♂; CNC, ROM; DCD Slide Nos. 1200, 1202, 1208 [♀ forewing], 1201, 1203 [♀ antenna], 1204 [♂ forewing], 1205 [♂ antenna], 1209 [♀ hindwing]). NOVA SCOTIA: Cape Breton Highlands Nat. Pk. (VIII.2; 1 ♀; ZB). U.S.A. (3 ♀♀)—MARYLAND: Howard Co., Clarksville (VI.13.1986; 1 ♀; USNM). NORTH CAROLINA: McDowell Co., 37°00'N, 81°30'W (IV–VII.9.1987; 1 ♀; CNC). VIRGINIA: Warren Co., Shenandoah Nat. Park, Compton Gap, 800 m (VII.23–VIII; 1 ♀; CNC).

DIAGNOSIS

Spalangiopelta canadensis is very similar to the Palearctic species *S. alata*. These are the only species that have the

following combination of characters: uniformly dark in colour with distinct imbricate sculpture; and forewing without admarginal setae but with hyaline break in the parastigma (Figs. 33–35, 55, 56 cf. Figs. 32, 53). Both sexes of *S. canadensis* can be distinguished from *S. alata* by the structure of the mesoscutum: the notauli of *S. canadensis* are linear, not indicated as broad pitlike depressions. Additional distinguishing features are listed in the Diagnosis section of *S. alata*. The configuration of the forewing, viz. no admarginal setae and a hyaline break, is shared with three other Nearctic species but all three (*S. albigena*, *S. laevis*, and *S. ciliata*) are characterized by iridescent reflections on the mesoscutum. *Spalangiopelta canadensis* is the only Nearctic species that lacks admarginal setae and has both a linear forewing, with the fore and hind margins parallel, and evenly distributed setae, without an asetose band along the hind margin (Figs. 33, 34, 55).

DISTRIBUTION

Transcontinental in North America, between about 35° and 50° north latitude.

HOST

Unknown.

FEMALE

Length about 1.2–1.5 mm, robust in habitus, mesosoma about 1.6 times as long as wide. Head and mesosoma black with distinct green iridescent reflections, metasoma dark brown; legs brown except coxae black, tibia yellow distad concolorous with basal tarsomeres, distal tarsomeres brown; antenna uniformly brown. Forewing short, not extended distinctly beyond apex of metasoma, 0.7 body length; infusate between basal and stigmal veins (Figs. 33, 34).

Head. In dorsal view transverse, HW/HL = 1.7–1.8; sculpture imbricate, except scrobal cavity glabrous; MS/EH = 0.4; malar sulcus indistinct, integrated with sculpture and only clearly indicated at eye margin. Antenna (Fig. 46): scape spindle-shaped; A3 elongate, almost as long as wide, length subequal to A1+A2; F1 quadrate, length 1.2–1.5 times width, wider than annelli; F2–F5 longer than F1, elongate, but length less than twice width; clava elongate and expanded, subequal in length to F3–F5, C2 and C3 equal in length to F5, C1 shorter, segments conical, equal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum arched in lateral view, mesonotum and propodeum making an angle of about 135° (Fig. 66); with imbricate sculpture, except where noted; notauli distinct, without pit-shaped depressions; pronotum 0.8–0.9 length of mesoscutum; scutellum subequal in length to mesoscutum; axillula without longitudinal costae, frenum distinct; metanotum one-third SC, with glabrous region laterad along propodeum, dorsellum not distinctly

delimited laterad, transverse, subequal in length to frenum; propodeum shorter than scutellum, distinctly alveolate, with nuchal concavity clearly indicated, with incomplete median and submedian carinae, foveae laterad along metanotum and beneath spiracle (Fig. 68); prepectus alveolate, narrowly triangular, with rounded flange at upper posterior corner (Fig. 68). Forewing (Figs. 33, 34) narrow, length about 4 times maximum width, linear, front and hind margins parallel from midpoint of marginal vein to end of postmarginal vein, apical setae longer than length of stigmal vein; without admarginal setae; parastigma with hyaline break and two sensilla; submarginal vein shorter than marginal vein; marginal vein of uniform thickness, length 2–3 times postmarginal; postmarginal vein long, about 3 times stigmal; stigmal vein short and wide, stigma variable (see Variation section) [HT: stigma triangular, enlarged below], uncus wider than sensilla, with four sensilla. Hindwing narrow, length 6–7 times maximum width, with setae on apical and posterior margins shorter than width of hindwing.

Metasoma. Petiole transverse and inconspicuous (Fig. 66); gaster smooth and shining with sparse white setae; T2 longer than following three tergites combined, laterotergite large, more than one-half height of gaster, imbricate; ovipositor short, sheaths only slightly extended beyond apex of metasoma, protruded distance 0.3–0.4 length of hind tibia.

MALE

Length 1.1–1.2 mm. Antenna (Figs. 63, 64): scape shorter, length about 3 times pedicel length; F1 longer than pedicel; F1–F5 subequal in length; club subequal in length to scape. Forewing (Figs. 54, 55) extended distinctly beyond apex of metasoma, 0.8 body length; apical setae longer; stigmal vein linear, stigma not expanded. Hindwing length about 7 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing. Petiole conical, wider along gaster. Genitalia not examined.

VARIATION

There are consistent differences in the shape of the stigmal vein when females from eastern and western North America are compared. The stigmal vein is slender and linear in all specimens from British Columbia and Alberta (Fig. 33), and shorter and triangular in the type material from the Ottawa region (Fig. 34). The stigmal vein of the western specimens is much more similar to that of *Spalangiopelta alata* (Fig. 32) than to that of the type material of *S. canadensis* (Fig. 34). However, these western specimens agree with the type material of *S. canadensis* in all other characters and are here considered to be conspecific. For this reason I have only designated specimens from the region around Ottawa as paratypes, in case future studies

demonstrate differentiation between eastern and western populations.

Spalangiopelta ciliata Yoshimoto

Figs. 2, 3, 6, 8–10, 22, 31, 37, 49, 57, 74

Spalangiopelta ciliata Yoshimoto, 1977, figs. 1, 2 [various SEMs; ♀ antenna, ♀ wings].

Spalangiopelta ciliata—Darling and Hanson, 1986:155, 161.

TYPE LOCALITY

Canada, Ottawa, Mer Bleue.

TYPE MATERIAL

Holotype (♀, examined). “Mer Bleue, Ottawa, Ont. 29.VII.75 L. Masner.” Paratype (♀, ♂). ONTARIO: Grenadier Island, St. Lawrence National Park (VII.22.1975; L. Masner; CNC; swept from shady forest undergrowth). The allotype and other male paratype are not here regarded as conspecific; see Remarks section.

TYPE REPOSITORY

Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada; CNC Type No. 14079.

