

JAMES F. GREENE

*A Revision of the
Nearctic Species of the
Genus Psammotettix
(Homoptera: Cicadellidae)*

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SMITHSONIAN CONTRIBUTIONS TO
ZOOLOGY

NUMBER 74

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Nearctic Species of the
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SMITHSONIAN INSTITUTION PRESS
CITY OF WASHINGTON
1971

ABSTRACT

Greene, James F. A Revision of the Nearctic Species of the Genus *Psammotettix*. *Smithsonian Contributions to Zoology*, number 74, 40 pages. 1971.—Nineteen Nearctic *Psammotettix* species were treated. Four of the species are Holarctic. Fifteen species were redescribed and four new species were described. The limits of the genus were redefined.

Interspecific, intraspecific, and individual variations were discussed. The first complete written keys to males and females of Nearctic species were prepared. Important diagnostic characters for each species were illustrated. New specific taxonomic characters in the genus, lobes at the base of the first valvula, were employed and illustrated.

Possible avenues for future investigation, host-plant data, disease vector relationships, and parasite data were included in the text.

Official publication date is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, Smithsonian Year.

UNITED STATES GOVERNMENT PRINTING OFFICE
WASHINGTON : 1971

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 50 cents (paper cover)

James F. Greene

A Revision of the Nearctic Species of the Genus *Psammotettix* (Homoptera: Cicadellidae)

Introduction

Since there has been a growing interest, both economically and taxonomically, in the genus *Psammotettix* Haupt in the last decade, the purpose of this paper is to revise the Nearctic species of this genus. Workers have experienced difficulty in resolving a species complex known to European workers as the *striatus* group. They were finding individual variation in the aedeagal characters which had been used as primary species diagnostic characters (Moravskaja, 1956).

When this study began there was a need for a closer comparison of Nearctic and Holarctic specimens of *Psammotettix* in order to identify objectively Nearctic specimens of Holarctic species that had been described from Europe. The fact that some of the Holarctic species were members of the unresolved *P. striatus* complex added to the problem. In addition there was a need for a revision of the Nearctic species of the genus to complement a revision of the Palearctic species by Ribaut (1938).

The present work has resulted in the preparation of keys to male and female species of Nearctic *Psammotettix*. Fifteen species were redescribed, four new species were described and named, and it was determined that *Psammotettix striatus* (Linnaeus) *sensu* Ribaut did not occur in the Nearctic region. Concerning the difficult *striatus* complex mentioned above, that portion of the problem related to the Nearctic species has been resolved if Ribaut's interpretation of *P. striatus* (Linnaeus) is accepted. Four

Nearctic species groups or complexes and one heterogeneous group were discovered and illustrated. Intraspecific variation in characters previously frequently interpreted as specific have been discovered and illustrated in this work. Female genitalic characters hitherto unknown were discovered. These characters were very helpful in establishing species relationships, but they have posed problems in determining relationship when they have not paralleled the aedeagal characters of the male.

The work on Nearctic *Psammotettix* is not yet complete. Additional distribution and host-plant data are needed. The most important work that remains to be done is an intensive study of *Psammotettix* on a Holarctic basis, utilizing the newly discovered female genitalic characters as well as the other characters employed in this paper.

Psammotettix species are extensively listed in the literature as feeding on grasses. The type of the genus, *Psammotettix maritimus* (Perris), feeds on *Convolvulus* (Haupt, 1929). *Psammotettix lividellus* (Zetterstedt) in North Carolina appears to be host specific for *Poa pratensis* Linnaeus. Moravskaja (1956) lists *P. striatus* (Linnaeus) as being adapted to young crops and *P. confinis* (Dahlbom) as polyphagous. In addition to previous records, species of *Psammotettix* have been collected on celery, corn, and sugar beet, reported here for the first time.

Psammotettix species have been reported as being vectors of virus diseases of sugar beet (Muraviov, 1930), wheat mosaic (Moravskaja, 1956), and a virus disease of potatoes (von Archimowitsch, 1952).

Haupt (1929) described the genus *Psammotettix* for *Athysanus maritimus* Perris, 1857 (type locality,

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southern France by the sea, on *Convolvulus soldanella*). Zachvatkin (1933) described the genus *Ribautiellus* for *Deltocephalus striatus* (Linnaeus), 1758 (type locality, Europe). Ribaut (1938) synonymized *Psammotettix* Haupt, 1929, and *Ribautiellus* Zachvatkin, 1933.

European workers such as Ossiannilsson (1937, 1938, 1941), Ribaut (1938), Wagner (1939), Dlabola (1945, 1954), and Remane (1965) added species until a total of 46 Palearctic species are included in the genus (Remane, 1965). The most comprehensive works on the Palearctic species of the genus are those of Wagner (1939) and Ribaut (1938).

American workers Osborn (1891), Ashmead (1904), Oman (1931), and DeLong and Davidson (1934, 1935) described a number of species in *Deltocephalus* and *Laevicephalus*, which Oman subsequently (1947, 1949) placed in *Psammotettix* Haupt.

There was some confusion among American workers as to the proper identity of Nearctic specimens of Holarctic species. DeLong and Davidson (1935) illustrated *Psammotettix lividellus* (Zetterstedt) as *Laevicephalus striatus* (Linnaeus). True *P. lividellus* (Zetterstedt) was also treated as *Deltocephalus affinis* Gillette and Baker (Beirne, 1954), and true *Psammotettix alienus* (Dahlbom) was described as *Laevicephalus latipex* DeLong and Davidson (1935). Oman (1949) synonymized *latipex* with *Psammotettix striatus* (Linnaeus) and listed ten Nearctic species of *Psammotettix*. Knull (1954) named and described three new species of Nearctic *Psammotettix*: *P. obesus*, *P. revae*, and *P. dentatus*. Beirne (1954) redescribed *Psammotettix lapponicus* (Ossiannilsson) and recorded it from Chesterfield, Northwest Territories. He redescribed *Psammotettix confinis* (Dahlbom) and recorded it as a Nearctic species. *Deltocephalus harrimani* Ashmead (Ashmead, 1904), one of the ten species listed by Oman (1949), was synonymized with *confinis* by Beirne. Beirne (1954) redescribed *Psammotettix alienus* (Dahlbom) and synonymized it with *Deltocephalus latipex* DeLong and Davidson and with *Psammotettix striatus* DeLong, 1948 (not Linnaeus). Beirne (1954) redescribed *Psammotettix lividellus* (Zetterstedt) and synonymized it with *Deltocephalus affinis* Gillette and Baker and with *Psammotettix striatus* DeLong, 1948 (not Linnaeus). McClure (1943) reported *Psammotettix*

asper from Manitoba.

Beirne (1956) redescribed *Psammotettix cephalotes* (Herrich-Schaeffer) and synonymized it with *Psammotettix obesus* Knull.

Combining Oman's (1954) checklist, Knull's (1954) three new species, McClure's (1943) report from Manitoba, and accounting for Beirne's (1954, 1956) synonymies, there were 15 Nearctic species of *Psammotettix* recorded in the literature in 1956, not including what then were considered to be synonyms. This was the situation when this study was started.

Dried, pinned specimens of *Psammotettix* from the United States, Canada, Europe, and Asiatic Russia were used in this study. Living specimens of *Psammotettix lividellus* (Zetterstedt) from North Carolina were examined, but all descriptions are based on dried or cleared specimens.

The methods of Young (1952) were followed in preparing the specimens with the following exceptions. The genital capsule was treated in 17 percent KOH at room temperature for two hours rather than in 10 percent KOH heated to the boiling point. The specimens were not stained with acid fuchsin, and the glycerine in which they were observed was not acidulated.

The genitalic parts were observed under transmitted light of varying intensities with both dissecting and compound microscopes. In the males, drawings of genitalic structures were made at a magnification of 160x with use of a camera lucida. A wide-angled ocular was used in order to get the complete structure to be drawn in the field of view. When making drawings of the aedeagus in caudodorsal aspect, the aedeagal shaft was placed as nearly perpendicular to the axis of the barrel of the microscope as possible. This was difficult in specimens with curved aedeagal shafts. Drawings were made of the aedeagus in the lateral aspect, which give a more accurate measure of the shaft length. The aedeagal shaft apex was studied in cross section by making "end-on" observations of the longitudinal axis of the shaft. Only a few such observations are incorporated in this paper. This technique gives a more complete picture of the aedeagal shaft. Cross-sectioning the aedeagal shaft might yield additional taxonomic information. In the female subtle differences can regularly be observed between species after clearing. The seventh abdominal stern-

um of the female was drawn while attached to the abdomen, after being cleared in 17 percent KOH. In dried, unrelaxed specimens it is often not possible to see constant differences between species. In order to get a constant orientation under the microscope, for drawing purposes, the sternum was oriented in such a way that the median part of the posterior and the anterior edge were in sharp focus at the same setting of the microscope. These drawings were made with camera lucida at 160x magnification.

After clearing the female genital capsule in KOH, the capsule was removed from the abdomen for observation and illustration. To do this it was necessary to rupture the membrane connecting the posterior edge of the seventh abdominal sternum and the base of the first valvulae. This was accomplished by probing gently with a fine point under and to the base of the seventh sternum and the first valvulae. The membrane was thus torn from its connection with the base of the first valvulae. The genital capsule was separated from the eighth tergum with a needle.

The bases of the first valvulae were illustrated in ventral aspect from the intact genital capsule. The bases of the first valvulae were oriented as nearly perpendicular to the axis of the barrel of the microscope as possible. The basidorsal median lobes and the articulating lobes were drawn or observed.

Drawings of the head, pronotum, and scutellum were made in the dorsal aspect with a stereoscopic microscope at 160x magnification and a camera lucida. In order to get a constant attitude, the head was arranged so the ocelli were barely visible at the front edge of the crown. Observations, drawings, and measurements were made in this position under reflected light. Note that longitudinal head measurements in this paper were made while the specimen was in this position. Measurements made with the long axis of the specimen perpendicular to the line of sight of the microscope would have a different value. Measurements of total length and greatest width were made with long axis of the specimen perpendicular to the line of sight. Measurements of length of macropterous forms were made from apex of crown to apex of fore wings. Total length measurements were made from apex of crown to tip of hindmost setae of pygofer in subbrachypterous forms. Very precise length measurements could not

be made accurately for subbrachypterous forms because of the tendency of the abdominal apex to bend dorsally in dried specimens.

All length measurements of parts of the specimens were made parallel to the median longitudinal axis of the specimen in the dorsal aspect. The length of crown was measured medially and also tangentially to the mesal border of the eye. The width of the head, including eyes, was measured between the outermost parts of the eyes.

As is true with many leafhopper species, it is usually possible to see differences in the head shape between species in this group, but it is hard to document or describe them. The curvature of the anterior edge of the crown, when viewed in dorsal aspect, seems to be the most variable character. There is much intraspecific variation in this character.

Unusual variations were studied for possible unnatural causes. In several specimens the capsule in which the genitalia were stored had lost the preserving fluid. This dry storage resulted in some distortions that could be misinterpreted as being characters of taxonomic importance.

Differences of possible taxonomic importance were noted in the setal pattern on the caudal apex of the style, but not incorporated in this paper.

The general morphology of *Psammotettix* is not discussed in this paper, which is concerned for the most part with characters of taxonomic importance. The morphology and terminology used in this paper are from Oman (1949), Young (1952), and Snodgrass (1935).

The anterior edge of the crown in dorsal aspect varies from blunt as in *Psammotettix attenuens* (DeLong and Davidson) (Figure 1A) to pointed as in *Psammotettix dentatus* Knull (Figure 1B). This character varies both interspecifically and intraspecifically. A median longitudinal sulcus, the base of the epicranial suture, extends from the posterior edge of the crown anteriorly for a distance about equal to the longitudinal length of the crown next to the mesal border of the eye.

The area of the pronotum varies relative to the area of the crown. The relative median longitudinal lengths of the crown and pronotum give an index of their relative area. The anterior edge of the pronotum is raised or ridged dorsally (Figure 1). The

posterior edge of this raised portion outlines the anterior edge of the scutum of the alinotum which lies beneath. The raised portion is above the cervix. The area above the alinotum is covered with circular pits. The pits are often found to be confined to the anterior edge of this area.

The wings of *Psammotettix* vary in length. *Psammotettix* species are macropterous, subbrachypterous, or brachypterous. The distance the hind wings extend posteriorly varies as compared to the distance the fore wings extend posteriorly. This character is used in the key to the females.

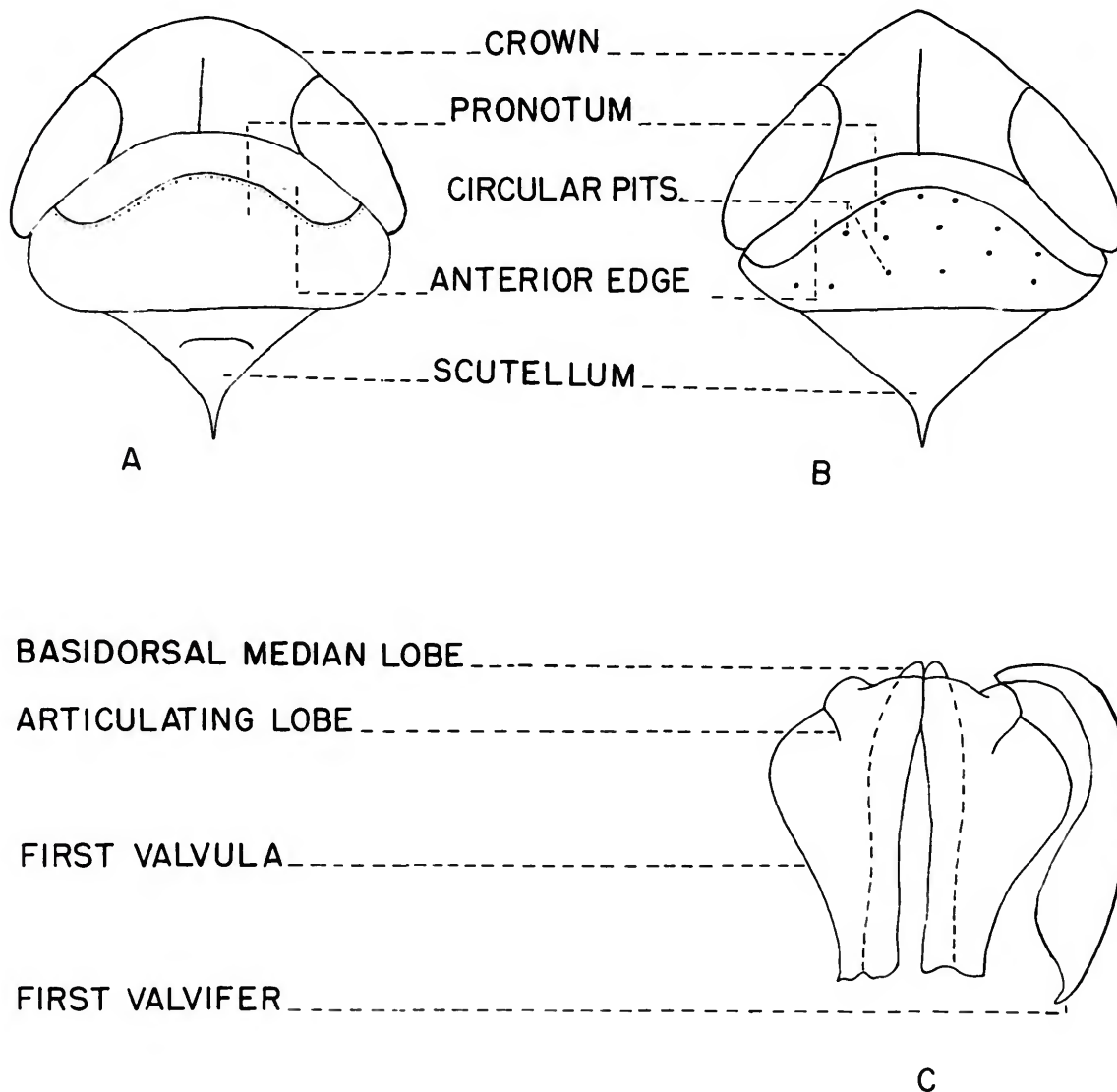


FIGURE 1.—Head and thorax of *Psammotettix* in dorsal aspect and first valvulae and first valvifer in ventral aspect: A, head and thorax of *P. attenuens* (DeLong and Davidson); B, head and thorax of *P. dentatus* Knull; C, first valvulae and first valvifer of *P. totalis* (DeLong and Davidson).