ADDITIONAL MATERIAL EXAMINED

Canada (14 ♀♀, 1 ♂)—NOVA SCOTIA: Cape Breton Highlands Nat. Pk. (VI.4; 2 ♀♀; CNC, ROM). ONTARIO: Grenville Co., Oxford Mills (VIII.24; 1 ♀; CNC); Grenville Co., Spencerville (IV.30; 5 ♀♀; CNC, ROM; DCD Slide Nos. 884 [♀ forewing], 885 [♀ antenna]); Leeds Co., Chaffey's Locks (X.16; 1 ♀; CNC); Ottawa-Carleton Reg. Mun., Ottawa (VII.15–27; 3 ♀♀; CNC, ROM); Prescott Co., Alfred Bog (V.12; 1 ♀; CNC). QUEBEC: Gatineau Co., Gatineau Park (VI.14, IX.6–13; 1 ♀, 1 ♂; CNC). U.S.A. (49 ♀♀, 18 ♂♂)—FLORIDA: Alachua Co., Felasco Hammock St. Pk. (V.1–VII.13; 1 ♀; CNC; hardwood forest); Alachua Co., Gainesville (I.12–20, XII.21–31; 2 ♀♀, 13 ♂♂; CNC, AEI, ROM, USNM; DCD Slide Nos. 1189, 1191 [♂ forewing], 1190, 1192 [♂ antenna]); Clay Co., Goldhead State Park (IV.20–30; 1 ♀; CNC); Dade Co., Everglades Nat. Pk., Lone Pine Key (VIII.31–XII.9; 4 ♀♀; CNC, ROM; pineland forest); Liberty Co., Torreya St. Pk. (X.7; 1 ♂; ROM; DCD Slide No. 890 [forewing]). LOUISIANA: St. Bernard Parish (XI.10; 1 ♀; FMNH). MARYLAND: Calvert Co., 6 km W Prince Frederick (VIII.25; 1 ♀; CNC); Calvert Co., Chesapeake Beach (VI.13; 3 ♀♀; CNC, USNM; mature Carolinian forest undergrowth); Howard Co., Clarksville (VI.26, VII.13; 2 ♀♀; USNM); Prince Georges Co., Patuxent Wildlife Center (VI.4, X.16; 2 ♀♀; CNC); Seneca Co., Potomac River Trail (VI.16; 1 ♀, 1 ♂; CNC). MICHIGAN: Arenac Co. (VII.19; 1 ♀; USNM). MISSOURI: Wayne Co., Willi-

amsville (V; 2 ♀♀; CNC). NORTH CAROLINA: Caldwell & Avery Co., Blue Ridge Mtns, Pisgah Nat. For. (IX.24; 2 ♀♀; CNC); Macon Co., Witheside Mt., 1600 m. (IV–VI; 3 ♀♀; CNC, ROM; DCD Slide Nos. 1212 [antenna], 1213 [forewing], 1214 [hindwing]); Pamlico Co., Hwy 55 (X.15; 1 ♀; CNC). OKLAHOMA: Marshall Co., 2 mi SE Willis (IV.5–6; 2 ♀♀; FMNH, ROM). SOUTH CAROLINA: Anderson Co., Pendleton, 225 m. (V.13–19, IX.1–9; 1 ♀; CNC); Anderson Co., Pendleton, 250 m. (V.13–19, VII.10–17; 8 ♀♀; CNC, ROM). TENNESSEE: Laurence Co., 20 km E Waynesboro (VIII.19; 1 ♂; CNC). TEXAS: Bandera Co., Lost Maples State Park (VIII.18; 1 ♂; TAM); Brazos Co., College Station (V.11; 1 ♀; TAM); San Jacinto Co., 5 km S Coldspring (V.22–24; 2 ♀♀; CNC, ROM); Walker Co., Ellis Prison Unit (V.3; 1 ♀; TAM). VIRGINIA: Arlington Co., Rosslyn (X.1; 1 ♀; USNM); Fairfax Co., Annadale (VII.12; 1 ♀; USNM); Louisa Co., Cuckoo (VI.3–18, X.7–XI.4; 3 ♀♀; USNM, ROM); Pendleton Co., Spruce Knob (VII.31; 1 ♂; CNC; spruce-birch litter). WISCONSIN: Kenosha Co., Chiwaukee Prairie (IV.20; 2 ♀♀; FMNH, ROM).

DIAGNOSIS

Both males and females of *Spalangiopelta ciliata* can be recognized immediately by the following combination of characters: long petiole (Figs. 8, 22); scape, fore and hind coxae, and petiole white; longitudinal striations on midlobe of mesoscutum (Fig. 2); and finely areolate propodeum. The forewing of females is also diagnostic; this is the only species in which the forewing is spatulate and cupped, with very long setae (Fig. 31). The males provisionally referred to *S. laevis* also have a long white petiole, but the midlobe of the mesoscutum is weakly imbricate and the propodeum is glabrous.

DISTRIBUTION

Widely distributed in eastern North America, west to Oklahoma, south to Florida and Texas, and possibly Mexico. See Remarks under *Spalangiopelta laevis*.

HOST

Unknown.

REMARKS

The type material contains males of both *Spalangiopelta ciliata* and *S. apotherisma*. Unfortunately, figures 2c–e of Yoshimoto (1977) were made from specimens that are here referred to *S. apotherisma* based on the presence of the short transverse petiole. These males, both from St. Clet, Quebec, were collected in a beef pasture, not a beet pasture as indicated in the original description.

FEMALE

Length 1.4–1.7 mm, slender in habitus with distinct elongate petiole (Fig. 22), mesosoma about twice as long as wide. Head and mesosoma light reddish-brown, darker on vertex, frons, mesoscutum, and scutellum, with blue-green iridescent reflections especially prominent on midlobe of mesoscutum; petiole white, rest of metasoma dark brown, ovipositor sheaths black; legs yellow except fore and hind coxae white; antenna tricoloured, scape white, pedicel and annelli yellow, funicular segments and club black. Forewing elongately spatulate with long apical setae (Fig. 31), of intermediate length, extended to apex of metasoma, about 0.6 body length; distinctly infusate between basal and stigmal veins.

Head. In dorsal view subquadrate, HW/HL = 1.6; sculpture imbricate except vertex and gena glabrous; scrobal cavity narrow above, with transverse rugae, divergent and glabrous below; MS/EH = 0.4; malar sulcus absent. Antenna (Fig. 37): scape spindle-shaped; A3 quadrate, length about one-half width, length subequal to A1+A2; F1 elongate, length twice width, wider than annelli; F2–F5 progressively shorter and wider, F5 transverse, wider than long; clava expanded and elongate, longer than F3–F5, C1 and C2 longer on dorsal than on ventral surface, C3 longer on ventral than on dorsal surface.

Mesosoma. Pronotum and mesonotum strongly arched in lateral view, scutellum swollen, and propodeum subhorizontal (Fig. 22); pronotum with imbricate sculpture, mesoscutum with longitudinal striations (Fig. 2), reticulate laterad and scutellum finely reticulate; notauli distinct; pronotum transverse, about one-half length of mesoscutum, posterior margin strongly emarginate; scutellum shorter than mesoscutum; axillula with strong longitudinal costae (Fig. 2), frenum glabrous, delimited by distinct change in sculpture; metanotum one-third SC, dorsellum glabrous and distinctly delimited laterad by punctate (anterior) and glabrous (posterior) areas, transverse, subequal in length to frenum; propodeum large, subequal in length to scutellum, finely areolate, without nuchal concavity, with distinct alveolate median groove, without submedian carinae, very large smooth foveae laterad along metanotum and beneath spiracle; prepectus broadly triangular, alveolate (Fig. 22); mesepimeron alveolate ventrad, rest of mesopleuron glabrous; legs long and thin. Forewing (Fig. 31) length about 4 times maximum width, apical setae much longer than stigmal vein; without admarginal setae; parastigma without hyaline break and without sensilla; submarginal vein shorter than marginal vein; marginal vein of uniform thickness, very long, length about 5 times postmarginal; postmarginal vein about twice stigmal; stigmal vein linear, thick, stigma short, only slightly enlarged, uncus short with four sensilla. Hindwing

narrow, length about 6–7 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing.

Metasoma. Petiole elongate, narrowed slightly anteriorly, alveolate with longitudinal costae on posterior half (Fig. 22); gaster smooth and shining, with sparse white setae, underside with distinct rugose collar that articulates with petiole; T2 short, only slightly longer than T3, laterotergite small, about one-quarter height of gaster, glabrous; ovipositor sheaths extended beyond apex of metasoma, protruded distance about one-half length of hind tibia.

MALE

Length about 1 mm, slender in habitus with distinct petiole (Fig. 8). Head, mesosoma, and metasoma light brown, with blue-green iridescent reflections on midlobe of mesoscutum; petiole and legs white; antenna bicoloured, scape white; pedicel, annelli, funicular segments, and club brown, concolorous with general body colour (Fig. 57); forewing weakly infusate throughout (Fig. 49).

Head in dorsal view transverse, HW/HL = 1.8; scrobal cavity glabrous; eyes smaller, SL/EH = 1.3. Antenna (Fig. 57): scape slender, not distinctly spindle-shaped, length about 3 times pedicel length; F1 longer than pedicel; F1–F4 subequal in length, F5 shorter than F4; club indistinctly segmented, longer than scape, CL/SL = 1.3.

Mesosoma: dorsum arched in lateral view, mesonotum and propodeum making an angle of about 130° (as in Fig. 23); pronotum with longitudinally imbricate sculpture, mesoscutum and scutellum finely reticulate; mesoscutum smaller, not strongly arched and swollen, subequal in length to scutellum, SC/MS = 0.9; propodeum shorter than scutellum; axillula with longitudinal costulae; metanotum smaller, only 0.2 SC, dorsellum imbricate; propodeum alveolate, with short carinae medially, without distinct punctate median groove, foveae laterad along metanotum and beneath spiracle smaller. Forewing (Fig. 49) not elongately spatulate, extended beyond apex of metasoma, about 0.9 body length; apical setae shorter; marginal vein shorter, only about 3 times postmarginal vein. Hindwing length about 11 times maximum width, setae on apical and posterior margins longer than width of hindwing.

Metasoma: petiole elongate, length almost twice maximum width, narrowed only slightly anteriorly, with paired setae directly laterad at midpoint, sculpture weaker; gaster smaller, cylindrical, with rugose collar less distinct; T2 with posterior margin excised medially, without laterotergites. Genitalia not examined.

Spalangiopelta dudichi Erdős

Figs. 30, 38, 70

Spalangiopelta dudichi Erdős, 1955:193, fig. 2 [mislabelled in caption, see corrigenda].

Spalangiopelta dudichi—Bouček, 1961:56.

Spalangiopelta dudichi—Graham, 1966:188.

Spalangiopelta dudichi—Graham, 1969:48.

Spalangiopelta dudichi—Darling and Hanson, 1986:155, 161.

TYPE LOCALITY

Hungary, Budapest.

TYPE MATERIAL

Lectotype (♀, **here designated**). “Budapest. Biró. 1926. [underside] XI.21 cribri ope Sashegy,” “*Spalangiopelta dudichi* Erd. det Erdős,” “Cotypus.” Paralectotypes (13 ♀♀). See Erdős 1955:194 for label data; DCD Slide Nos. 907 [forewing], 908 [antenna].

TYPE REPOSITORY

Hungarian Natural History Museum, Budapest, Hungary.

ADDITIONAL MATERIAL EXAMINED

Sweden (3 ♀♀)—NARKE: Orebro, O. Mark (VI.26; 1 ♀; DCD; DCD Slide Nos. 657 [wings], 658 [antenna]); Orebro, Oset (II.9; 1 ♀; LUND). SKANE: Veberod (VIII.2; 1 ♀; LUND).

DIAGNOSIS

Spalangiopelta dudichi and *S. procera* are the only Palearctic species with admarginal setae and with ovipositors at least one-half the length of the hind tibia. *Spalangiopelta dudichi* is more robust in habitus, does not have blue-green iridescent reflections on the mesosoma, and has a transverse dorsellum (Fig. 70). The males are not known for either of these species. *Spalangiopelta dudichi* is most easily confused with the Nearctic species *S. apotherisma*. Females of these two species can be distinguished by the colour of the metasoma, dark chestnut brown versus black, and by the shape and size of F1, elongate and longer than F2 versus quadrate and subequal to F2 (Fig. 38 cf. Figs. 39–40).

DISTRIBUTION

Hungary, Moldavian S.S.R., Sweden.

HOST

Unknown.

FEMALE

Length 1.7 mm [LT], robust in habitus, mesosoma about 1.5 times as long as wide. Head and mesosoma dark brown,

metasoma chestnut brown, without iridescent reflections; legs brown except tibia and basal tarsomeres yellow, distal tarsomeres brown. Forewing long, but not extended beyond apex of metasoma, 0.6 body length; lightly infusate beyond basal vein (Fig. 30).

Head. In dorsal view transverse, HW/HL = 1.7–2.0; sculpture imbricate, except scrobal cavity glabrous; MS/EH = 0.5; malar sulcus distinct. Antenna (Fig. 38): scape narrowly linear; A3 quadrate, length about one-half width, length subequal to A1+A2; F1 elongate, length 1.38–1.45 times width (n = 2), wider than annelli; F2–F5 subequal in length to F1, quadrate, length subequal to width; clava elongate, subequal in length to F3–F5, C1 and C3 each shorter than F5, C2 longer than C1 and C3, segments conical, equal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum arched in lateral view, mesonotum and propodeum making an angle of about 135°; with imbricate sculpture, finer on disk of scutellum; notauli distinct; pronotum transverse, about one-half length of mesoscutum; scutellum subequal in length to mesoscutum; axillula with longitudinal costae, frenum distinct; metanotum one-third SC, dorsellum distinctly delimited laterad by punctate (anterior) and glabrous (posterior) areas, transverse, subequal in length to frenum; propodeum shorter than scutellum, distinctly alveolate, with nuchal concavity clearly indicated, with distinct median and submedian carinae, distinct foveae laterad along metanotum and laterad of submedian carinae beneath spiracle (Fig. 70); prepectus alveolate, narrowly triangular, mesopleuron with narrow glabrous band parallel to posterior margin of prepectus, rest of mesopleuron imbricate. Forewing (Fig. 30) broad, length about 3 times maximum width, apical setae shorter than stigmal vein; with 6–10 admarginal setae; parastigma without hyaline break, with two sensilla; submarginal vein subequal in length to marginal vein; marginal vein of uniform thickness, length 2–3 times postmarginal; postmarginal vein about twice stigmal; stigmal vein slender and curved, stigma slightly enlarged, uncus long with four sensilla. Hindwing broad, length less than 5 times maximum width, with setae on apical and posterior margins one-half width of hindwing.

Metasoma. Petiole transverse with longitudinal costae; gaster smooth and shining with sparse white setae; T2 longer than following four tergites combined, laterotergite large, more than one-half height of gaster, imbricate; ovipositor long, sheaths distinctly extended beyond apex of metasoma, protruded distance about 0.7 length of hind tibia.

MALE

Unknown.

Spalangiopelta felonia Darling and Hanson

Figs. 1, 4, 5, 23, 24, 27, 41, 58, 67, 75

Spalangiopelta felonia Darling and Hanson, 1986:154, figs. 1, 2 [SEM habitus], 3 [SEM head], 4–6 [♀ antennae], 11–16 [♀ wings], 21 [habitus], 23 [prepectus].

Spalangiopelta felonia—Darling, 1988:2821, fig. 27 [labrum].

TYPE LOCALITY

U.S.A., Oregon, Benton Co.

TYPE MATERIAL

Holotype (♀, examined). “OR: Benton Co. 3 mi NW Corvallis McDonald Forest February 14 1985,” “D.C. Darling J.A. DiGiulio P.E. Hanson,” “Ex: needle litter *Pseudotsuga menziesii*,” “Holotype ♀ *Spalangiopelta felonia* D. C. Darling & P. E. Hanson 1985.” Paratypes (35 ♀♀). 34 ♀♀, same data as holotype except collected between 17 January and 11 April 1985; DCD Slide Nos. 353, 359, 375 [wings], 329 [antenna], 354–358 [complete specimen]. OREGON: Benton Co., 14 mi. W Corvallis, Marys Peak (I.24.1985; 1 ♀; G. L. Parsons and J. D. Oswald; moss, lichens, and bryophytes). Paratypes widely distributed, see Darling and Hanson 1986:155.

TYPE REPOSITORY

Royal Ontario Museum, Toronto, Canada.