The female genitalic characters do not delimit species as precisely as do the aedeagal characters of the male. The basal lobes of the first valvula vary in relative position, length, and degree of sclerotization and can be used in conjunction with wing length and shape of the posterior edge of the seventh abdominal sternum to separate species. These two lobes (Figure 1c) have not been previously named. One lobe that is at the base of the first valvula in a dorsal position is called the basidorsal median lobe; the other that is laterad of the basidorsal median lobe and appears to articulate with the first valvifer is called the articulating lobe.

The most reliable taxonomic characters in *Psammotettix* are on the male aedeagus. The aedeagal shaft varies from linear (Figure 11A) to expanded at apex (Figure 17c), from entire (Figure 11c) to dentate (Figure 13c), and from symmetrical to asymmetrical (Figure 3c) in caudodorsal aspect. In lateral aspect the shaft varies from straight (Figure 4b) to curved (Figure 10b) to bisinuate in lateral aspect. The connective varies interspecifically from linear with basal arms contiguous (Figure 7c) to Y-shaped with basal arms separated (Figure 2A). The caudal end of the shaft of the connective varies from truncate (Figure 7c) to bifid (Figure 20c) in dorsal aspect.

Acknowledgments

The writer is indebted to many people who have directly or indirectly made completion of this paper possible. Acknowledgment and gratitude are extended to the following who have been especially helpful.

Dr. David A. Young, chairman of the author's graduate committee, initiated the project, made preliminary studies, and obtained specimens; he gave direction, advice, criticism, and encouragement. The other members of the author's graduate committee at North Carolina State University, Dr. M. H. Farrier of the Department of Entomology and Dr. J. W. Hardin of the Department of Botany, helped the author through teaching, advice, encouragement, and review of the work. The staffs of the Department of Botany and the Department of Entomology made suggestions and provided equipments as needed. The writer's colleagues in the

North Carolina Department of Agriculture were patient and helpful. Mr. J. A. Harris was particularly understanding in the arrangement of work schedules and Dr. D. L. Wray gave advice and provided equipment.

The following people loaned specimens from their respective collections: Dr. D. M. DeLong of Ohio State University, specimens from his personal collection; Dr. Paul H. Freytag and Dr. C. A. Triplehorn, specimens from the Ohio State University collection; Dr. J. P. Kramer, specimens from the National Museum of Natural History; Dr. C. D. Michener, specimens from the Snow Entomological Museum at the University of Kansas; Dr. W. R. Richards, specimens from the Canadian National collection; Dr. Edward S. Ross, specimens from the California Academy of Science collection; Dr. A. Soos, specimens from the Hungarian Natural History Museum, Budapest; Dr. D. A. Young, specimens from the North Carolina State University collection; Dr. W. Wagner, specimens from the Zoological Institute in Hamburg.

Genus *Psammotettix* Haupt

Psammotettix Haupt, 1929, pp. 173-286. [Type by original designation, *Athysanus maritimus* Perris, 1857.]
Ribautiellus Zachvatkin, 1933, pp. 262-272. [Type by original designation, *D (eltocephalus) striatus* Linnaeus.]

From elongate, slender to elliptical in dorsal aspect. Length 2.80 to 4.20 mm, greatest width 0.86 to 1.30 mm. Head, pronotum, scutellum, and abdomen with ground color creamy, occasional amber or cinereous. Head, pronotum, and scutellum with or without brown markings. Abdomen marked with black, brown, orange, or red. Wings transparent, subhyaline, or opaque; with brown to smoky markings. Hind wing veins clear or darkened.

Head including eyes slightly wider than pronotum. Crown produced, with median length greater than length tangent to mesal border of eye; with median sulcus extending anteriorly 0.56 to 0.90 length from pronotum to apex. Crown with anterior edge a median blunt curve with radius of curvature varying from equal to one-fifth the radius of curvature of the pronotum in dorsal aspect. Crown granulate along front margin, glabrous discally; center of disc depressed in dried specimens. Clypeus with horizontal brown stripes connected longitudinally at or near median line in cephalic aspect. Clypellus

nearly parallel-sided, gradually tapering to a rounded point distally, longer than lorum; trans-clypeal suture distinct.

Pronotum almost as large as crown, including eyes; from 0.8 to 1.6 as long as crown measured longitudinally in dorsal aspect, with anterior portion slightly raised beginning at anterior edge of scutum. With or without six longitudinal brown stripes. Scutellum almost covered by pronotum, exposed portion triangular, with straight, crescentiform, or undulate transverse suture. Wings macrop-terous, subbrachypterous, or brachypterous. Hind wings terminating much before or nearly at apex of fore wings when in resting position. Wings varying in length, attaining or not, or exceeding apex of abdomen when in resting position. Outer antepical cell not always stalked.

Female abdomen with seventh sternum wider anteriorly; anterior edge truncate; posterior edge truncate, emarginate, or with median projection. Ventral intersegmental membrane connecting posterior edge of seventh sternum with base of first valvulae rigid posteriorly, appearing as a closely appressed flap of the sternum, visible as wrinkles through cleared sternum (Figure 4B). Female pygofer setiferous, cephalodorsal edge with well-developed, horseshoe-shaped, internal apodeme. First valvula with a basidorsal median lobe flanked by (usually) sclerotized folds or articulating points where the first valvifer articulates (Figure 1c).

Male valve wider anteriorly, large compared to exposed tips of plates. Pygofer with group of setae near point of attachment to tenth tergum which is a narrow C-shaped sclerite with arms of C attached to pygofer. Male plates thickened, each with mesal groove which receives apex of style and with lateral row of setae; distal third of plate twice as wide as proximal two-thirds. Connective linear (Figure 7c) rarely Y-shaped (Figure 2A), length equal to or three times as long as aedeagus, divided anteriorly in two, usually contiguous, arms. Style attached to anterior third of connective, with well-developed preapical lobe; apex curved, forming a hook, with numerous small setae on inner surface. Aedeagus not fused to connective, with well-developed dorsal apodemes. Shaft of aedeagus tubular or flattened, curved or bisinuate, with apex flanged, dentate or entire in caudodorsal aspect. Gonoduct median or

asymmetrical. Gonopore subterminal, opening into a spatulate or spoonlike apex.

The linear connective, the articulation between aedeagus and connective, the male plates with spinelike setae, the length of the connective (at least twice as long as aedeagus), and the small male plates set *Psammotettix* apart from other Deltocephaline genera (Oman, 1949). The connective of *Psammotettix ferratus* (DeLong and Davidson) differs from other species in the genus in that it is Y-shaped anteriorly, the arms are not contiguous, and it is not twice as long as the aedeagus. The connective in all other Nearctic species is divided anteriorly and would be Y-shaped if the anterior arms were separated. The genus is classed with those Deltocephalinae having a linear connective because the contiguous anterior arms give a linear appearance.

The genus appears to be close to the genus *Laevicephalus* DeLong. *Psammotettix* Haupt and *Laevicephalus* are similar in many external characters, differing in characters associated with the external genitalia. The female seventh abdominal sternum of *Laevicephalus* has a very pronounced median projection on the posterior margin. This margin is usually emarginate in *Psammotettix*, being blunt and rounded in those species with a median projection. The sclerite that is appressed to the female seventh abdominal sternum is weakly sclerotized or membranous in *Psammotettix*, heavily sclerotized in *Laevicephalus*. This sclerite is possibly associated with the eighth abdominal sternum. The basidorsal median lobe does not extend dorsad and is expanded anteriorly in *Laevicephalus*. The basidorsal median lobe extends dorsad and is not expanded anteriorly in *Psammotettix*. The basidorsal median lobe of *Laevicephalus* is flanged and covered dorsally by two flaplike projections that are not present in *Psammotettix*. The dorsal aedeagal apodemes are large in *Psammotettix*, small in *Laevicephalus*. The exposed portion of each male plate of *Psammotettix* is small; comprising about one-third the length of the plate, while that of *Laevicephalus* comprises about one-half the total length of the plate.

The aedeagal shaft of *Laevicephalus* DeLong is long, slender, and undulate in lateral aspect, and with a terminal gonopore. The aedeagus of *Psammotettix* varies from short to long, from slender to expanded at apex, and the gonopore is sub-

terminal. The connective is shorter than the aedeagus in *Laevicephalus* but longer than the aedeagus in *Psammotettix*.

Psammotettix species possess many discordant characters, making the determination of species relationships difficult. The species can be grouped in at least five different ways, with no two groups the same, by grouping them on the basis of different single characters. Males grouped on the basis of aedeagal characters fall into different groups from females grouped on the basis of ovipositor characters. This, per se, is a strong argument against one-character taxonomy.

Probably, however, some of the characters should be weighted. For example, the Y-shaped connective is held to be a phyletic character in Deltocephalinae; hence, *Psammotettix ferratus* (DeLong and Davidson), the only species in *Psammotettix* with this character, can be grouped to itself, based on the weight of this one character, which is probably secondary in this genus. *Psammotettix totalus* (DeLong and Davidson) has an asymmetrical gonoduct, and might, therefore, be grouped alone since asymmetry is generally accepted as an advanced character in the Metazoa.

The present arrangement of species in *Psammotettix* is based on geographic and distributional data in combination with morphological characters. Each of the species differs from the others in at least two characters. Usually these are aedeagal characters, comparative wing lengths, characters at base of the first valvula, and at posterior edge of the

female seventh sternum. Some of the differences found are clinal.

Psammotettix amplus (DeLong and Davidson), *P. cahuillus* (Van Duzee), *P. lividellus* (Zetterstedt), and *P. alienus* (Dahlbom) are species with much intraspecific variation. Some of these variations are illustrated (Figures 7, 8, and 9). Further study of these species, as indicated in the text, would be profitable.

Psammotettix is divided into the following Nearctic species groups:

1. The lapponicus group, consisting of *P. lividellus* (Zetterstedt), *P. lapponicus* (Ossiannilsson), *P. alexanderi*, new species, and *P. revae* Knull. *Psammotettix alienus* (Dahlbom), a member of the Palearctic striatus group of European authors, can also be grouped with the lapponicus group.

2. The cahuillus group consisting of *P. cahuillus* (Van Duzee), a species with much intraspecific variation, and *P. attenuens* (DeLong and Davidson).

3. The excavatus group consisting of *P. excavatus* (Oman), *P. shoshone* (DeLong and Davidson), and *P. emarginatus*, new species.

4. The amplus group consisting of *P. amplus* (DeLong and Davidson), a species with much intraspecific variation, and *P. asper* (Ribaut).

5. A heterogeneous group with each species actually constituting a group to itself: *P. confinis* (Dahlbom), another member of the Palearctic striatus group of European authors, *P. ferratus* (DeLong and Davidson), *P. totalus* (DeLong and Davidson), *P. knullae*, new species, and *P. dentatus* Knull.

Key to Species of *Psammotettix*

MALES

1. Connective Y-shaped (Figure 2A), the basal arms not contiguous
ferratus (DeLong and Davidson) 2
 Connective linear (Figure 7c), the basal arms contiguous 3
- 2 (1). Aedeagus with gonoduct symmetrical in caudodorsal aspect 3
 Aedeagus with gonoduct asymmetrical in caudodorsal aspect (Figure 3c)
totalus (DeLong and Davidson) 3
- 3 (2). Aedeagus with apex of shaft not expanded or not more than one-eighth greater than narrowest width of shaft in caudodorsal aspect (Figure 6c) 4
 Aedeagus with apex of shaft expanded to more than one-fourth greater than narrowest width of shaft in caudodorsal aspect (Figure 17c) 13
- 4 (3). Aedeagus with apical two-thirds of shaft straight in lateral aspect (Figure 4b)
knullae, new species 5
 Aedeagus with apical two-thirds of shaft curved in lateral aspect (Figure 10b) 5
- 5 (4). Aedeagus with apical two-thirds of shaft bisinuate in lateral aspect (Figure 6d) 6
 Aedeagus with apical two-thirds of shaft not bisinuate in lateral aspect (Figure 11b) 7

- 6 (5) . Aedeagus with apex abruptly narrowed to one-half greatest width well before tip; resembling a nipple in caudodorsal aspect (Figure 5E) *cahuillus* (Van Duzee)
 Aedeagus with apex gradually narrowed to a sharp or blunt point in caudodorsal aspect (Figure 7c) *attenuens* (DeLong and Davidson)
- 7 (5) . Aedeagus with apical one-third of shaft gradually tapering to a blunt point in caudodorsal aspect 8
 Aedeagus with apical one-third of shaft not gradually tapering to a blunt point in caudodorsal aspect 9
- 8 (7) . Aedeagus with shaft regularly tapering to a point at apex in lateral aspect (Figure 8E) *amplus* (DeLong and Davidson)
 Aedeagus with shaft not regularly tapering to a point at apex in lateral aspect (Figure 10c) *asper* (Ribaut)
- 9 (7) . Aedeagus with lateral teeth or lobes on apical portion of shaft in caudodorsal aspect (Figure 16c) 10
 Aedeagus without lateral teeth and lobes on apical portion of shaft in caudodorsal aspect (Figure 11E) *lividellus* (Zetterstedt)
- 10 (9) . Aedeagus with apical portion of shaft bearing more than eight lateral dentations per side in caudodorsal aspect (Figure 13c) *dentatus* Knull
 Aedeagus with apical portion of shaft bearing less than six lateral dentations per side in caudodorsal aspect (Figure 15c) 11
- 11 (10) . Aedeagus with lobe of toothed portion at apex in caudodorsal aspect (Figure 14c) *emarginatus*, new species
 Aedeagus with lobe of toothed portion preapical in caudodorsal aspect (Figure 15c) 12
- 12 (11) . Aedeagus with greatest width of lobed portion more than five times width of tip in caudodorsal aspect (Figure 15c) *shoshone* (DeLong and Davidson)
 Aedeagus with greatest width of lobed region less than four times width of tip in caudodorsal aspect (Figure 16c) *excavatus* (Oman)
- 13 (3) . Aedeagal shaft with apical emargination in caudodorsal aspect (Figure 17c) *alienus* (Dahlbom)
 Aedeagal shaft without apical emargination in caudodorsal aspect 14
- 14 (13) . Aedeagal shaft with apex wide, truncate in caudodorsal aspect (Figure 18c) *confinis* (Dahlbom)
 Aedeagal shaft with apex rounded, not wide, truncate in caudodorsal aspect 15
- 15 (14) . Aedeagal shaft with widest portion of apex equal to or greater than distance from gonopore opening to extreme tip in caudodorsal aspect (Figure 19c) *obesus* Knull
 Aedeagal shaft with widest portion of apex less than distance from gonopore opening to extreme tip in caudodorsal aspect (Figure 21b) 16
- 16 (15) . Aedeagal shaft with greatest width of apex equal to five-eighths or more distance from gonopore opening to extreme tip in caudodorsal aspect (Figure 20b) 17
 Aedeagal shaft with greatest width of apex equal to one-half or less the distance from gonopore opening to extreme tip in caudodorsal aspect (Figure 22b) 18
- 17 (16) . Connective stem with posterior end clearly bifid at point of articulation with aedeagus in caudodorsal aspect *beirnei*, new species
 Connective stem with caudal end not clearly bifid at point of articulation with aedeagus in caudodorsal aspect *alexanderi*, new species
- 18 (16) . Hind wings exceeding apex of abdomen *revae* Knull
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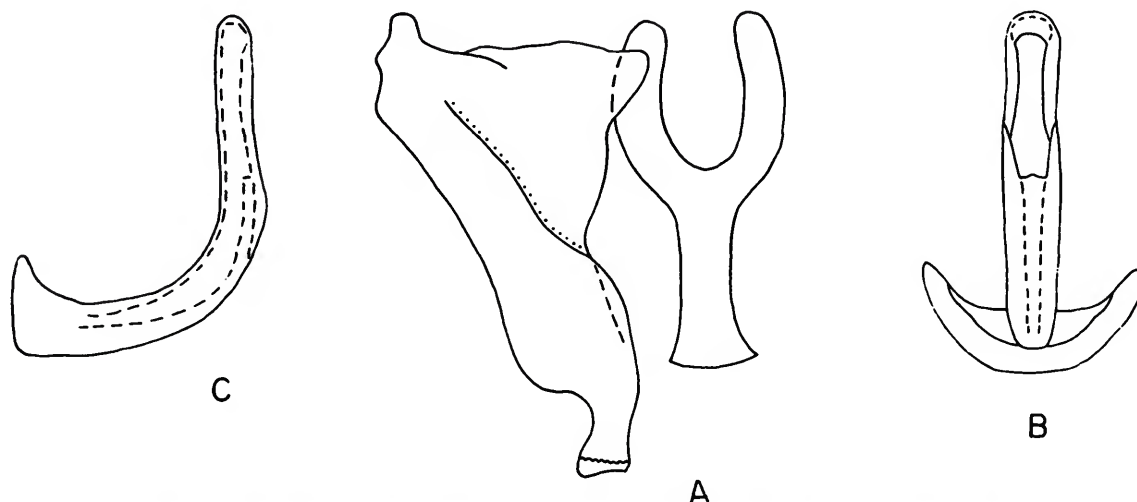


FIGURE 2.—Male genitalia of *Psammotettix ferratus* (DeLong and Davidson): A, connective and style in dorsal aspect; B, aedeagus in caudodorsal aspect; C, same in lateral aspect.