ADDITIONAL MATERIAL EXAMINED

U.S.A. (8 ♀♀, 1 ♂)—CALIFORNIA: Humboldt Co., 2 mi N Redway (III.1; 1 ♀; CDFA); Inyo Co., nr Westgard Pass, 7300' (III; 1 ♀; CDFA; DCD Slide No. 899 [antenna]); Riverside Co., Whitewater Canyon (XII.27; 1 ♂; CDFA; DCD Slide No. 1193 [antenna]); Solano Co., Mt. Tamalpais, 430 m (II.18; 1 ♀; DCD); Solano Co., 2 km SE Mt. Vaca, 680 m (III.3; 1 ♀; DCD; chaparral, sifted litter; DCD Slide Nos. 900 [wings], 901 [antenna]). OREGON: Lane Co., 14 mi ENE Lowell, 1200' (VIII.30; 1 ♀; FMNH); Lane Co., H. J. Andrews Exp. For., 11 mi NE Blue River (V.7–VII.14; 3 ♀♀; OSU).

DISTRIBUTION

Coast Range of Oregon and California.

DIAGNOSIS

Spalangiopelta felonia and *S. brachyptera* are the only species with reduced forewings. These two species can be distinguished by the colour of the antenna and legs, brown in *S. felonia* versus yellow in *S. brachyptera*. Only fully winged females of *S. felonia* have admarginal setae and a short ovipositor, less than one-half the length of the hind tibia. *Spalangiopelta felonia* can be distinguished from its sympatric congener *S. apotherisma* by the structure of the

antenna, A3 quadrate and F1 elongate versus A3 transverse and F1 quadrate (Fig. 41 cf. Figs. 39, 40), and of the forewing, stigmal vein short and angulate versus longer and curved (Fig. 27 cf. Fig. 29). In addition, *S. felonia* has a more slender habitus and shorter ovipositor than *S. apotherisma* (see Darling and Hanson 1986, figs. 21, 22).

HOST

Unknown.

REMARKS

The male specimen can be only tentatively associated with *Spalangiopelta felonia*. It was not collected with females but was collected within the geographic range specific to *S. felonia* (Fig. 75). This specimen is clearly not conspecific with *S. apotherisma*, the only other species found in western North America. The male is short-winged and similar in this regard to the majority of the females of *S. felonia*. This is the only short-winged male reported for *Spalangiopelta*. The exact label data are as follows: "CALIF: Riverside Co., Whitewater Canyon XII-27-1979. 79-127 KW Cooper," "berlese abandoned *Neotoma* nest at base of *Prosopis*," "D. Chris Darling Slide No. 1193 antenna" (CDFA).

FEMALE

Length 0.9–1.4 mm, slender in habitus, mesosoma about twice as long as wide. Head, mesosoma, and metasoma dark brown with iridescent blue-green to bronze reflections on head and mesosoma, especially prominent on propodeum; legs becoming lighter in colour distad, coxae dark brown, concolorous with mesosoma, trochanters and femora brown, tibiae yellowish-brown, tarsomeres yellow, darker distad; antenna uniformly dark brown. Forewing variable in length, 0.14–0.94 body length; weakly infumate, darker in region bounded by basal and stigmal veins (Fig. 27).

Head. In dorsal view subquadrate, HW/HL = 1.6; sculpture weakly imbricate, except scrobal cavity glabrous; MS/EH = 0.5; malar sulcus distinct. Antenna (Fig. 41): scape narrowly linear; A3 quadrate, length about one-half width, length subequal to A1+A2; F1 elongate, length 1.4 times width, subequal in width to annelli; F2–F5 subequal in length to F1, F3–F5 quadrate, length subequal to width; clava elongate, subequal in length to F2–F5, C1 and C3 each shorter than F5, C2 longer than C1 and C3, segments conical, equal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum either arched in lateral view, mesonotum and propodeum making an angle of about 135° (Fig. 23), or depressed, mesonotum and propodeum making an angle of about 150° (Fig. 24); with weakly imbricate sculpture, effaced on scutellum anterior to frenal groove; notauli distinct but reduced in shorter-winged specimens; pronotum elongate, length subequal to

mesoscutum; scutellum subequal in length to mesoscutum; axillula with longitudinal costae, frenum distinct; metanotum one-third SC, dorsellum distinctly delimited laterad by punctate (anterior) and glabrous (posterior) areas, transverse, subequal in length to frenum; propodeum large, subequal in length to scutellum, distinctly alveolate, convex with slight indication of nuchal concavity, acarinate and afoveate, sculpture reduced to form narrow region along posterior margin (Fig. 67); prepectus alveolate, broadly triangular; mesopleuron imbricate. Forewing (Fig. 27) in fully winged specimens narrow, length about 4 times maximum width, apical setae longer than stigmal vein; with 4–5 admarginal setae; parastigma without hyaline break, with two sensilla; submarginal vein subequal in length to marginal vein; marginal vein of uniform thickness, length about twice postmarginal; postmarginal vein about 3 times stigmal; stigmal vein linear, stigma slightly enlarged, uncus short with three sensilla. Hindwing very narrow, length about 8 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing.

Metasoma. Petiole transverse with longitudinal costae; gaster smooth and shining with sparse white setae; T2 longer than following two tergites combined, laterotergite large, more than one-half height of gaster, imbricate; ovipositor short, sheaths only slightly extended beyond apex of metasoma, protruded distance about one-third length of hind tibia.

MALE (cf. *S. felonia*)

Length 1 mm. Head, mesosoma, and metasoma brown, without iridescent reflections; legs brown, except trochanters, base and apices of femora, and tibiae yellow. Forewing very short and truncate, extended to base of metasoma, 0.28 body length; without apical and marginal setae. Hindwing reduced and spatulate. Antenna (Fig. 58): scape slender, length about 2.5 times pedicel length; F1 subequal in length to pedicel; F1–F4 subequal in length, F5 shorter than F4; club slightly shorter than scape, CL/SL = 0.9. Mesosoma arched in lateral view; frenum distinct, with deeply impressed imbricate sculpture; dorsellum shorter than frenum; propodeum with distinct nuchal concavity, incomplete median and submedian carinae, and distinct foveae; prepectus narrowly triangular. Petiole conical and rugose. Genitalia not examined.

VARIATION

This is the only species of the genus in which wing-length variation has been documented (see Darling and Hanson, 1986, for discussion). The biological implications of this variation are unclear, but there does not appear to be any seasonal pattern. This species is regarded as primarily subterranean, being strongly associated with the duff formed by the needles of Douglas fir. In such a habitat,

wings could be regarded as an impediment to movement; however, if hosts are distributed in patches throughout the forest, then wings would seem necessary for dispersal to colonize new areas. Such arguments would perhaps explain a polymorphism in wing development (brachypterous and macropterous forms), but are less satisfactory with regard to continuous variation in the degree of wing development. Also, the presence of short-winged males argues against an ecological basis for wing-length variation in *Spalangiopelta felonia*.

***Spalangiopelta laevis* Darling sp. nov.**

Figs. 25, 43, 51, 59, 72, 75

TYPE LOCALITY

Costa Rica, Alajuela, Peñas Blancas.

TYPE MATERIAL

Holotype (♀). "Costa Rica: Alajuela, Penas Blancas 700 m, 7.VII.1987, E. Cruz MT primary rain forest," "D. Chris Darling Slide No. 1215 forewing, 1216 antenna." Paratype (♀). Mexico—OAXACA: 4.4 mi NE San Pedro Mixtepec (VII.16.1985; J. Woolley, G. Zolnerowich; TAM).

TYPE REPOSITORY

Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada; CNC Type No. 20915.

ETYMOLOGY

From Latin, a reference to the smooth and polished appearance of this species.

ADDITIONAL MATERIAL EXAMINED

Costa Rica (1 ♂)—ALAJUELA: Peñas Blancas, 700 m. (VI.9; 1 ♂; CNC; DCD Slide Nos. 1350 [forewing], 1351 [antenna]). Mexico (2 ♂♂)—GUERRERO: 32 mi SE Petatlan [*sic* for Petatlan] (VII.14; 1 ♂; TAM). PUEBLA: 2 km N Xicotepec [*sic* for Xicotepec] de Juarez (VI.17; 1 ♂; CNC).