***Psammotettix ferratus* (DeLong and Davidson)**

FIGURE 2

Laevicephalus ferratus DeLong and Davidson, 1935, p. 170, pl. 7.

Psammotettix ferratus.—Oman, 1947, p. 62.

Length of male 3.16 mm; width of head including eyes 0.94 mm. Crown 1.26 times longer medially than next to eye, with median longitudinal suture extending 0.62 median length from pronotum to apex. Ground color of head, pronotum, scutellum, and fore wings creamy; brown markings very faint. Fore wings with apical cells smoky. Hind wings transparent; veins not darkened.

Pronotum with round pits confined to area overlying anterior edge of scutum. Scutellum with sinuate transverse suture. Macropterous form with fore and hind wings exceeding abdomen when at rest.

Aedeagal shaft tubular, not expanded at apex in caudodorsal aspect. Aedeagus with dorsal apodemes short, less than one-fifth length of shaft. Connective not much longer than aedeagus, Y-shaped. Style with arms broadly triangular. Plates fused to valve.

The type series consists of male holotype, allotype, and female paratype, Presque Island, Penn-

sylvania, 21 July 1920 (DeLong) in the DeLong collection.

This description is based on the male holotype. The Y-shaped connective, short with respect to the length of the aedeagus, and the short dorsal apodemes set *Psammotettix ferratus* (DeLong and Davidson) well apart from other species in *Psammotettix*. Oman (1949) separates deltocephaline genera on the basis of the connective being Y-shaped or linear and sets *Psammotettix* apart by the connective being twice as long as the aedeagus, and the arm of the style being long and slender. *Psammotettix ferratus* differs from other species of *Psammotettix* in all of these respects. *Psammotettix ferratus* (DeLong and Davidson) is retained in *Psammotettix* because of the small number of available specimens, and because it is similar to other species of *Psammotettix* in many respects. Occasionally, specimens of *Psammotettix lividellus* (Zetterstedt) have been observed with a Y-shaped connective. In these specimens it was obvious that the Y-shaped condition was caused by distortion. The connective of *P. ferratus* (DeLong and Davidson) appears to be normal, very flat, and evenly formed without distortion. No internal parasites were found. The only unusual condition was that the aedeagus was pliable and the style appeared in-

flated. These structures are normally sclerotized and hard. This pliability would indicate that the specimen is either teneral or has been softened in KOH or some other desclerotizing agent. This specimen could be a teneral form. The aedeagus of a specimen of a species of *Psammotettix* left in 17 percent KOH remained for 36 hours at room temperature before becoming softened. The styles softened before the aedeagus. This would indicate that the softening was not due to a desclerotizing agent and that the specimen is probably teneral.

***Psammotettix totalus* (DeLong and Davidson)**

FIGURE 3

Laevicephalus totalus DeLong and Davidson, 1935, p. 171.
Psammotettix totalus.—Oman, 1947, p. 62.

Length of male 3.5 to 3.6 mm, of female 3.9 to 4.1 mm; width of head, including eyes, of male 1.0 mm, of female 1.1 mm. Crown with median length 1.3 to 1.4 length next to eye, with median suture extending anteriorly from 0.66 to 0.69 median length. Ground color of head, pronotum, scutellum,

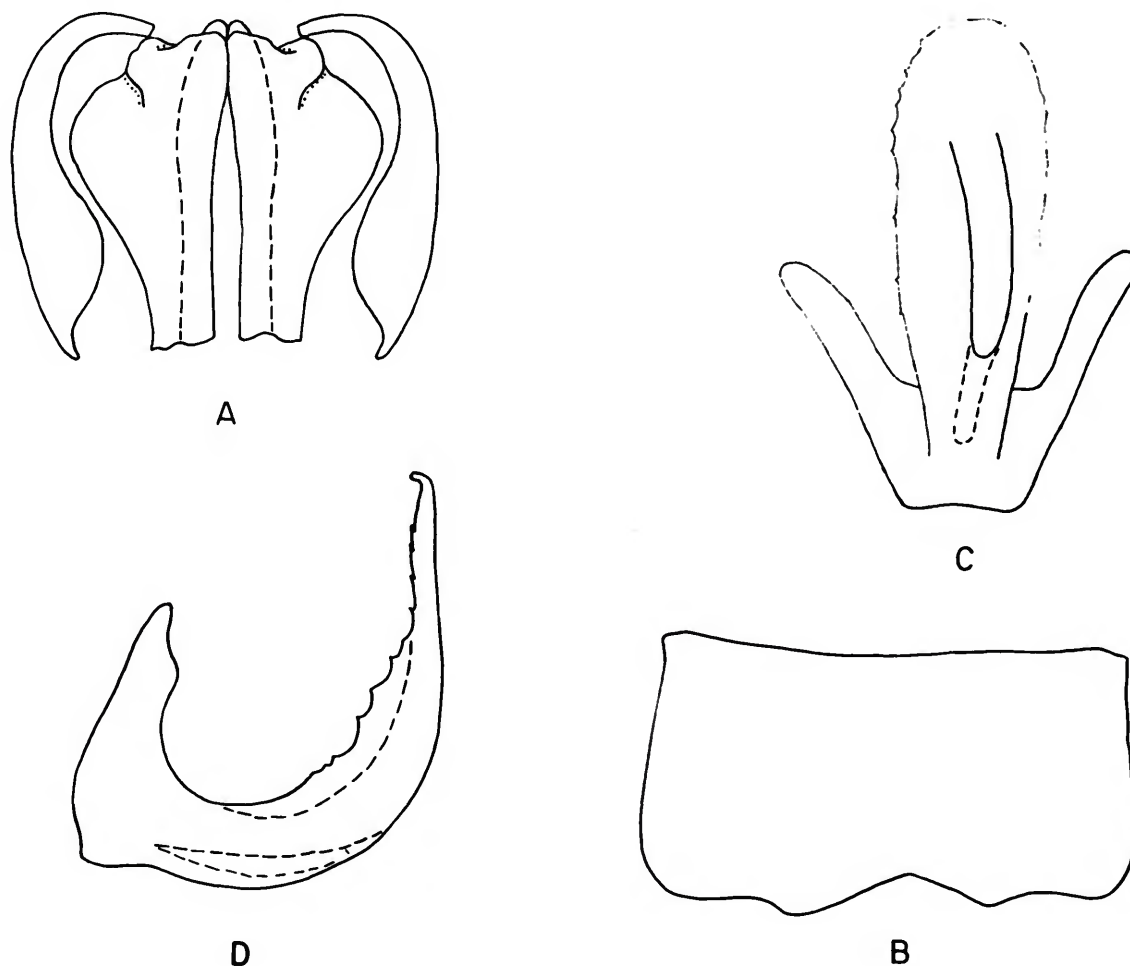


FIGURE 3.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix totalus* (DeLong and Davidson): A, first valvulae and first valvifers in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

and wings light cream, lightly to heavily marked with brown. Crown unmarked or with two triangular anterolateral areas, two longitudinal posterolateral stripes, and a spot cephalad of each eye, brown. Pronotum unmarked or with six longitudinal brown stripes. Fore wing with veins unmarked or bordered with brown in claval, brachial, central, and inner anteapical and apical cells. Hind wings and veins colorless.

Pronotum with round pits randomly distributed over area above scutum. Scutellum with crescentiform transverse suture. Macropterous form with fore and hind wings exceeding apex of abdomen, hind wings reaching distal end of inner apical cell of front wings when at rest.

Aedeagus with shaft flattened dorsoventrally, with decurved and serrated lateral flanges; gonoduct asymmetrical in caudodorsal aspect.

Female seventh abdominal sternum with posterior margin scarcely produced, with a broad median shallow emargination. First valvula with basidorsal median lobe well developed and sclerotized, with articulating lobe arising laterad of median basidorsal lobe at a distance of about one-third width of latter, in ventral aspect; median basidorsal lobe extending only slightly farther cephalad than articulating lobe.

The male holotype and the allotype are in the DeLong collection. The paratypes are in the DeLong and Osborn collections. The type habitat is not known. The type locality is Murtaugh, Idaho, and Cane Tree and Cattail Spring, Wyoming. The distribution is in the Northwestern States (Oman, 1949).

This is one of the larger species of *Psammotettix*. It resembles *P. confinis* (Dahlbom), *P. alienus* (Dahlbom), and *P. lividellus* (Zetterstedt) externally. This species is difficult to relate closely to any one species in *Psammotettix*. The asymmetrical gonoduct and gonopore set it apart. The shape of the posterior edge of the female seventh abdominal sternum would place it close to *P. obesus* Knull and *P. attenuens* (DeLong and Davidson). Based on wing lengths it is in a group with *P. confinis* (Dahlbom), *dentatus* Knull, *alienus* (Dahlbom), and *lividellus* (Zetterstedt). Based on characters of the first valvulae, it is more closely related to *P. amplus* (DeLong and Davidson), *lapponicus* (Ossiannilsson), and *alexanderi*, new species.

Psammotettix knullae, new species

FIGURE 4

Psammotettix ferratus.—Knull, 1954, p. 56, figs. 3, 4.

Length of male 3.20 to 3.64 mm, of female 3.13 to 3.58 mm; width of head, including eyes, of male 0.97 to 1.03 mm, of female 0.99 to 1.10 mm; crown with median longitudinal sulcus extending 0.60 to 0.70 median length from pronotum to apex. Ground color of head, pronotum, scutellum, and abdomen creamy. Crown unmarked or marked with two broad longitudinal stripes laterally. Pronotum unmarked or with six longitudinal brown stripes. Scutellum unmarked or with two longitudinal stripes laterally. Fore wings subhyaline, unmarked, or marked with brown along commissural border; hind wings transparent and unmarked.

Pronotum with round pits as in *P. totalus* (DeLong and Davidson). Scutellum with crescentiform transverse suture. Macropterous form with fore wings barely reaching or exceeding abdominal apex when at rest, hind wings shorter than abdomen, reaching proximal end of inner apical cell of fore wing when at rest.

Aedeagus with shaft tubular throughout length, apex with internal sclerite resembling a "y" in caudodorsal aspect, shaft with apical two-thirds straight in lateral aspect. Connective with stem greatly widened caudally, with small notch at point of articulation with aedeagus in ventral aspect.

Female seventh abdominal sternum with notch-like median emargination. Intersegmental membrane lightly sclerotized, with wrinkles visible through cleared seventh sternum (Figure 42). First valvula (Figure 4A) with median basidorsal lobe well developed, extending farther cephalad than articulating lobe which is not well defined medially.

Holotype male, allotype, two male and three female paratypes. Toppenish, Washington, 8 July, 1935 (Beamer); paratypes from Rocky Ford, Colorado; Hot Lake, Oregon; Snowville, Utah; Gardner, Montana; Burley and Twin Falls, Idaho; Saskatoon and Elbow, Saskatchewan; McMurray, Foremost, and Manyberries, Alberta. Holotype in the National Museum of Natural History.

This species is named in honor of D. J. Knull. It was misidentified and illustrated as *Psammotettix ferratus* (DeLong and Davidson) by Knull. The

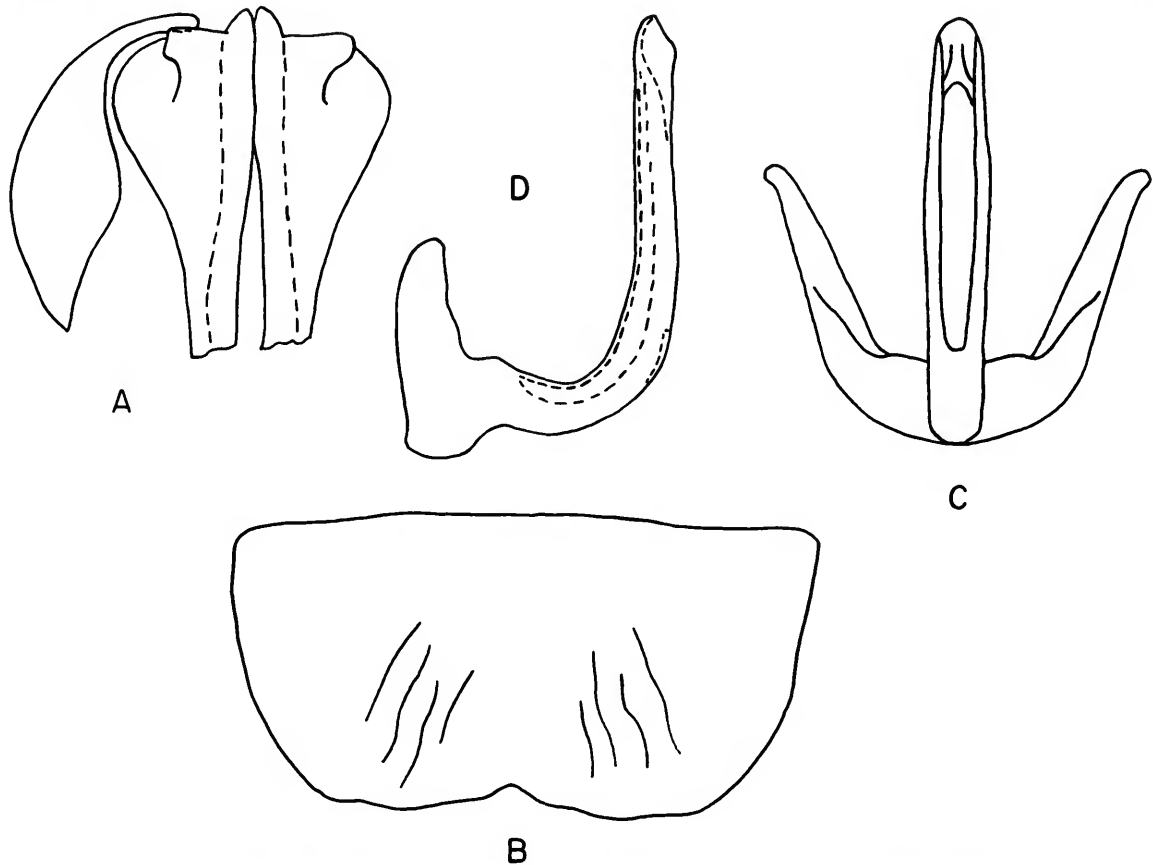


FIGURE 4.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix knullae*, new species: A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

type of *P. ferratus*, described elsewhere in this paper, is entirely different in aedeagal characters from those illustrated by Knull. This species stands apart from other Nearctic *Psammotettix* species in that the apical two-thirds of aedeagal shaft is straight in lateral aspect. The relative wing lengths are close to *P. revae* Knull. The internal sclerotization of the aedeagal apex is close to an illustration by Remane (1965, fig. 2c) which is either *Psammotettix koeleriae* Zachvatkin or *Psammotettix angulatus*.

A specimen from Rocky Ford, Colorado, was collected from sugar beet.

Psammotettix cahuillus (Van Duzee)

FIGURE 5

Deltocephalus cahuilla Van Duzee, 1925, p. 417.

Latalus cahuilla.—DeLong and Caldwell, 1937.

Laeviocephalus cahuillus.—DeLong and Knull, 1946, p. 28.

Psammotettix cahuillus.—Oman, 1949, p. 162.

Length of male 3.00 mm, of female 2.70 to 3.25 mm; width of head, including eyes, of male 0.95 to 1.00 mm, of female 0.93 to 1.30 mm. Crown with median length 1.13 to 1.29 length next to eye, with median sulcus extending from 0.56 to 0.86 median length. Ground color of head, pronotum, fore wings, and scutellum varying from creamy to cinereous, and from unmarked to heavily marked with brown. Crown with four spots on anterior margin,

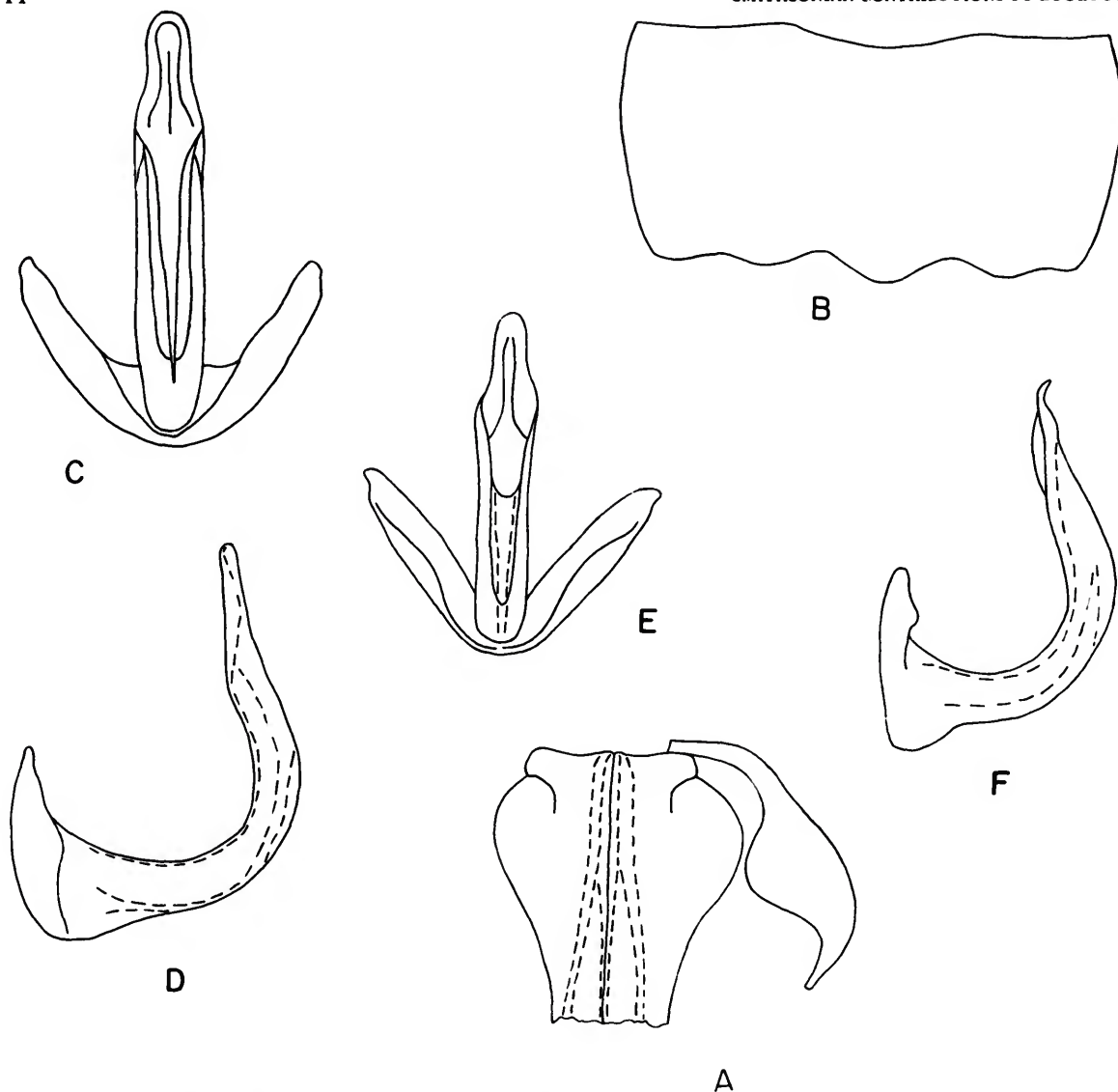


FIGURE 5.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix cahuillus* (Van Duzee): A, first valvulae and first first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect, Riverside, California; D, same in lateral aspect; E, aedeagus in caudodorsal aspect, Keen Camp, California; F, same in lateral aspect.

two mediolateral triangular spots, and four stripes along caudal edge, brown. Pronotum with six longitudinal brown stripes with superimposed brown splotches. Fore wing veins bordered with brown; with eight spots, two anteriorly, four in transverse

row at midlength, and two in inner anteapical cells, brown. Scutellum with two longitudinal brown stripes.

Pronotum with round pits absent or confined to area just above anterior edge of scutum. Scutellum

with transverse suture crescentiform. Macropterous form with fore wings reaching or exceeding apex of abdomen, with hind wings shorter than abdomen, reaching midlength of inner anteapical cell of fore wings when at rest.

Aedeagus with shaft tubular, apical two-thirds bisinuate in lateral aspect, with apical portion abruptly narrowed to one-half greatest width well before tip, resembling a nipple in caudodorsal aspect; without lateral dentations on shaft; connective weakly concave in ventral aspect at articulation with aedeagus.

Female seventh abdominal sternum with relatively strong median projection on posterior margin. First valvula with basidorsal median lobe well

developed and sclerotized; articulating lobe arising one-half its width laterad of basidorsal median lobe in ventral aspect; median basidorsal lobe and articulating lobe extending about equally cephalad.

The type locality is Keen Camp, California. The type habitat is grass. The distribution is California (Van Duzee, 1925).

Psammotettix cahullus (Van Duzee) shows a wide color variation. The bisinuate shaft of the aedeagus would place it close to *P. attenuens* (DeLong and Davidson), but other characters such as head shape and wing length indicate a more distant relationship. The median projection of the posterior edge of the female seventh abdominal sternum is similar to *P. alienus* (Dahlbom). The wing lengths of *P.*

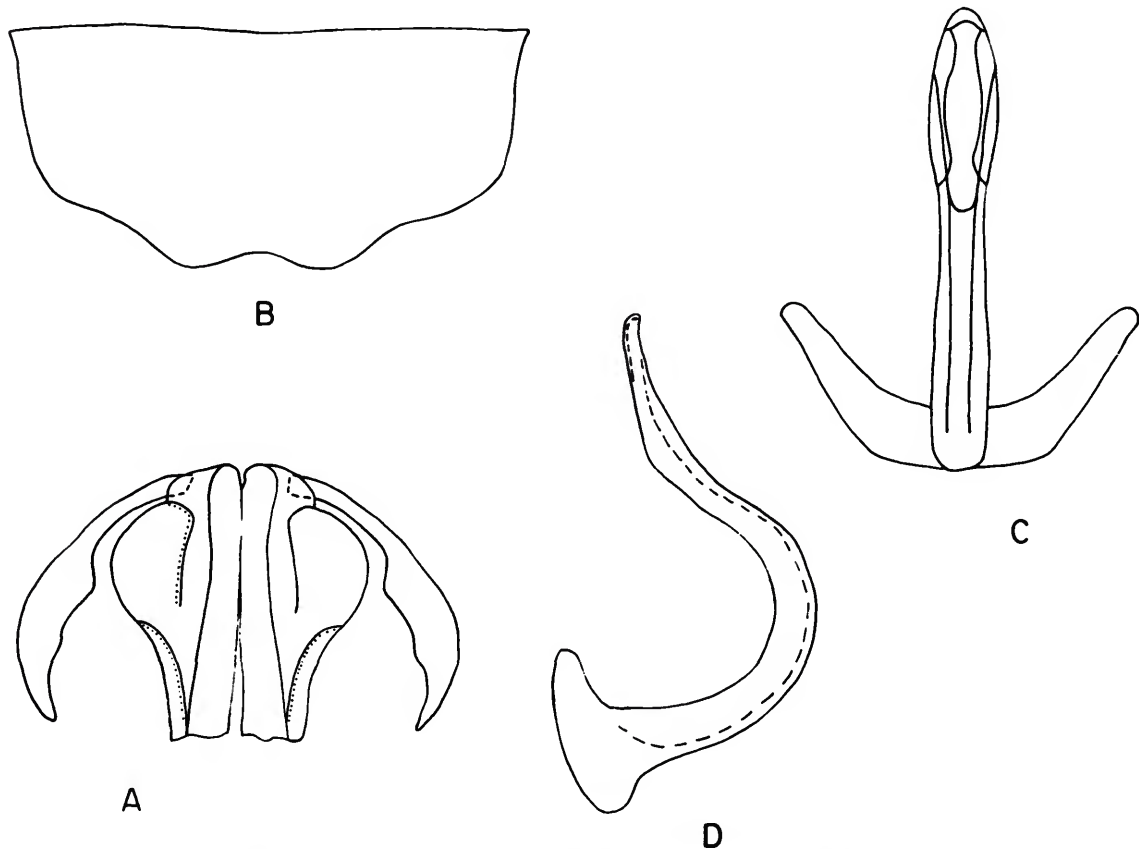


FIGURE 6.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix attenuens* (DeLong and Davidson): A, first valvulae and first valvifers in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

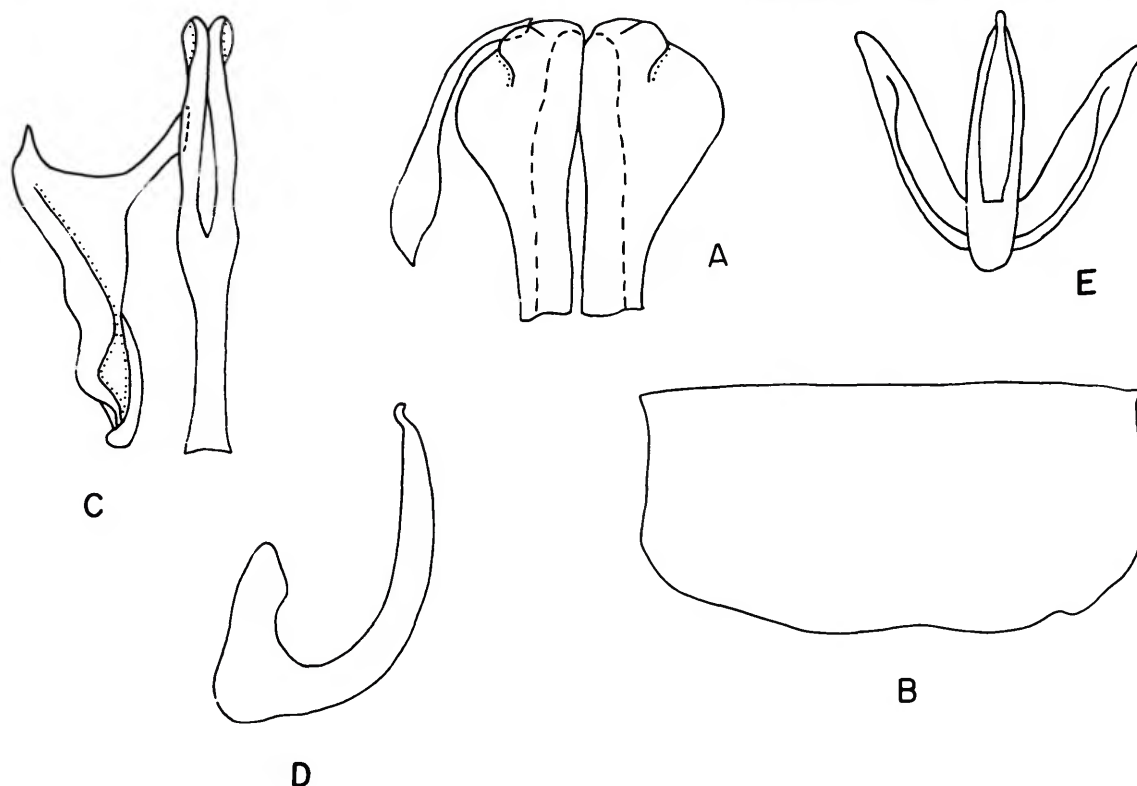


FIGURE 7.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix amplus* (DeLong and Davidson): A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, connective and style in dorsal aspect; D, aedeagus in lateral aspect, Monterey, California; E, same in caudodorsal aspect.

cahuillus are close to those of *P. alexanderi*, new species, *P. lapponicus* (Ossiannilsson), *P. excavatus* (Oman), *P. amplus* (DeLong and Davidson), *P. obesus* Knull, and *P. shoshone* (DeLong and Davidson). In the characters at the base of the first valvula *cahuillus* is close to *amplus*.

Psammotettix cahuillus (Van Duzee) shows a greater range of color variation than do most of the *Psammotettix* species. There is also variation in the aedeagus (Figures 5 c, D, E, and F). More information is necessary to verify the infraspecific taxonomic status of these forms.

Psammotettix attenuens (DeLong and Davidson)

FIGURE 6

Laevicephalus attenuens DeLong and Davidson, 1935, p. 170.
Psammotettix attenuens.—Oman, 1947, p. 62.

Length of male 3.50 mm, of female 3.46 to 3.60 mm; width of head, including eyes, of male 0.96 to 1.00 mm, of female 0.96 to 1.00 mm; crown 1.10 to 1.33 times longer medially than next to eye, with median longitudinal suture extending 0.64 to 0.98 median length from pronotum to apex. Pronotum 1.21 to 1.42 times longer medially than length of crown. Ground color of head, pronotum, scutellum, and wings creamy, lightly to heavily marked with brown. Dorsal horizontal brown stripe of face visible from above, causing crown to appear more pointed than it actually is. Crown with two anterolateral triangles, mediolateral blotches, and four spots along posterior edge, brown. Pronotum with or without six longitudinal stripes, brown; without numerous circular pits. Scutellum with or without four brown spots or two inner brown and two outer

orange spots, under posterior edge of pronotum; with transverse suture straight to crescentiform.

Macropterous form with front and hind wings longer than abdomen; similar to *Psammotettix totalis* (DeLong and Davidson).

Shaft of aedeagus bisinuate in lateral aspect; gradually tapering to a blunt point in caudodorsal aspect; without lateral wings or projections.

Seventh sternum of female with posterior edge strongly produced caudad and emarginate. First valvula with basidorsal median lobe well developed; with articulating lobe poorly developed, represented by a basal fold of the first valvula (Figure 6A). Articulating lobe or fold appearing

contiguous to median basidorsal lobe in ventral aspect. Articulating lobe and median basidorsal lobe extending about equally cephalad.

The type series is from Yellowstone Park, Wyoming, 4 July 1930 (D. M. DeLong). The type habitat is not known.

In aedeagal characters, *Psammotettix attenuens* is close to *Psammotettix caluillus* (Van Duzee). In the blunt apex of the crown, *attenuens* is not close to other species of *Psammotettix*.

A female specimen of *Psammotettix attenuens* (DeLong and Davidson) from Kalispell, Montana, was stylized between the fifth and sixth abdominal segments.