DIAGNOSIS

Spalangiopelta laevis females can be distinguished by the following combination of characters: mesosoma uniformly light brown in colour, mesoscutum imbricate with iridescent reflections; gena with white maculation; and scape expanded but without anteriorly directed laminae (Fig. 43). Females are most similar to *S. albigena*; both species have a modified scape, white gena, and iridescent reflections on the mesosoma. Females of *S. laevis* and *S. albigena* can be distinguished in two ways: by the sculpture of the mesoscutum, weakly imbricate versus with transverse costulae (as in Fig. 67 cf. Fig. 69); and by the colour of the mesopleuron, uniformly light brown versus with white maculations.

The males here referred to *S. laevis* are petiolate and most similar to males of *S. ciliata*, but can be distinguished by the sculpture of the mesoscutum, which is effaced imbricate versus longitudinally striate, and the propodeum, which is glabrous versus finely areolate.

DISTRIBUTION

Costa Rica, possibly north to southern Mexico; see Remarks.

HOST

Unknown.

REMARKS

Although collected from the type locality, the male from Costa Rica may not be conspecific with the holotype female. This male (like the two males from Mexico) differs in a number of important regards from the holotype female, most notably by the presence of an elongate petiole. This would be the first example of a sexually dimorphic petiole in *Spalangiopelta*; only males and females of *S. ciliata* are known with certainty to have an elongate petiole. These males also resemble *S. ciliata* in colour pattern, in the absence of the hyaline break, and in having the antennal club only indistinctly segmented. The unassociated males from Brazil are also petiolate, suggesting it is unlikely that all petiolate males are conspecific with *S. ciliata*. Females of *Spalangiopelta* are not known from Mexico or South America, and additional material will be necessary to clarify the status of these petiolate males.

FEMALE

Length 0.9 mm, robust in habitus, mesosoma about 1.5 times as long as wide. Head, mesosoma, and metasoma brown, with blue-violet iridescent reflections on dorsum of head and mesosoma, except gena white along ventral eye margin; legs brown, except tibiae white distad. Antenna brown. Forewing extended beyond apex of metasoma, 0.8 body length; lightly infusate throughout (Fig. 25).

Head. In dorsal view subquadrate, HW/HL = 1.57; glabrous, except ocular-ocellar region and lower half of inner orbits imbricate; MS/EH = 0.46; malar sulcus distinct and located posteriorad. Antenna (Fig. 43): scape wide and expanded in lateral view, but without anteriorly directed lamina on mesal margin; A3 transverse, length about one-quarter width, shorter than A1+A2; F1 elongate, longer than wide, as wide as annelli; F2–F5 longer than F1, F2 elongate, F3–F5 quadrate, length subequal to width; clava narrow and long, subequal to F1–F5, C1 and C2 longer on dorsal than on ventral surface, C3 longer on ventral than on dorsal surface.

Mesosoma. Dorsum arched in lateral view, mesonotum and propodeum making an angle of about 135°; with weak imbricate sculpture except where noted; notauli distinct,

sidelobe of mesoscutum glabrous; scutellum longer than mesoscutum, SC/MS = 1.34; axillula with longitudinal costae, frenum distinct; metanotum large, about 0.4 SC, with glabrous triangle region laterad, dorsellum distinctly delimited laterad, quadrate, longer than frenum; propodeum very short, less than one-half length of scutellum, glabrous with strong median carina that bifurcates to form distinct rim along posterior margin, without nuchal concavity (Fig. 72); prepectus broadly triangular, without rounded flange at upper posterior corner. Forewing (Fig. 25) narrow, length about 4 times maximum width, apical setae longer than stigmal vein; without admarginal setae [HT: one admarginal seta]; parastigma with hyaline break and two sensilla; submarginal vein shorter than marginal vein, SM/M = 0.83; marginal vein of uniform thickness, length about 3 times postmarginal; postmarginal vein short, about 1.5 times stigmal; stigmal vein oblique, stigma not enlarged, uncus long with four sensilla. Hindwing narrow, length about 7 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing.

Metasoma. Petiole transverse and inconspicuous; gaster smooth and shining with long setae; T2 subequal in length to T3, laterotergite indistinct; ovipositor sheaths extended beyond apex of metasoma, protruded distance about one-half length of hind tibia.

MALE (cf. *S. laevis*)

Length approximately 0.7 mm. Head, mesosoma, and metasoma uniformly brown in lateral view, antenna light brown except A1 and A2 yellow; forewing hyaline. Malar sulcus indistinct. Antenna (Fig. 59): scape narrower, not expanded, length about 2.5 times pedicel length; A3 more quadrate than A1 and A2; F1 longer than pedicel; F1–F5 subequal in length; club indistinctly segmented, much longer than scape, CL/SL = 1.4. Mesosoma arched in lateral view, scutellum rounded. Forewing (Fig. 51) extended beyond apex of metasoma, 0.9 body length; apical setae longer; parastigma without distinct hyaline break, with one sensillum; submarginal vein subequal in length to marginal vein; marginal vein 2.2 times postmarginal; stigma expanded below. Hindwing length about 10 times maximum width, with setae on apical and posterior margins almost twice width of hindwing. Metasoma: petiole elongate, length almost twice maximum width, narrowed only slightly anteriorly, with paired setae directly laterad at midpoint, sculpture weaker. Genitalia not examined.

VARIATION

The notch along the posterior margin of the left forewing evident in Fig. 25 is not present on the right forewing and is regarded as an artifact of either development or preservation. The holotype of *Spalangiopelta laevis* has a single

admarginal seta (Fig. 25), but these setae are absent in the paratype female and the males referred to this species. In the phylogenetic analysis, this species is coded as not having admarginal setae.

Spalangiopelta procera Graham

Figs. 28, 73

Spalangiopelta procera—Graham, 1966:187.

Spalangiopelta procera—Graham, 1969:48.

Spalangiopelta procera—Darling and Hanson, 1986:155, 161.

TYPE LOCALITY

England, Berkshire.

TYPE MATERIAL

Holotype (♀, examined). “Wytham, BERKS. M. de V. Graham (1) 23.9.1960 [underside] Betula,” “*Spalangiopelta procera* sp. n. M. de V. Graham det 1968 Holotype ♀.”

TYPE REPOSITORY

Hope Department, University Museum, Oxford, England; Type HYM: 1215.

DISTRIBUTION

England, Ireland, Sweden.

DIAGNOSIS

Spalangiopelta procera and *S. dudichi* are the only Palearctic species with admarginal setae and with ovipositors at least one-half the length of the hind tibia. *Spalangiopelta procera* can be distinguished from *S. dudichi* by the gracile habitus, by the mesosoma which is twice as long as wide versus more robust, and by general body colour, mesosoma blue-green with prominent iridescent reflections on the propodeum versus dark brown. *Spalangiopelta procera* is most similar to long-winged females of *S. felonia*, but can be distinguished by the longer ovipositor, sheaths at least one-half length of hind tibia versus about one-third length of hind tibia. The males are not known for either of these species.

HOST

Unknown.

REMARKS

The holotype of *Spalangiopelta procera* has only four admarginal setae. This is the smallest number of admarginal setae for a Palearctic species, but the generality of this character in this species is unknown.

FEMALE

Length, 1.1–1.4 mm, slender in habitus, mesosoma about twice as long as wide. Head, mesosoma, and metasoma brown, with blue-green iridescent reflections, especially prominent on propodeum; legs and antenna uniformly light brown, except tibiae and basal tarsomeres yellow. Forewing long, extended beyond apex of metasoma, 0.7 body length; lightly infusate between basal and stigmal veins (Fig. 28).