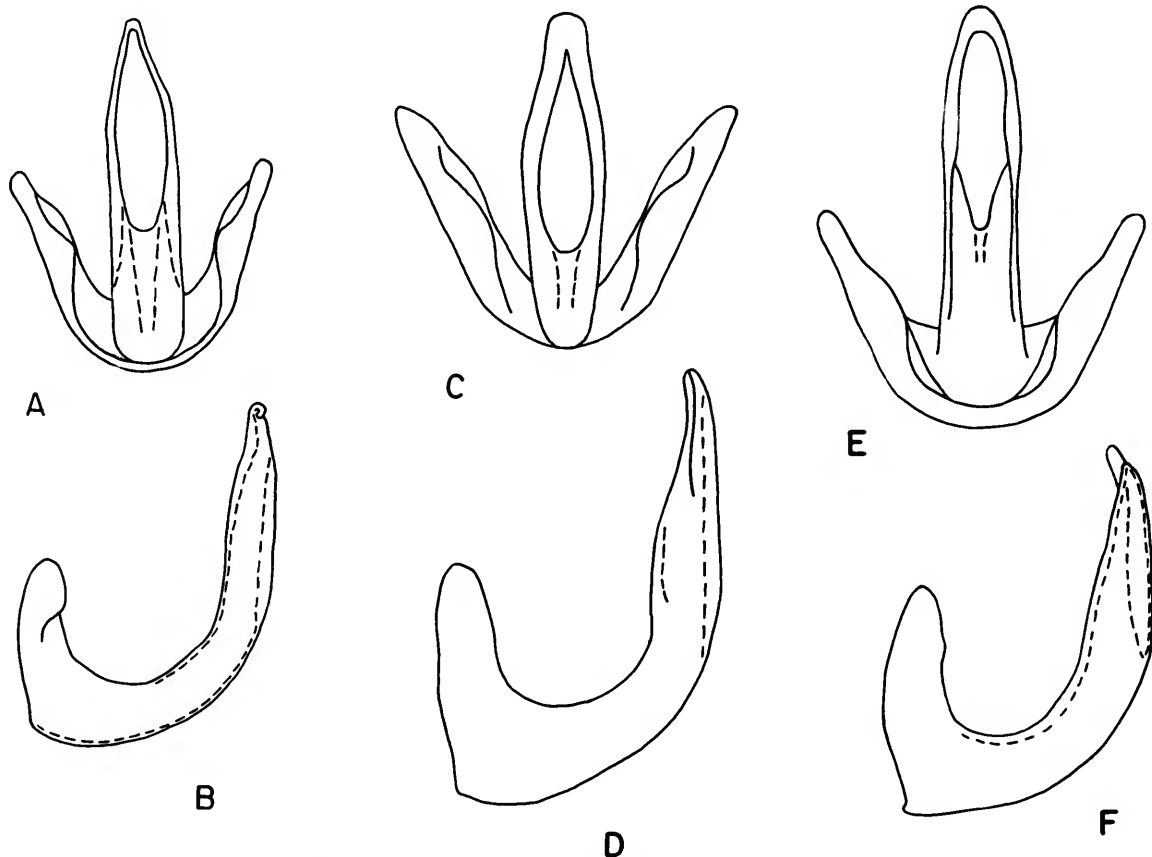


FIGURE 8.—Aedeagus of *Psammotettix amplus* (DeLong and Davidson): A, aedeagus in caudodorsal aspect, Cuyama Ranch, California; B, same in lateral aspect; C, aedeagus in caudodorsal aspect, Tehachapi, California; D, same in lateral aspect; E, aedeagus in caudodorsal aspect, Monolith, California; F, same in lateral aspect.

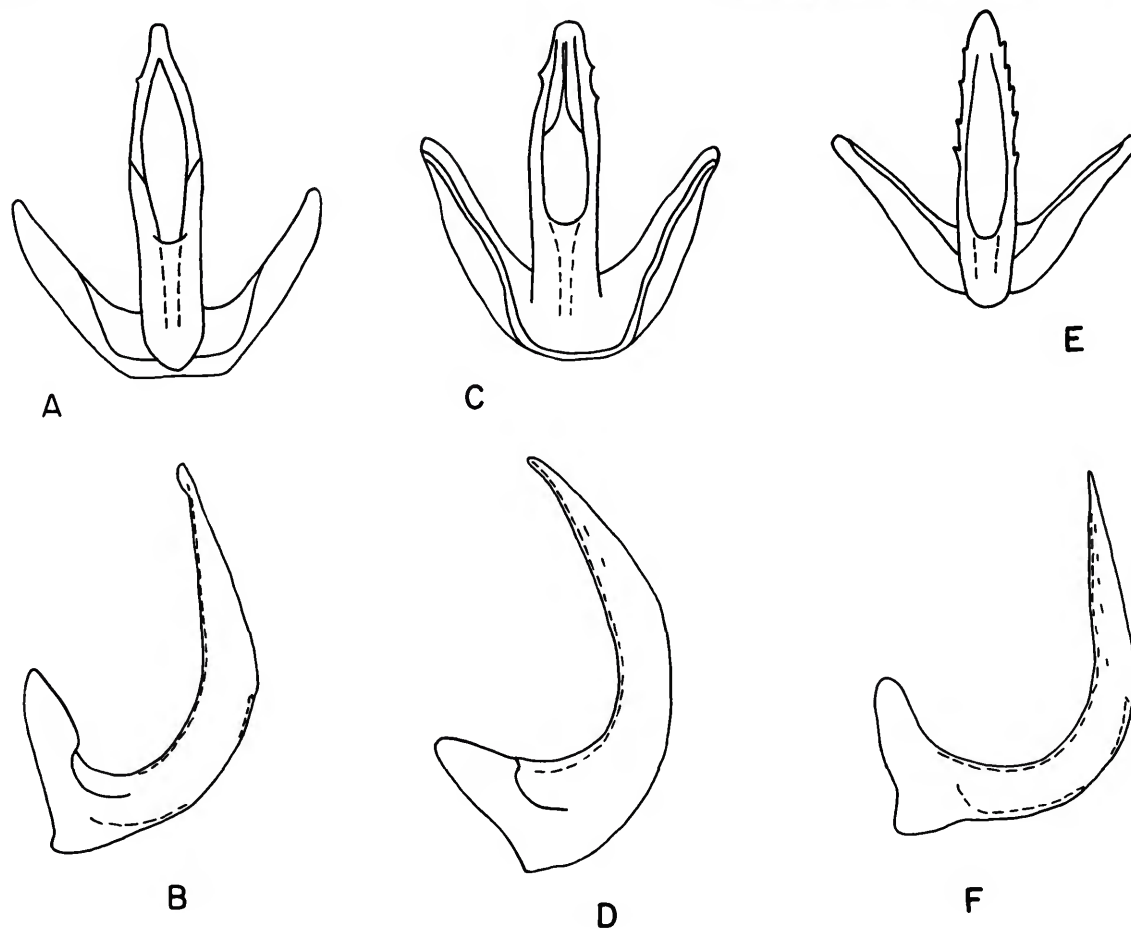


FIGURE 9.—Aedeagus of *Psammotettix amplus* (DeLong and Davidson): A, aedeagus in caudodorsal aspect, San Margarita, California; B, same in lateral aspect; C, aedeagus in caudodorsal aspect, Visalia, California; D, same in lateral aspect; E, aedeagus in caudodorsal aspect, Fort Lewis, Washington; F, same in lateral aspect.

***Psammotettix amplus* (DeLong and Davidson)**

FIGURES 7, 8, 9

Laevicephalus amplus DeLong and Davidson, 1935, p. 171.

Psammotettix amplus.—Oman, 1947, p. 62.

Length of male 2.90 mm to 3.97 mm, of female 2.97 mm to 3.80 mm; width of head, including eyes, of male 0.90 mm to 1.20 mm, of female 0.90 mm to 1.00 mm. Color varying as in *Psammotettix totalis* (DeLong and Davidson).

Pronotum with round pits on area overlying anterior edge of scutum. Scutellum with straight to

weakly crescentiform transverse suture. Macropterous form with fore and hind wings longer than abdomen when at rest; hind wings at rest reaching distal end of inner apical cell of fore wings.

Aedeagus with shaft changing from tubular at gonopore to flattened dorsoventrally at apex; with apex of shaft varying in attitude from curved ventrally and anteriorly to curved dorsally in lateral aspect; lateral edge of apical one-half of shaft varying from entire to dentate with up to five teeth on each side in caudodorsal aspect, shaft without lateral flanges, with apical one-third gradually taper-

ing to a blunt point in caudodorsal aspect.

Female seventh abdominal sternum with posterior margin slightly produced, weakly emarginate, or almost truncate. First valvula with basidorsal median lobe well developed and sclerotized, almost reaching base of valvula which with its complement is convex in ventral aspect; with articulating lobe arising laterad of median basidorsal lobe at a distance of less than one-third width of latter in ventral aspect and extending slightly farther cephalad than basidorsal median lobe.

The male holotype and the allotype are in the Osborn collection. There are no paratypes. The type locality is Bakersfield, California. The distribution is California (Oman, 1949) and Fort Lewis, Washington.

P. amplus (DeLong and Davidson) is one of the more variable species of *Psammotettix*. There is a morphological continuum from an aedeagal apex that is turned dorsally to one that is turned ventrally and anteriorly in the lateral aspect. The aedeagal shaft varies from untoothed to toothed laterally in caudodorsal aspect. Both characters vary geographically according to available data. The ventral and anteriorly directed apex occurs in higher altitudes; the coiled dorsally directed apex occurs in coastal areas. The untoothed aedeagal shaft occurs in the south and teeth increase in number to the north. In addition to the clinal aedeagal variation in this species, there is much individual variation in size and coloration. Our knowledge of *P. amplus* would benefit from an intensive geographic and host-plant study.

Psammotettix amplus (DeLong and Davidson) appears to be close to *Psammotettix asper* (Ribaut). The tip of the aedeagal shaft of *asper* is developed more than that of *amplus*, and it has a slight lateral flange in caudodorsal aspect.

Psammotettix asper (Ribaut)

FIGURE 10

Deltocephalus asper Ribaut, 1925, p. 16.

Psammotettix asper.—Ribaut, 1938, p. 168.

Length of male 2.90 to 3.05 mm, of female 2.90 to 3.00 mm; width of head, including eyes, of male 0.88 to 0.92 mm. Crown with median sulcus extending anteriorly about 0.7 median length. Ground color of head, pronotum, and scutellum creamy to

amber, marked with brown or orange. Ground color of wings ivory; claval, brachial, inner discal, inner antepical, and apical cells marked with brown. Brown markings on crown as in *Psammotettix totalis* (DeLong and Davidson), occasionally with median longitudinal stripe orange. Pronotum unmarked or with two orange longitudinal stripes.

Pronotum with round pits as in *Psammotettix totalis* (DeLong and Davidson). Scutellum with transverse suture straight or undulate. Macropterous form with wing lengths as in *totalis*.

Aedeagus tubular, with widest point of shaft in caudodorsal aspect about midway between gonopore opening and apex; aedeagal shaft not widened at apex, with series of serrations on cephaloventral surface between dorsal apodemes and gonopore opening; shaft with weak lateral flanges.

Female seventh abdominal sternum with posterior margin not produced, sinuate, with convexities and concavities approximately equal; median emargination not as broad as and deeper than that of *Psammotettix totalis* (DeLong and Davidson). First valvula with basidorsal median lobe well developed and sclerotized, with articulating lobe extending farther cephalad than basidorsal median lobe, with articulating lobe appearing to arise contiguous to the median basidorsal lobe in ventral aspect.

No holotype has been designated. The type locality is Sarkeresztur, Hungary. This description is based on specimens obtained from W. Wagner. The Nearctic specimens of *Psammotettix asper* (Ribaut) have not been examined. The Nearctic occurrence of *asper* is based on a Manitoba record (McClure, 1943). The distribution is Hungary (Ribaut, 1925), Bohemia, Moravia (Dlabola, 1945), Slovakia (Dlabola, 1954), and Manitoba.

Psammotettix asper (Ribaut) appears to be close to *Psammotettix amplus* (DeLong and Davidson). This is the only Nearctic species of *Psammotettix* with a two-toned ground color. *Psammotettix asper* also stands apart from other Nearctic species by the row of serrations dorsad on the aedeagal shaft.

Psammotettix lividellus (Zetterstedt)

FIGURES 11, 12

Cicada lividella Zetterstedt, 1840, p. 290.

lassus lividellus.—Walker, 1851, p. 882.

Deltocephalus lividellus.—Sahlberg, 1871, p. 37.

Deltocephalus affinis Gillette and Baker, 1895, p. 84.

- Deltocephalus excisus* Matsumura, 1906, p. 79.
Deltocephalus excisus (sic) Matsumura, 1908, p. 2.
Deltocephalus incisus (sic) Matsumura, 1908, p. 2.
Deltocephalus striatus.—Sanders and DeLong, 1920, p. 8.
Deltocephalus striatus lividellus.—Blöte, 1927, p. 220.
Laevicephalus striatus.—DeLong and Davidson not (Linnaeus),
 1935, p. 168.
Psammotettix lividellus.—Ribaut, 1938, p. 166.
Psammotettix striatus.—DeLong (not Linnaeus), 1948, p. 258.

Length of male 3.15 to 3.70 mm, of female 3.13 to 3.80 mm, width of head, including eyes, of male 0.86 to 1.01 mm, of female 0.95 to 1.05 mm. Crown with median sulcus varying in length. Ground color of head, pronotum, scutellum, and wings light cream to yellowish amber, very lightly marked with brown. Crown unmarked or with paired anterolateral brown lines forming crescentiform arcs from apex to ocelli. Pronotum unmarked. Fore wings unmarked or with apical cells bordered with brown.

Hind wings transparent, veins not darkened. Pronotum with pits as in *P. totalis* (DeLong and Davidson). Scutellum with transverse suture almost straight, with weak median undulate impression. Macropterous form with fore and hind wings exceeding apex of abdomen; hind wings extending to midlength or distal end of inner apical cell of fore wings at rest.

Aedeagus tubular with shaft of nearly uniform diameter throughout length, not appreciably narrowed or expanded in any aspect; with gonoduct symmetrical in caudodorsal aspect; varying in size; lateral edge of shaft entire or with minute dentations; slightly narrowed or expanded distad of gonopore in caudodorsal aspect (Figures 11A, C, E).

Female seventh abdominal sternum with median emarginations as in *P. totalis* (DeLong and Davidson); lateral emarginations shallower than in

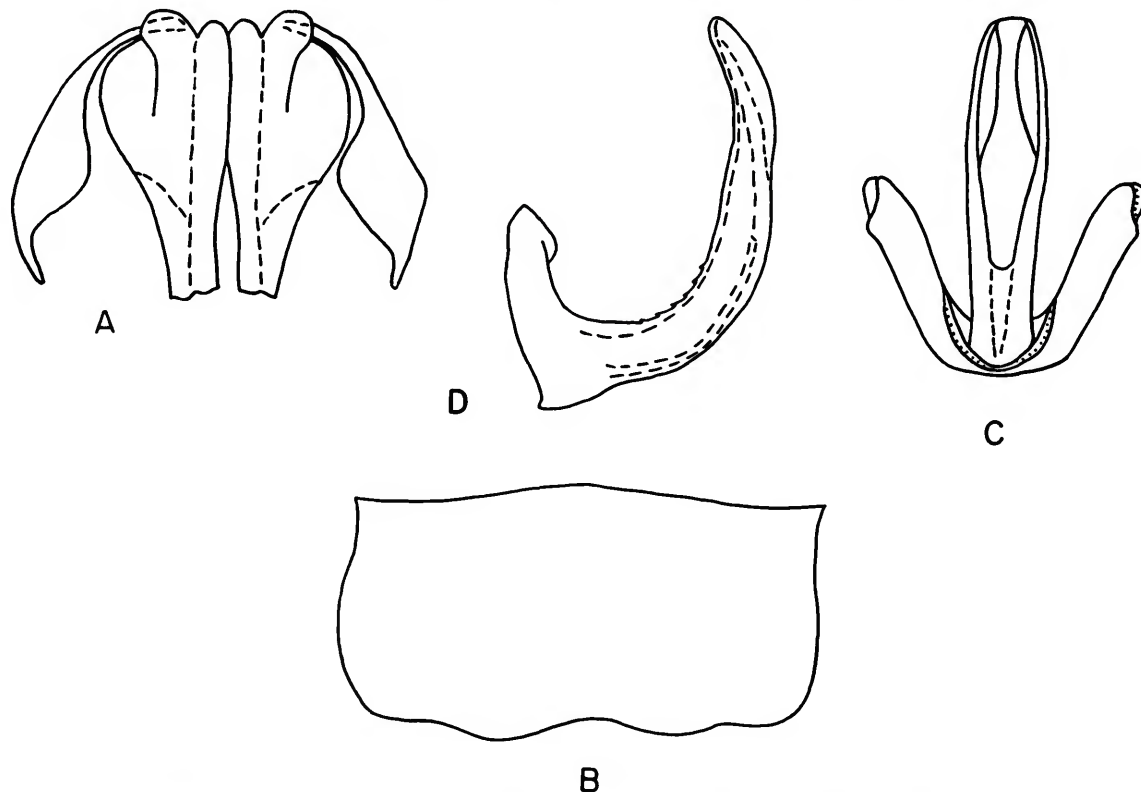


FIGURE 10.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix asper* (Ribaut): A, first valvulae and first valvifers in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

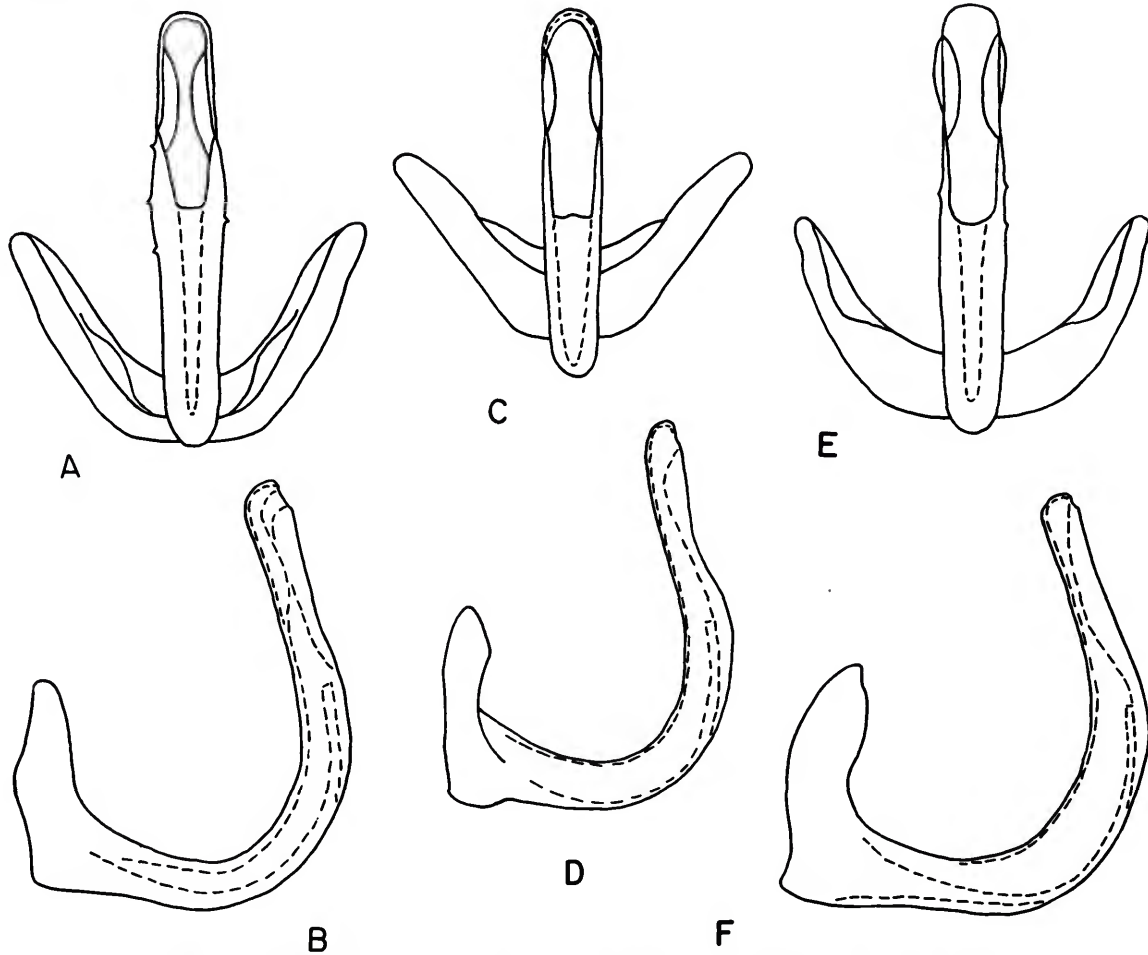


FIGURE 11.—Aedeagus of *Psammotettix lividellus* (Zetterstedt): A, aedeagus in caudodorsal aspect, Indian House Lake, Quebec; B, same in lateral aspect; C, aedeagus in caudodorsal aspect, Soda Creek, British Columbia; D, same in lateral aspect; E, aedeagus in caudodorsal aspect, Hebron, Labrador; F, same in lateral aspect.

totalus. First valvulae with articulating lobe arising laterad of median basidorsal lobe, the two appearing contiguous in ventral aspect. Median basidorsal lobe and articulating lobe extending about the same distance cephalad.

Described from Greenland on the basis of external characters. The labeled types are in Zetterstedt's collection. Their abdomens are missing (Beirne, 1954). No holotype was designated. Osianilsson (1938) designated a neotype (invalid because original types are not lost) and illustrated the aedeagus.

Psammotettix lividellus (Zetterstedt) shows variation in size, internal sclerotization, and lateral ornamentation of the aedeagal shaft. It has not been determined whether these variations are individual or geographic or a combination of the two. This species is most closely related to a group of *Psammotettix* species referred to herein as the *lapponicus* group. Nearctic species in this group are *lapponicus*, *alexanderi*, new species, *reva* Knull, *beirnei*, new species, and *obesus* Knull. This group is characterized by a lateral expansion of the aedeagal shaft apex, giving it an oval appearance in the

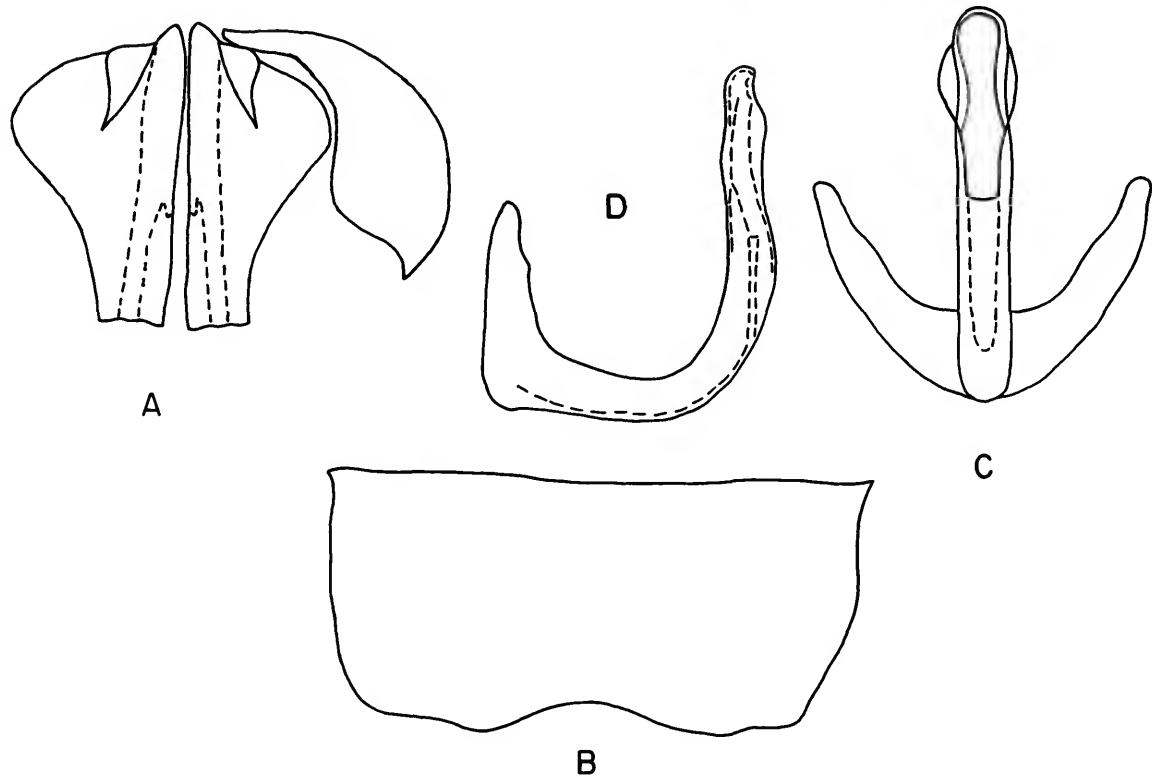


FIGURE 12.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix lividellus* (Zetterstedt): A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect, Lusk, Wyoming; D, same in lateral aspect.

caudodorsal aspect. Some specimens of *lividellus* show a tendency toward a similar expansion. A morphological gradation for this character can be demonstrated through the increasingly oval shaft apex of *lapponicus* (Ossiannilsson), *revaе* Knull, *alexanderi*, new species, to the almost round apex of *obesus* Knull. This gradation could not be clinal as the morphological changes do not parallel the geographic distribution of these species. The apparent geographic variation in *P. amplus* yields intraspecific aedeagal character differences as great as the interspecific character differences in the *lapponicus* group. Supporting characters such as relative length of wings in rest position, shape of posterior edge of female seventh abdominal sternum, and characters at the base of the first valvulae

confirm the specific status of the taxa in the *lapponicus* group.

Psammotettix lividellus (Zetterstedt) is closely related to *P. revaе*, based on characters of the first valvulae. This species has been reported as *P. striatus* (Linnaeus) by earlier North American workers. This is not the *striatus* of European workers. A lectotype for *P. striatus* (Linnaeus) has not yet been designated. The erroneous reporting of *lividellus* as *striatus* is confusing. It will not be possible to resolve the problem until a lectotype or neotype for *striatus* (Linnaeus) has been designated. Ribaut (1938) redescribed *striatus* (Linnaeus) but did not designate a type. If Ribaut's redescription of *striatus* (Linnaeus) is accepted, *lividellus* (Zetterstedt) is a separate and distinct species, and records

of Nearctic *striatus* are actually records of *lividellus* (Zetterstedt). The writer has not found a Nearctic specimen of *P. striatus* (Linnaeus) sensu Ribaut. Dr. W. J. Knight has examined the male type of "striata" in the Linnean Society collection and finds it to be *Aphrodes flavostriatus* (Donovan, 1799). He is not fully convinced that he has the true *Cicada striata* Linnaeus since it is difficult to imagine that past authors, even without dissection, could have considered his specimen even remotely similar to a species of *Psammotettix*.

***Psammotettix dentatus* Knull**

FIGURE 13

Psammotettix dentatus Knull, 1954, p. 55.

Length of male 3.4 to 3.6 mm, of female 3.5 to 3.8 mm; width of head, including eyes, of male 0.9 mm to 1.0 mm; of female 1.0 mm; crown with median length 1.2 to 1.4 length next to eye, with median longitudinal sulcus extending anteriorly 0.6 to 0.8 median length. Ground color of head, pronotum, scutellum, and wings cream, lightly to heavily marked with brown. Crown and pronotum with color as in *P. totalus* (DeLong and Davidson).

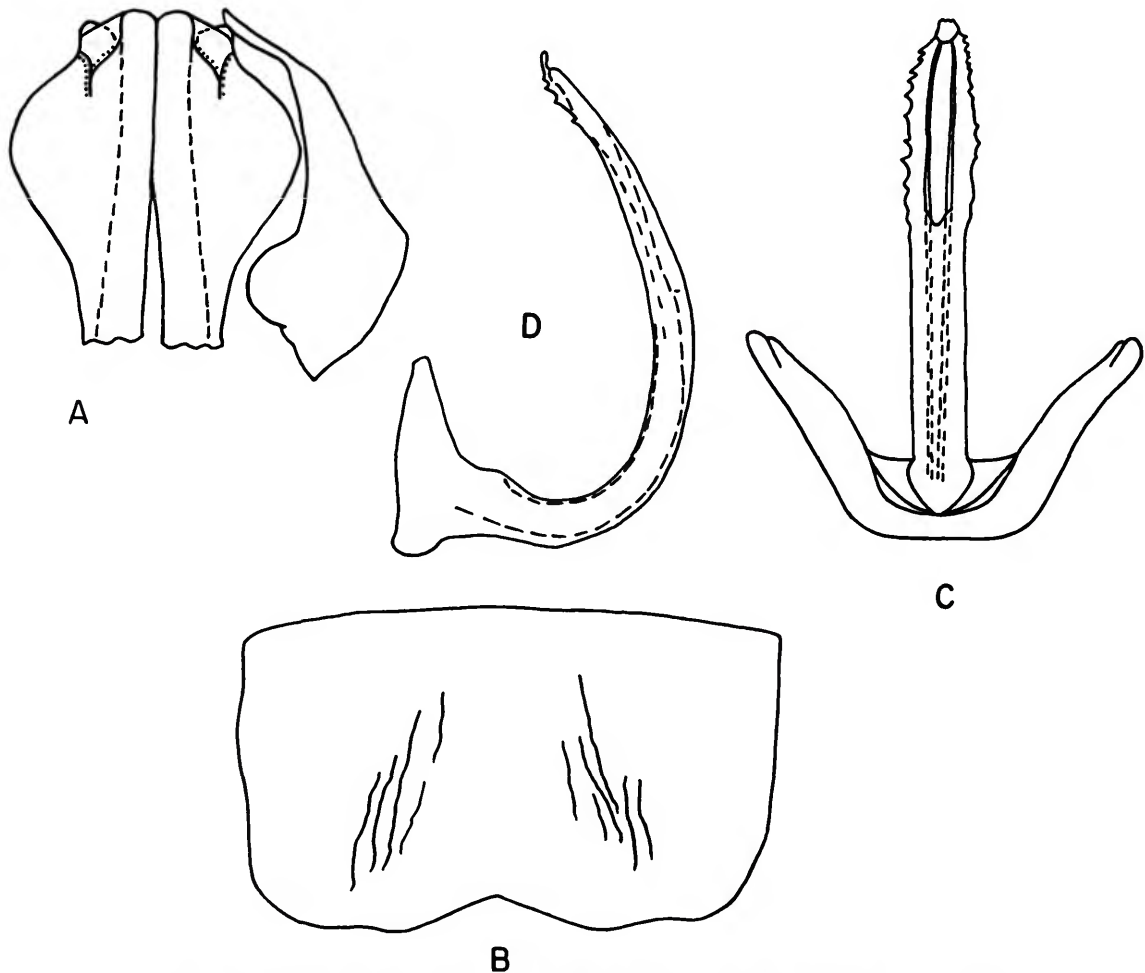


FIGURE 13.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix dentatus* Knull: A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

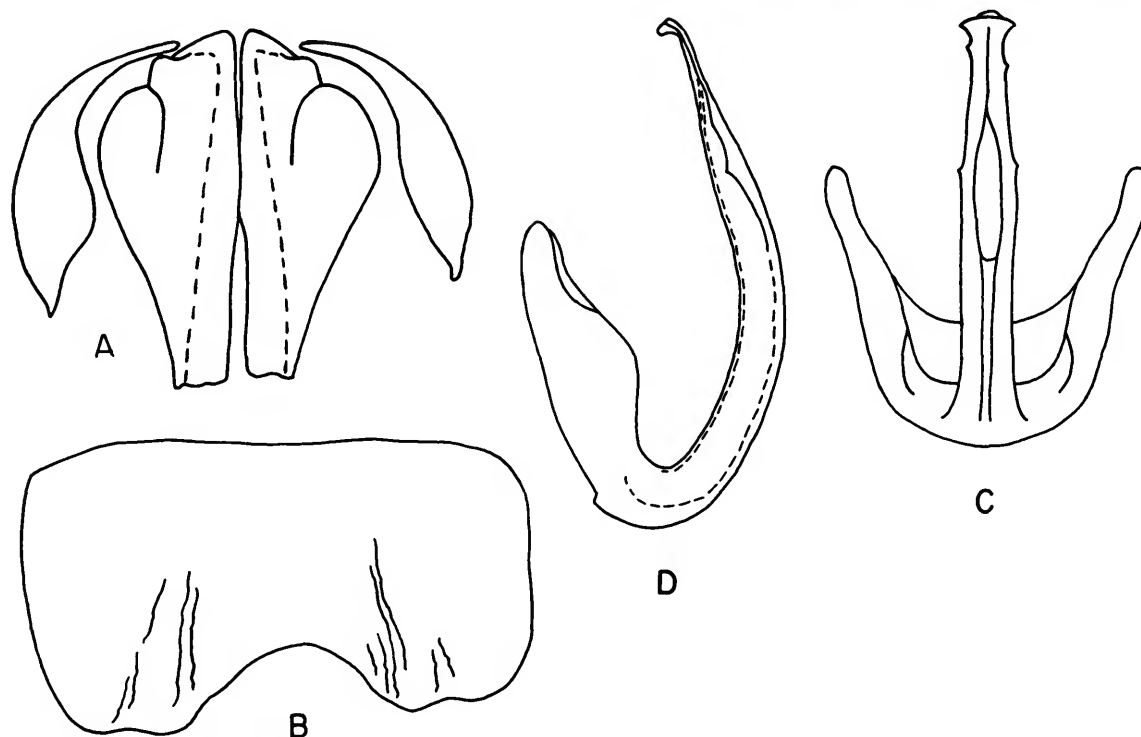


FIGURE 14.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix emarginatus*, new species: A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, aedeagus in lateral aspect.