Head. In dorsal view transverse, HW/HL = 1.7–2.0; sculpture very weakly imbricate except vertex, scrobal cavity, and malar region glabrous; MS/EH = 0.6; malar sulcus distinct. Antenna: scape narrowly linear; A3 quadrate, length about one-half width, length subequal to A1+A2; F1 elongate, length 1.7 times width, subequal in width to annelli; F2–F5 longer than F1, elongate, length twice width; clava elongate, subequal in length to F3–F5, segments conical, equal in length on dorsal and ventral surfaces.

Mesosoma. Dorsum arched in lateral view, mesonotum and propodeum making an angle of about 135°; with faint imbricate sculpture, effaced on disk of scutellum and frenalum; notauli distinct; pronotum transverse, about one-half length of mesoscutum; scutellum subequal in length to mesoscutum; scutellum with two pairs of long lateral setae on disk of scutellum and just anterior to frenalum, axillula with longitudinal costae, frenalum distinct, metanotum one-third SC, dorsellum distinctly delimited

laterad by punctate (anterior) and glabrous (posterior) areas, quadrate, longer than frenalum; propodeum shorter than scutellum, distinctly alveolate, with only slight indication of nuchal concavity, acarinate, with foveae laterad along metanotum and beneath spiracle, sculpture reduced to form narrow region along posterior margin (as in *Spalangiopelta felonia*, Fig. 67); prepectus alveolate, broadly triangular; mesepimeron alveolate, rest of mesopleuron imbricate. Forewing (Fig. 28) broad, length about 3 times maximum width, apical setae subequal in length to stigmal vein; four admarginal setae; parastigma without hyaline break; submarginal vein subequal in length to marginal vein; marginal vein slightly expanded at stigmal vein, length 2–3 times postmarginal; postmarginal vein about twice stigmal; stigmal vein narrow at base, gradually expanded distad, stigma slightly enlarged, uncus long with four sensilla. Hindwing narrow, length about 6 times maximum width, with setae on apical and posterior margins subequal in length to width of hindwing.

Metasoma. Petiole transverse but distinct; gaster smooth and shining with sparse white setae; T2 shorter than following two tergites combined, laterotergite large, covering entire lateral surface of gaster, alveolate; ovipositor sheaths extended beyond apex of metasoma, protruded distance about one-half length of hind tibia.

MALE

Unknown.

FIG. 74. Collection localities for *Spalangiopelta ciliata*. Circles indicate localities where this species is sympatric with other species of *Spalangiopelta* (see Fig. 75).

FIG. 75. Collection localities for *Spalangiopelta* species in the New World. Circles indicate localities where species are sympatric (see also Fig. 74). The three records for *S. laevis* from Mexico are tentative (see text for discussion).

Phylogeny and Biogeography

Phylogenetic relationships within the genus *Spalangiopelta* were investigated using parsimony methods. Character polarity was determined using *Cea pulicaris* as the outgroup, based on the hypothesis that Ceinae is monophyletic (see Introduction and Comparative Morphology sections for discussion). Seventeen morphological characters were coded for females (Table 2); males were not included because the sexes are only positively associated for five of the ten species. Four multistate characters were coded as unordered or non-additive because no transformation series seemed more probable on morphological grounds (see Darling, 1988, for a discussion of the treatment of multistate morphological characters).

Character 1. Hyaline break in parastigma. Plesiomorphic state: absent (Figs. 17, 36). Apomorphic state: present (Fig. 35).

Character 2. Ovipositor length. Plesiomorphic state: long, sheaths extended beyond apex of metasoma by at least one-half length of hind tibia. Apomorphic state: short, sheaths only slightly extended beyond apex of metasoma, about one-third length of hind tibia (Fig. 1).

Character 3. Sculpture of midlobe of mesoscutum. Plesiomorphic state: imbricate (Fig. 67). Apomorphic states: longitudinally striate [1] (Fig. 2); transversely costulate [2] (Fig. 69); effaced imbricate, subglabrous [3].

TABLE 2. Character states for *Spalangiopecta* females and the outgroup taxon *Cea pulicaris* (0 = ancestral state; 1, 2, 3 = derived states; ? = missing data). See text for discussion.

	CHARACTERS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<i>Cea pulicaris</i>	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0
<i>S. ciliata</i>	0	0	1	1	1	2	0	1	1	0	0	1	0	0	1	1	0
<i>S. albigena</i>	1	0	2	0	0	1	0	3	1	0	1	0	1	1	1	3	0
<i>S. laevis</i>	1	0	0	0	0	1	0	0	1	0	1	0	1	1	0	3	1
<i>S. canadensis</i>	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	2	1
<i>S. alata</i>	1	1	0	0	0	3	0	2	1	1	0	0	1	0	0	2	1
<i>S. felonia</i>	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
<i>S. brachyptera</i>	0	1	0	0	0	0	1	?	0	0	0	0	0	0	0	2	0
<i>S. procera</i>	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
<i>S. apotherisma</i>	0	0	0	0	0	3	0	2	0	0	0	1	0	0	0	2	1
<i>S. dudichi</i>	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	2	1

Character 4. Length of petiole. Plesiomorphic state: short, length at most one-half maximum width (Fig. 68). Apomorphic state: long, length greater than maximum width (Fig. 22).

Character 5. Forewing habitus. Plesiomorphic state: wings flat with shorter apical setae (Figs. 17, 33). Apomorphic state: cupped with very long apical setae (Fig. 31).

Character 6. General body colour. Plesiomorphic state: head, mesosoma, and metasoma dark blue-violet with iridescent blue-green to bronze reflections. Apomorphic states: head, mesosoma, and metasoma light brown with iridescent reflections [1]; head and mesosoma light reddish-brown, gaster dark brown [2]; head, mesosoma, and metasoma black, without iridescent reflections [3].

Character 7. Wing length variation. Plesiomorphic state: present. Apomorphic state: absent.

Character 8. Shape of forewing. Plesiomorphic state: linear, fore and hind margins parallel (Figs. 17, 33). Apomorphic states: spatulate [1] (Fig. 31); rounded, hind margin not parallel with fore margin [2] (Fig. 32); narrow, length about 4 times maximum width [3] (Fig. 26).

Character 9. Admarginal setae. Plesiomorphic state: present (Figs. 17, 29). Apomorphic state: absent (Fig. 32). *Spalangiopecta laevis* is coded as not having admarginal setae; see Variation section of species account for discussion.

Character 10. Antenna habitus. Plesiomorphic state: F2–F5 elongate, length at least 1.5 times width (Figs. 19, 45). Apomorphic state: F2–F5 subquadrate (Fig. 37).

Character 11. Scape. Plesiomorphic state: linear (Figs. 19, 39). Apomorphic state: expanded (Figs. 43, 44).

Character 12. Sculpture of petiole. Plesiomorphic state: with longitudinal costae (Fig. 65). Apomorphic state: without longitudinal costae (Fig. 68).

Character 13. Size of dorsellum. Plesiomorphic state: length much less than one-half length of scutellum along midline (Figs. 67, 68). Apomorphic state: longer than frenum, about one-half length of scutellum along midline (Fig. 69).

Character 14. Colour pattern of head. Plesiomorphic state: concolorous. Apomorphic state: bicoloured, brown with white coloration on gena.

Character 15. Colour of forecoxa. Plesiomorphic state: concolorous with mesopleuron, brown to black. Apomorphic state: white, strongly contrasted with mesopleuron.

Character 16. Sculpture of submedian areas of propodeum. Plesiomorphic state: imbricate. Apomorphic states: finely areolate [1] (Yoshimoto, 1977, fig. 1e); alveolate [2] (Figs. 70, 71, 73); glabrous [3] (Figs. 69, 72).

Character 17. Median carina on propodeum. Plesiomorphic state: absent (Fig. 67). Apomorphic state: present (Fig. 68).