Scutellum unmarked or with four spots behind pronotum, and with two spots behind transverse suture, brown. Fore wing veins unmarked to bordered with brown in all cells. Hind wing veins darkened distally or colorless.

Crown with area cephalad of ocelli triangular in shape in dorsal aspect, its apex sharp. Pronotum with round pits as in *P. totalis* (DeLong and Davidson). Scutellum with transverse suture crescentiform to straight. Macropterous form with wing length ratios as in *totalis*.

Aedeagus with shaft long, slender, changing from round in cross section at gonopore to flattened dorsoventrally at apex with decurved and serrated lateral flanges in caudodorsal aspect, with more than twelve dentations each side.

Female seventh abdominal sternum with posterior margin not produced, with median emargination as in *P. lividellus* (Zetterstedt), lateral emarginations

weak (Figure 13b); intersegmental membrane sclerotized with wrinkles visible through cleared female seventh sternum. First valvula with basidorsal median lobe well developed and sclerotized; with articulating lobe arising contiguous to the basidorsal median lobe in ventral aspect. Basidorsal median lobe extending farther cephalad than articulating lobe.

The male holotype, allotype, and paratypes are in the D. J. and J. W. Knull collection. The type locality and locality of allotype and paratypes is Quincy, California. The type habitat is not known. The distribution is northern California (Knull, 1954), Siskiyou National Forest, California, North Farmington, Utah, and British Columbia.

Psammotettix dentatus Knull appears to stand well apart from other species of *Psammotettix*. The shape of the crown in dorsal aspect is close to *P. amplus* (De Long and Davidson), *P. cahuillus* (Van

Duzee), *P. lapponicus* (Ossiannilsson), and *P. alexanderi*, new species. The long slender aedeagal shaft sets it apart from the other Nearctic species of *Psammotettix*. *Psammotettix lividellus* (Zetterstedt), *P. ferratus* (DeLong and Davidson), *P. knullae*, new species, *P. attenuens* (DeLong and Davidson), and *P. cahuillus* (Van Duzee) have slender aedeagal shafts, but they are not as long in comparison as that of *dentatus*. *Psammotettix alboniger* (Lethierry) (Linnavuori, 1953), a Palearctic species, has a long slender undulating aedeagal shaft which is comparatively longer than that of *dentatus*. The form of the aedeagal shaft of *alboniger* resembles the aedeagal shaft of the species of the genus *Laevicephalus*. *Psammotettix dentatus* is of the typical striata color. The relative positions of the median basidorsal lobe and the articulating lobe place this species close to *lividellus*, *revae*, *asper*, and *amplus*. *Psammotettix dentatus* is set apart from most other Nearctic species of *Psammotettix* by the darkening of some of the veins of the hind wing.

A specimen of this species was collected from celery at North Farmington, Utah.

Psammotettix emarginatus, new species

FIGURE 14

Length of male 3.00 to 3.40 mm, of female 2.95 to 3.40 mm, width of head, including eyes, of male 0.94 to 0.98 mm, of female 0.92 to 1.00 mm; crown with median sulcus extending anteriorly 0.61 to 0.79 median length. Color varying as in *P. totalus* (DeLong and Davidson).

Pronotum with round pits confined to area overlying anterior edge of scutum. Scutellum with transverse suture crescentiform to straight. Macropterous form with fore wings at rest exceeding abdominal apex, hind wings at rest shorter than abdomen, reaching distal end of inner apical cell of fore wings.

Aedeagus with shaft tubular at gonopore, dorsoventrally flattened distally, with less than six lateral dentations and with large lateral projection on each side at apex in caudodorsal aspect. Connective divided at point of articulation with aedeagus; stem one-half length of arms.

Female seventh abdominal sternum with posterior margin strongly emarginate, with median emargination extending one-third the distance from posterior margin to base (Figure 14b). Intersegmental

membrane lightly sclerotized, with wrinkles visible through cleared seventh sternum (Figure 14b). First valvula with median basidorsal lobe well developed, anteriorly resembling a hook that overlaps articulating lobe at base in ventral aspect (Figure 14a).

Holotype male, allotype, and paratypes, Klamath, Oregon, 1 July 1935 (Oman) in the National Museum of Natural History.

Psammotettix emarginatus, new species, is closely related to *P. excavatus* (Oman) and *P. shoshone* (DeLong and Davidson). The chief distinguishing character is the degree of emargination of the posterior margin of the female seventh abdominal sternum. The emargination of *emarginatus* extends about one-third, of *excavatus* about one-half, and of *shoshone* about two-thirds the distance from the hindmost point to the hindmost point of the sixth sternum. In the aedeagus, *excavatus* and *shoshone* are very close, but the difference in the posterior margin of the female seventh abdominal sternum is distinct. In the aedeagus, *excavatus* and *emarginatus* are clearly different, but there seems to be some overlap in characters at the posterior margin of the seventh abdominal sternum. Further study of this group is desirable.

Psammotettix shoshone (DeLong and Davidson)

FIGURE 15

Laevicephalus shoshone DeLong and Davidson, 1934, p. 222. *Psammotettix shoshone*.—Oman, 1947, p. 62.

Length of male 3.4 mm; width of head, including eyes, of male 0.92 to 0.96 mm, of female 1.0 mm; crown with median length 1.3 to 1.5 length next to eye, with median sulcus extending anteriorly 0.7 to 0.8 median length from pronotum to apex. Color varying as in *P. totalus* (DeLong and Davidson).

Pronotum with round pits as in *Psammotettix totalus* (DeLong and Davidson). Scutellum with transverse suture as in *totalus*. Macropterous form with fore wings barely exceeding apex of abdomen, hind wings at rest shorter than abdomen.

Aedeagus with shaft changing from tubular at gonopore to dorsoventrally flattened at apex; apex of shaft with lateral flanges bearing four dentations on each side, with greatest width of toothed region more than five times width of tip in caudodorsal aspect. Connective as in *Psammotettix emarginatus*, new species.

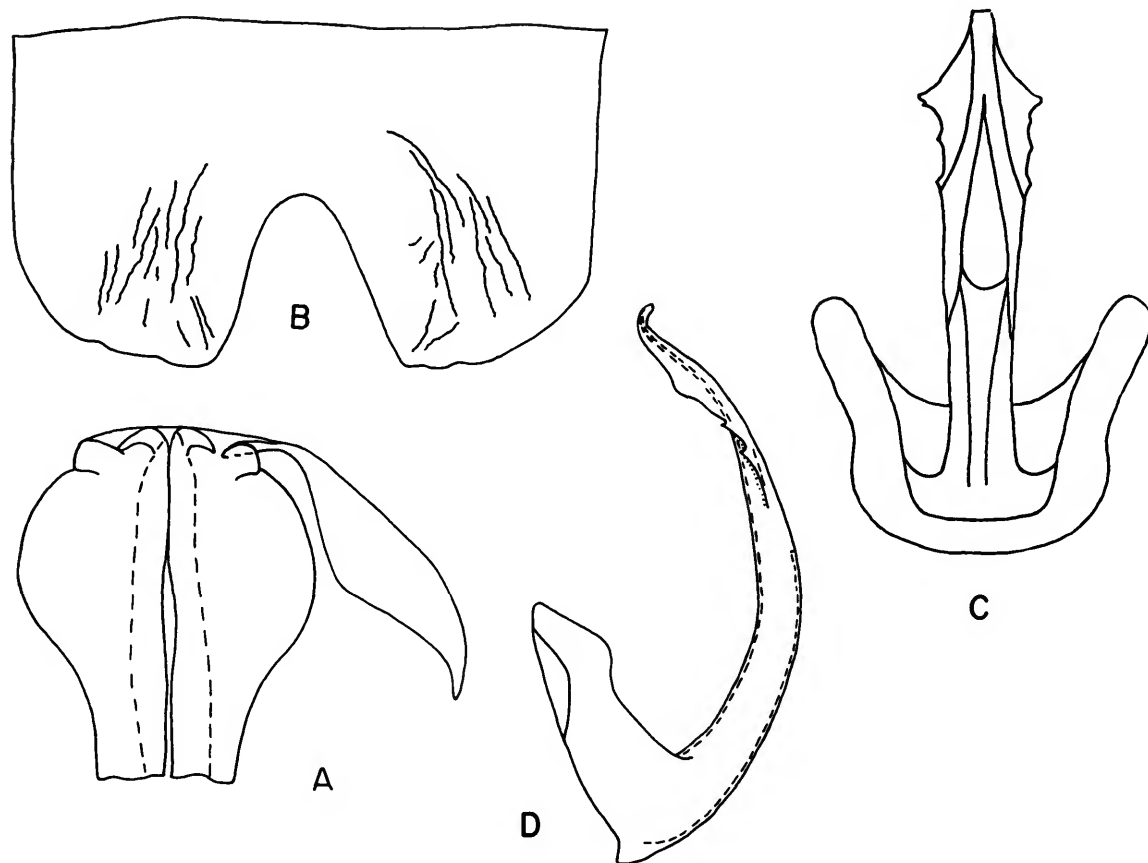


FIGURE 15.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix shoshone* (DeLong and Davidson): A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

Female seventh abdominal sternum with posterior margin strongly emarginate; with median emargination extending one-half the distance from posterior margin to base; extending two-thirds the distance from posterior margin to posterior margin of sixth abdominal sternum. Intersegmental membrane with wrinkles visible through cleared seventh sternum. First valvula with median basidorsal lobe well developed, with anterior hook ending at base of articulating lobe in ventral aspect (Figure 15A).

The female holotype and twelve female paratypes are in the DeLong collection. The type locality is Shoshone Basin, Idaho. The type habitat is grasses. The distribution is Shoshone Basin, Idaho, and Contact, Nevada.

Psammotettix shoshone (DeLong and Davidson) is close to *P. excavatus* (Oman). *Psammotettix shoshone* differs from *excavatus* in the relative width of the aedeagal apex in caudodorsal aspect; the greatest width of the toothed region being more than five times the width of the apex in *shoshone*, less than four times the width of the apex in *excavatus*. *Psammotettix shoshone* differs from *excavatus* in the relative distance the median emargination of the female seventh abdominal sternum extends from the posterior edge of the seventh abdominal sternum to the posterior edge of the sixth abdominal sternum, extending about two-thirds the distance in *shoshone*, about one-half the distance in *excavatus*.

Psammotettix excavatus (Oman), *P. shoshone* (DeLong and Davidson), and *P. emarginatus*, new species, are in a closely related group which is hereafter referred to as the *excavatus* group. The bifid stem of the connective in the *excavatus* group is present in some species of the *lapponicus* group.

Psammotettix excavatus (Oman)

FIGURE 16

Laevcephalus excavatus Oman, 1931, p. 430.

Psammotettix excavatus.—Oman, 1947, p. 62.

Length of female 3.05 to 3.20 mm; width of head including eyes 0.97 to 0.99 mm. Crown with median sulcus extending anteriorly 0.73 to 0.80 median length. Ground color of head, pronotum, scutellum, and fore wings light cream, unmarked or lightly marked with brown as in *P. totalis* (DeLong and Davidson). Hind wings transparent, veins colorless.

Pronotum with round pits confined to area above anterior edge of scutum. Scutellum with transverse suture nearly straight. Macropterous form with fore wings exceeding apex of abdomen, with length of hind wings at rest equal to or shorter than abdo-

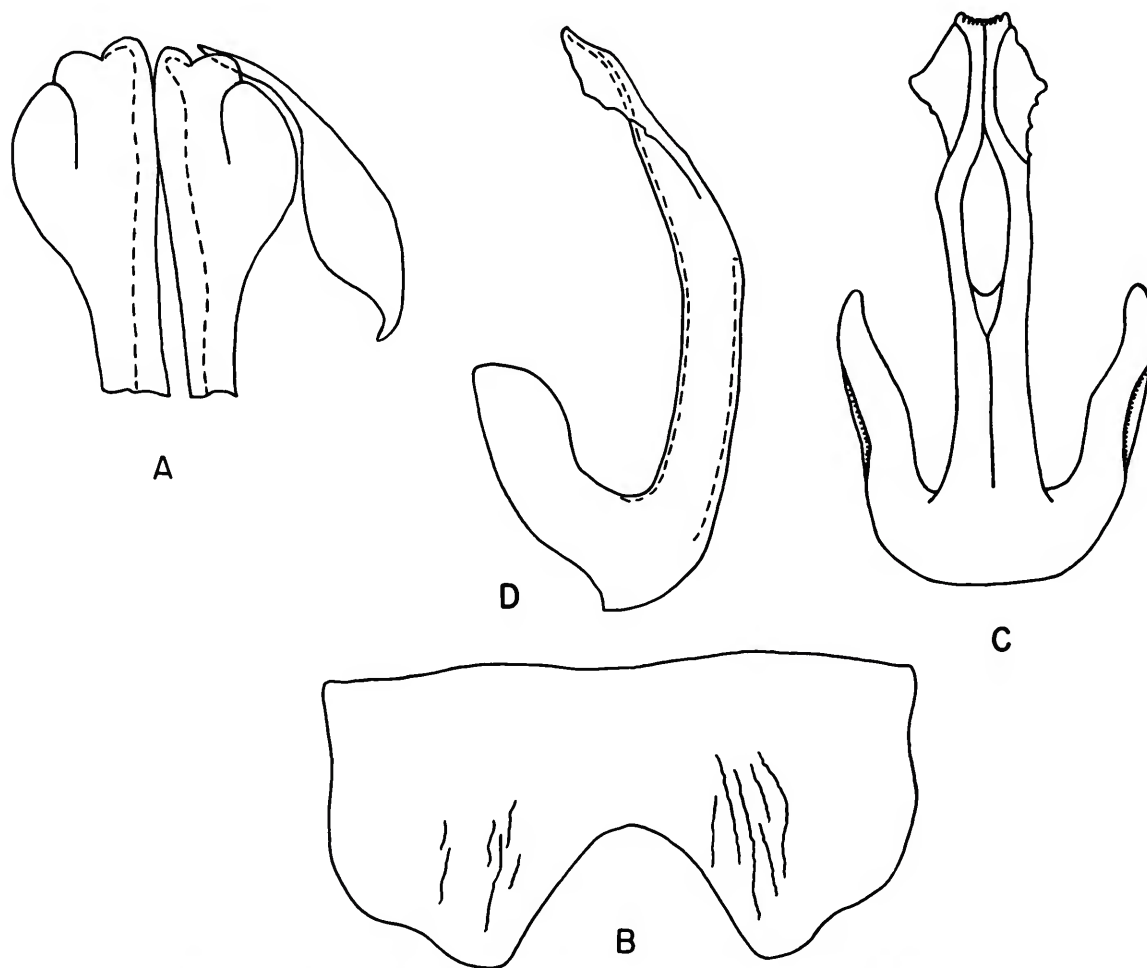


FIGURE 16.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix excavatus* (Oman): A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

men. Hind wings at rest extending only to mid-length or distal part of inner anteapical cell of fore wings.

Aedeagus with shaft flattened distally and toothed as in *Psammotettix emarginatus*, new species, with largest lateral lobe anteapical in caudodorsal aspect; with greatest width of toothed region less than four times width of apex in caudodorsal aspect (Figure 16c). Connective as in *emarginatus*.

Female seventh abdominal sternum strongly emarginate, with median emargination extending one-half distance from posterior margin to base (Figure 16b). Intersegmental membrane as in *P. emarginatus*, new species. First valvula with median basidorsal lobe well developed, anteriorly resembling a hook that terminates at base of articulating lobe in ventral aspect.

The type locality is Gazelle, California. Other specimens in type series from the type locality, Siskiyou, Oregon, and Lake Tahoe, California. The holotype is catalog number 43584 USNM. The type habitat is not known. The distribution is in the northwestern states (Oman, 1949).

This species is closely related to *P. emarginatus*, new species, and *P. shoshone* (DeLong and Davidson).