These data were analyzed with both the PAUP (Swofford, 1985) and HENNIG86 (Farris, 1988) parsimony programs; the options “MULPARS SWAP = GLOBAL” and “ie*” were used respectively. Both analyses resulted in two equally parsimonious cladograms of length 34 (Consistency Index = 0.67, with autapomorphies removed). The topology of these two cladograms differs in important regards, and hypothesis-independent (or *a posteriori*) character weighting (Sharkey, 1989) rather than a strict consensus tree (see Miyamoto, 1985) was used to select a solution cladogram. Following the suggestion of Carpenter (1988), I averaged the unit character consistencies for each character and assigned weights based on these means using the “WEIGHTS” command in PAUP. The unit character consistencies were different for only two characters, 9

(admarginal setae: 0.5, 1.0) and 12 (petiole sculpture: 0.5, 0.33), and the resultant weights assigned to these characters were 0.75 and 0.41, respectively. This weighting scheme resulted in the selection of the cladogram in Figure 76 as the solution cladogram; the rejected cladogram has *S. ciliata* as the sister species of *S. apotherisma* + *S. dudichi*, based on a shared reversal to the plesiomorphic sculpture of the petiole (12), i.e., with longitudinal costae. The preferred cladogram interprets the loss of admarginal setae (9) as unique and unreversed, and has homoplasy present in 8 of the 17 characters; the rejected cladogram has homoplasy present in 9 characters.

Figure 76 shows the distribution of character state changes; autapomorphies are not shown except when homoplasy is involved. It should be noted at the onset that many of the morphological characters used in the

descriptive taxonomy of *Spalangiopecta* are regarded *a priori* as prone either to homoplasy (e.g., sculpture, coloration) or possibly to involvement in functionally correlated character complexes related to host finding (e.g., mesosoma shape, wing structure, and ovipositor length). These same characters are the basis for this phylogenetic analysis, which argues against extended speculation about cladistic relationships, especially when it is almost certain that there are still undescribed species of *Spalangiopecta* in Central and South America.

Spalangiopecta ciliata is the most distinctive and autapomorphic species in the genus. The females have an elongate petiole, longitudinal striations on the mesoscutum, and cupped forewings with very long setae, all of which are unique in the genus; there are six additional autapomorphies that are not shown in Figure 76. These

FIG. 76. One of two most parsimonious cladograms for data matrix presented in Table 2 (see text for discussion of character polarity, coding, and selection among equally parsimonious cladograms). Numbers refer to characters discussed in the text; solid bars indicate unique and unreversed apomorphies, dashed bars indicate convergent apomorphies, and open bars indicate characters with reversals. The derived states of characters 6 and 16 are indicated as 6, 6' and 16, 16'. New World species are indicated with an asterisk (*).

characters provide no information concerning phylogeny. Of considerably more importance is the one derived character that unites *S. ciliata* with other species of *Spalangiopelta*: the loss of admarginal setae (9). It is important to note that this character exhibits homoplasy on the other equally parsimonious cladogram (unweighted analysis) and the relationships of *S. ciliata* are completely unresolved in a strict consensus tree. Furthermore, if males of *S. laevis* are petiolate, then either a sister-group relationship with *S. ciliata* would be supported or the similar male petiole is a result of convergence. The latter would be the most parsimonious interpretation in an unweighted analysis; the sister-group relationship of *S. albigena* + *S. laevis* is supported by multiple unique and unreversed synapomorphies. Notwithstanding the uncertainties in the affinities of *S. ciliata*, it should be stressed that the only viable approach to resolving the affinities of this species is to search for characters shared with congeneric species and not simply to enumerate the autapomorphies of this species.

Three primary clades are supported regardless of the affinities of *S. ciliata*, but the monophyly of both basal groups is supported only by characters that are convergent on the cladogram (Fig. 76). This scheme of phylogenetic relationships, albeit sketchy, nevertheless can be used to address some important aspects of the biogeography of *Spalangiopelta*. Each of the three species groups contains Nearctic and Palearctic species, and in each group there is a pair of species that differs only in very minor regards, viz. coloration and structure of forewings and antennae: *canadensis* + *alata*, *apotherisma* + *dudichi*, and *felonia* + *brachyptera*. This repeated pattern suggests a historical explanation, based on allopatric speciation and perhaps related to geological history and associated climatic factors during the Cretaceous and early Tertiary periods (Matthews, 1979). Land connections in the North Atlantic or in the Beringian region could explain these disjunctions without invoking repeated long-distance dispersal.

Another important biogeographic question concerns the distribution of the genus *Spalangiopelta* in Central and

South America. *Cea* is Holarctic in distribution, and until this study the Ceinae were also regarded as Holarctic in distribution. It is now known that *S. laevis* and *S. albigena* are widely distributed in the Neotropical region and that *S. ciliata* is distributed throughout eastern North America, south to northern Florida and west Texas (Fig. 74). The Rio Grande basin marks the geographic limits of two of the three southern species of the genus. Disjunct distributions between eastern North America and Middle America at the Rio Grande basin have been documented for various groups of animals and plants, and most thoroughly reviewed and studied in the poeciliid fishes of the genera *Heterandria* and *Xiphophorus* (Rosen, 1978). There are a number of possible causal explanations for this repeated pattern, but what is clear is that there was a biological relationship between eastern North America and southeastern Mexico for at least 50–60 million years (Rosen, 1978). In the past, species of *Spalangiopelta* may have been widely distributed in the neotropics with distributions similar to *S. albigena* (Fig. 75). More recently, these ranges may have been subdivided by the increasing aridity in the southwest and the subsequent interruption of once continuous tropical forest during the Middle Tertiary period (Axelrod, 1975). A sister-group relationship between *S. ciliata* and *S. laevis* would be consistent with this biogeographic hypothesis, but this relationship is not supported by the most parsimonious cladogram (Fig. 76). Widespread species, e.g., *S. albigena*, are also problematic. Cryptic species may be involved with distinct Nearctic and Neotropical species here referred to *S. albigena*, or the present distribution pattern may be the result of more recent dispersal. The relative merits of vicariance and dispersal as explanations of the distributions of *Spalangiopelta* species are uncertain. Clearly, more specimens and further collecting are necessary to determine species distributions with greater accuracy. Additional specimens will also allow for more detailed comparative morphological studies and further resolution of the phylogenetic relationships among the species of *Spalangiopelta*.

Acknowledgements

I would like to thank all of the curators for making specimens under their care available for study. Special thanks are extended to Drs. Jenő Papp (Budapest) and Roberto Poggi (Genova) for their patience in extending loans of type material, and to the hymenopterists at Biosystematics Research Centre in Ottawa: their sorting program provided the majority of the specimens for this study and their continued activity threatens to make many aspects of this study obsolete before its time. Valuable comments on the

manuscript were provided by Lonny Coote, Kathryn Coates, two anonymous reviewers, and the ROM Life Sciences Editorial Board.

This study was supported by operating grants (A2289 and OGPIN001) from the Natural Sciences and Engineering Research Council of Canada. All drawings were prepared by Patricia Stephens-Bourgeault, and considerable photographic advice and assistance were provided by Allan McColl and Brian Boyle.

Literature Cited

- ASKEW, R. R.
1965 Chalcidoidea (Hymenoptera) in the Manchester Museum (Part 4). *The Entomologist* 98:142.
- AXELROD, D. I.
1975 Evolution and biogeography of Madrean-Tethyan sclerophyll vegetation. *Annals of the Missouri Botanical Garden* 62:280–334.
- BARLIN, M. R., S. B. VINSON, and G. L. PIPER
1981 Ultrastructure of the antennal sensilla of the cockroach-egg parasitoid, *Tetrastichus hagenowii* (Hymenoptera: Eulophidae). *Journal of Morphology* 168:97–108.
- BOUČEK, Z.
1952 “Skupina Cea” z celedi Pteromalidae. The “group Cea” of the Chalcidoid family Pteromalidae. *Acta Entomologica Musei Nationalis Pragae* 28:157–164.
1961 Beiträge zur Kenntnis der Pteromalidenfauna von Mitteleuropa, mit Beschreibungen neuer Arten und Gattungen (Hymenoptera). *Acta Entomologica Musei Nationalis Pragae* 34:55–93.
1988 Australasian Chalcidoidea (Hymenoptera). Wallingford, UK., C. A. B. International. 832 pp.
- CARPENTER, J. M.
1988 Choosing among multiple equally parsimonious cladograms. *Cladistics* 4:291–296.
- DARLING, D. C.
1988 Comparative morphology of the labrum in Hymenoptera: the digitate labrum of Perilampidae and Eucharitidae (Chalcidoidea). *Canadian Journal of Zoology* 66:2811–2835.
- DARLING, D. C. and P. E. HANSON
1986 Two new species of *Spalangiopelta* from Oregon (Hymenoptera: Chalcidoidea), with a discussion of wing length variation. *Pan-Pacific Entomologist* 62:153–164.
- ERDŐS, J.
1955 Chalcidoidea nova in collectione Birói (Hymenoptera). *Annales Historico-Naturales Musei Nationalis Hungarici* (series nova) 7:181–194.
- FARRIS, J. S.
1988 Hennig86 Reference, Version 1.5 [Manual]. Available from the author.
- GAULD, I. and B. BOLTON, eds.
1988 *The Hymenoptera*. Oxford, Oxford University Press. 332 pp.
- GRAHAM, M. W. R. de V.
1966 A new species of *Spalangiopelta* (Hym., Chalcidoidea, Pteromalidae) from the British Isles. *The Entomologist* 99:187–189.
1969 The Pteromalidae of north-western Europe (Hymenoptera: Chalcidoidea). *Bulletin of the British Museum (Natural History), Entomology Supplement* 16. 908 pp.
- HARRIS, R. A.
1979 A glossary of surface sculpturing. *Occasional Papers in Entomology, State of California Department of Food and Agriculture*, 28. 31 pp.
- JANSSON, A.
1945 Studier över svenska chalcidider. I. De olika formerna hos *Cea pulicaris* Walk. *Entomologisk Tidskrift* 66:44–50.
- KERRICH, G. J.
1957 Discussion of *Cea* (Haliday mss.) Walker (1837) and *Spalangiopelta* Masi (1922). In Kerrich, G. J. and M. W. R. de V. Graham, *Systematic notes on British and Swedish Cleonymidae*, with description of a new genus (Hym., Chalcidoidea), p. 276. *Transactions of the Society for British Entomology* 12:165–311.
- MASI, L.
1922 Calcididi del Giglio. Terza serie: Eupelminae (seguito), Pteromalinae (partim). *Annali del Museo Civico di Storia Naturale Giacomo Doria* 50:140–174.
- MATTHEWS, J. V., Jr.
1979 Tertiary and Quaternary environments: historical background for an analysis of the Canadian insect fauna. In Danks, H. V., ed., *Canada and its insect fauna*, pp. 31–86. *Memoirs of the Entomological Society of Canada* 108. 573 pp.
- MIYAMOTO, M. M.
1985 Consensus cladograms and general classifications. *Cladistics* 1:186–189.
- NOYES, J.
1980 A review of the genera of Neotropical Encyrtidae (Hymenoptera: Chalcidoidea). *Bulletin of the British Museum (Natural History), Entomology Series* 41:107–253.

RICHARDS, O. W.

- 1977 Hymenoptera: Introduction and key to families. Second (revised) edition. Handbooks for the identification of British insects, Vol. 6, Part 1. London, Royal Entomological Society of London. 100 pp.

ROSEN, D. E.

- 1978 Vicariant patterns and historical explanation in biogeography. *Systematic Zoology* 27:159–188.

SHARKEY, M. J.

- 1989 A hypothesis-independent method of character weighting for cladistic analysis. *Cladistics* 5:63–86.

SWOFFORD, D. L.

- 1985 PAUP Phylogenetic Analysis Under Parsimony, Version 2.4 [Manual]. Available from the author.

YOSHIMOTO, C. M.

- 1977 A new species of *Spalangiopecta* Masi in North America (Chalcidoidea: Pteromalidae, Ceinae). *Canadian Entomologist* 109:541–544.

ROYAL ONTARIO MUSEUM LIFE SCIENCES CONTRIBUTIONS

Life Sciences Contributions are a numbered series of scientific publications of varied subject matter.
Most recent contributions include the following:

<p>155 Revision of the World Species of <i>Spalangiopecta</i>
(Hymenoptera: Chalcidoidea: Pteromalidae: Ceinae)
D. Christopher Darling
1991, 48 pp., ill., \$11.00, ISBN 0-88854-395-6</p> <p>154 Shallow-Water Hydroids of Bermuda: The Thecatae,
Exclusive of Plumularioidea
Dale R. Calder
1991, 144 pp., ill., \$24.50, ISBN 0-88854-354-9</p> <p>153 Silurian Trilobites from the Northern Yukon Territory
Rolf Ludvigsen and Ronald P. Tripp
1990, 64 pp., ill., \$12.95, ISBN 0-88854-349-2</p> <p>152 The Type Species of the Ordovician Trilobite Genus
<i>Isotelus</i>: <i>I. gigas</i> Dekay, 1824
David M. Rudkin and Ronald P. Tripp
1989, 24 pp., ill., \$10.25, ISBN 0-88854-345-X</p> <p>151 The Structure of the Call Note System of the
Warbling Vireo
Daryl Howes-Jones and Jon C. Barlow
1988, 40 pp., ill., \$11.00, ISBN 0-88854-343-3</p> | <p>150 Late Cretaceous-Early Tertiary Dinoflagellates and
Acartarchs from the Kashi Area, Tarim Basin, Xinjiang
Province, China
Mao Shaozhi and Geoffrey Norris
1988, 93 pp., ill., \$25.00, ISBN 0-88854-334-4</p> <p>149 Occurrence of the Cladid Inadunate Crinoid
<i>Thalamocrinus</i> in the Silurian (Wenlockian) of New
York and Ontario
George C. McIntosh and Carlton E. Brett
1988, 17 pp., ill., \$7.75, ISBN 0-88854-342-5</p> <p>148 Shallow-Water Hydroids of Bermuda: The Athecatae
Dale R. Calder
1988, 107 pp., ill., \$24.50, ISBN 0-88854-339-5</p> <p>147 Biostratigraphy and Palaeontology of the Scollard
Formation, Late Cretaceous and Paleocene of Alberta
Loris S. Russell
1987, 23 pp., ill., \$7.00, ISBN 0-88854-338-7</p> |
|---|---|

The Royal Ontario Museum also publishes Life Sciences Miscellaneous Publications and Life Sciences Occasional Papers.
Other titles of interest:

Annotated List of Ontario Lepidoptera

J. C. E. Riotte

Life Sciences Miscellaneous Publications

Forthcoming 1992, ISBN 0-88854-397-2

Revision of the Caddisfly Genus *Psilotreta*

(Trichoptera: Odontoceridae)

C. R. Parker and G. B. Wiggins

Life Sciences Contributions No. 144

1987, 55 pp., ill., \$12.00, ISBN 0-88854-332-8

A Systematic Study of the Nearctic Larvae

of the *Hydropsyche morosa* Group

(Trichoptera: Hydropsychidae)

Patricia W. Scheffer and Glenn B. Wiggins

Life Sciences Miscellaneous Publications

1986, 94 pp., ill., \$15.00, ISBN 0-88854-321-2

The Water-Striders of Ontario

(Heteroptera: Gerridae)

L. Cheng and C. H. Fernando

Life Sciences Miscellaneous Publications

1970, 24 pp., ill., \$3.95, ISBN 0-88854-268-2

A complete catalogue of publications in print is available from

Publication Services, Royal Ontario Museum
100 Queen's Park, Toronto, Ontario, Canada M5S 2C6
(416) 586-5581 Fax (416) 586-5863

ISBN 0-88854-395-6
ISSN 0384-8159