Psammotettix alienus (Dahlbom)

FIGURE 17

- Thamnotettix aliena* Dahlbom, 1850, p. 187.
Athysanus alienus.—Kirschbaum, 1858, p. 3.
Deltocephalus breviceps Sahlberg, 1871, p. 342.
Thamnotettix alicia.—(sic) Melichor, 1896.
Laeviocephalus latipex Beirne, 1954, p. 496.
Deltocephalus striatus.—var. *breviceps* Ossiannilsson, 1937, p. 133.
Psammotettix allienus.—(sic) Farsky, 1952, p. 75

Length of male 3.8 to 4.2 mm, of female 3.9 to 4.1 mm; width of head, including eyes, of both sexes 1.0 to 1.1 mm. Crown with median length 1.1 to 1.5 length next to eye, with median sulcus extending anteriorly from 0.7 to 0.8 median length. Color varying as in *P. totalis* (DeLong and Davidson). Scutellum with or without one median longitudinal brown stripe and two lateral orange stripes. Hind wing veins mostly colorless; some specimens with apical veins partially darkened.

Pronotum with median length 1.3 to 1.6 median length of crown, with round pits as in *P. totalis*.

Aedeagus with shaft tubular, expanding into a keeled flanged spoonlike apex distad of the gono-

pore, with apex of shaft distinctly emarginate in caudodorsal aspect, without lateral teeth or dentations (Figures 17c and f).

Female seventh abdominal sternum with posterior margin slightly produced or almost truncate (Figure 17b). Intersegmental membrane visible as wrinkles through cleared seventh sternum. First valvula (Figure 17a) with basidorsal median lobe absent or weakly developed; base of valvula with its complement concave in ventral aspect. Articulating lobe much farther cephalad than basidorsal median lobe if present.

The type locality is Gotland Island. The original description was based on external characters. The aedeagus of the holotype was illustrated by Ossiannilsson (1947). The distribution is Holarctic.

Psammotettix alienus (Dahlbom) is close to *P. striatus* (Linnaeus) sensu Ribaut. This relationship has been discussed in the introduction. This species appears to be the same as *P. provincialis* Ribaut, based on the shape of the aedeagus. Ribaut's (1938) illustration of the aedeagus of *alienus* differs from Ossiannilsson's (1947) illustration of the type of *alienus*. Figures 17c and f show some of the variation in the aedeagal base.

In the characters at the base of the first valvula this species is close to *P. confinis* (Dahlbom). The shape of the posterior edge of the female seventh abdominal sternum of *P. alienus* (Dahlbom) is close to *P. cahuillus* (Van Duzee).

Von Archimowitsch (1952) reports *P. alienus* (Dahlbom) as a vector of a virus disease of potato in Spain.

A male from Fort Yukon, Alaska, is stylized between the second and third abdominal segments. There are no apparent morphological changes in the genitalia as a result of this parasitism.

A female was collected from corn at Caldwell, Idaho.

Psammotettix confinis (Dahlbom)

FIGURE 18

- Deltocephalus confinis* Dahlbom, 1850, p. 193.
Jassus striatus.—Kirschbaum (not Linnaeus), 1868, p. 132.—Thomson, 1869, p. 70.
Deltocephalus heydeni Fieber, 1872, p. 3.
Deltocephalus thenii Edwards, 1915, p. 208.
Deltocephalus spathifer Ribaut, 1925, p. 19.
Deltocephalus striatus var. *thenii* Blöte, 1927, p. 57.
Ribautiellus thenii.—China, 1938, p. 195.

Psammotettix thenii.—Ribaut, 1938, p. 166.

Psammotettix spathifer Ribaut, 1938, p. 166.

Psammotettix confinis.—Ribaut, 1938, p. 166.

Psammotettix striatus.—Wagner (not Linnaeus), 1939, p. 162.

Ribautiellus confinis.—Roche, 1944, p. 84.

Deltocephalus harrimani Beirne, 1954, p. 495.

Length of male 3.2 to 3.8 mm, of female 3.5 to 3.6

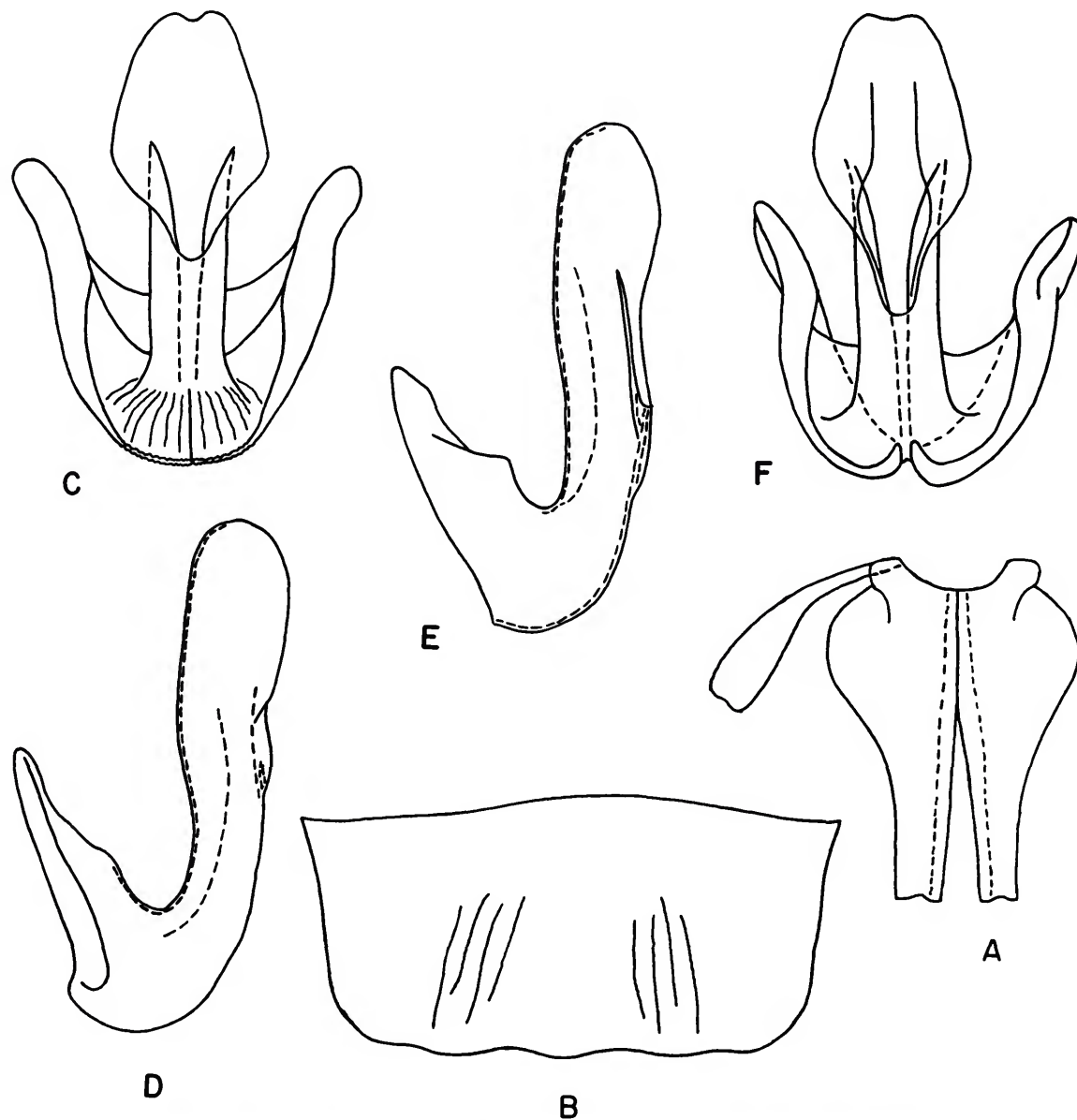


FIGURE 17.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix alienus* (Dahlbom): A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect, Pingre Park, Colorado; D, same in lateral aspect; E, aedeagus in lateral aspect, Sigurd, Utah; F, same in caudodorsal aspect.

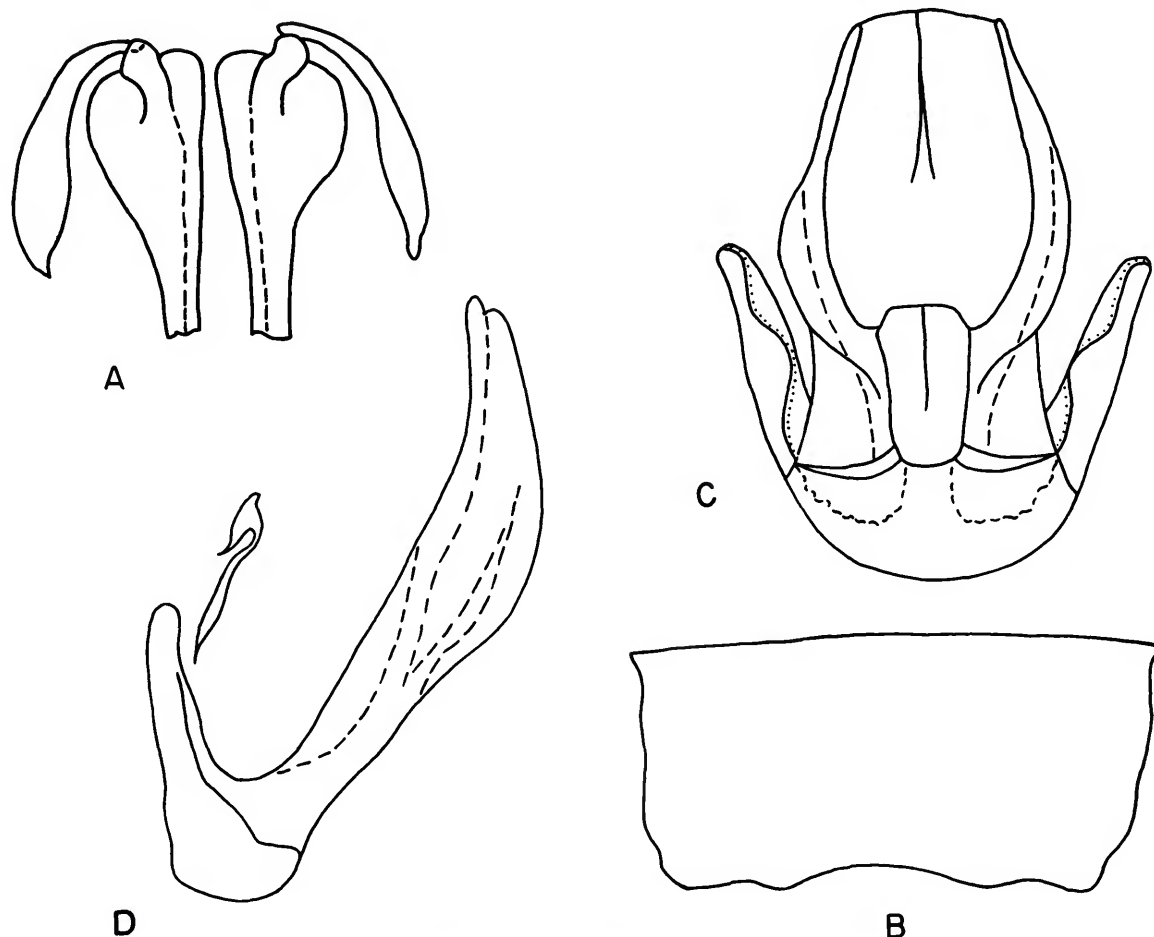


FIGURE 18.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix confinis* (Dahlbom): A, first valvulae and first valvifers in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

mm; width of head, including eyes, of male 9.9 to 1.0 mm, of female 0.96 to 1.0 mm. Crown with median length 1.2 to 1.4 length next to eye; with median sulcus extending anteriorly 0.7 to 0.9 median length. Color varying as in *P. alienus* (Dahlbom). Hind wings transparent, veins colorless.

Pronotum with median length 1.14 to 1.41 times length of crown; with round pits as in *P. totalus* (DeLong and Davidson). Scutellum with crescentiform transverse suture. Macropterous form with wings as in *totalus*.

Aedeagus with shaft expanded into a flat-bot-

tomized scooplake apex distad of gonopore, sides of apex joining bottom at approximately a right angle, apex truncate in caudodorsal aspect, greatest width two-thirds greatest distance between dorsal apodemes in caudodorsal aspect (Figure 18c).

Female seventh abdominal sternum with posterior margin broadly and shallowly emarginate, median emargination broader than the two lateral emarginations combined (Figure 18b). First valvula (Figure 18a) with basidorsal median lobe developed into thin vertical plates that do not extend as far cephalad as the articulating lobe; base of valvula

with its complement appearing concave in ventral aspect, with articulating lobe arising laterad of median basidorsal lobe, the two appearing contiguous in ventral aspect (Figure 18A).

The holotype was not designated in the original description which was based on external characters. Ossiannilsson (1937) listed the type as a male and illustrated the aedeagus of the "type." The type locality is Carices I Rohne, Sweden. The distribution is Holarctic.

Psammotettix confinis (Dahlbom) is close to *P. nodosus* (Ribaut) in the form of the aedeagus. It belongs to the *striatus* complex. In external characters it is close to *P. alienus* (Dahlbom), *P. totalus* (DeLong and Davidson), and *P. attenuens* (DeLong and Davidson) in the Nearctic region. The shape of the posterior edge of the female seventh abdominal sternum of *confinis* is close to *P. alexanderi*, new species.

Remane (1965) described *Psammotettix viridiconfinis* Remane. The aedeagus of the Nearctic *P. confinis* (Dahlbom) (Figure 18c) differs from Remane's illustration of *confinis* as much as does *viridiconfinis*. Further study may warrant recognizing specific or subspecific standing in the Nearctic form. *Psammotettix harrimani* (Ashmead) would be the type of this new taxon if Beirne's (1954) interpretation of the type were confirmed.

Kontkanen (1950) reports dryinid and pipunculid parasites attacking this species in Finland.

Moravskaja (1956) reports this species as being polyphagous. It is found on grasses and herbaceous plants of the Compositae, Juncaceae, and Cyperaceae.

Psammotettix obesus Knull

FIGURE 19

Psammotettix obesus Knull, 1954, p. 57.

Length of male 2.9 to 3.3 mm, of female 3.0 to 3.6 mm; width of head, including eyes, of male 0.9 to 1.0 mm, of female 1.0 to 1.1 mm. Crown with median length 1.1 to 1.4 length next to eye, with median sulcus extending anteriorly from 0.6 to 0.9 median length. Color varying as in *P. totalus* (DeLong and Davidson). Scutellum marked with median stripe, or with two spots at posterior edge of pronotum and two lateral stripes, brown.

Pronotum with round pits as in *P. totalus* (De-

Long and Davidson). Scutellum with transverse suture that is almost straight medially with lateral ends angled anteriorly. Macropterous form with fore wings reaching or exceeding abdominal apex, with hind wings shorter than, equal to, or longer than abdomen, reaching distal end of first apical cell of fore wings at rest position.

Aedeagus with shaft tubular throughout length to gonopore; apex of shaft expanded with lateral flanges in caudodorsal aspect (Figure 19b). Median longitudinal distance from gonopore to apex less than or equal to greatest width of apex of shaft in caudodorsal aspect. Apex of shaft almost round in caudodorsal aspect.

Female seventh abdominal sternum slightly produced posteriorly, with a shallow median emargination (Figure 19b). First valvula with basidorsal median lobe well developed and sclerotized, not extending as far cephalad as the articulating lobe, which is strongly folded laterad, its form resembling an interrogation point, its mesal border not well defined in ventral aspect (Figure 19a).

The holotype, allotype, and two male paratypes are in the Knull collection at the Ohio State University. The type series is from Grand Teton National Park and San Francisco Mountains, Arizona. The allotype and two male paratypes are from the type locality.

Psammotettix obesus Knull is one of the shorter species of *Psammotettix*. Its front wings at rest reach or slightly exceed the apex of the abdomen. The short wings of *P. obesus* Knull are like those of *P. alexanderi*, new species, *P. cahuillus* (Van Duzee), *P. lapponicus* (Ossiannilsson), and *P. beirnei*, new species, in the Nearctic region. The shape of the aedeagus of *obesus* is close to *beirnei*. The shape of the seventh abdominal sternum and the characters at the base of the first valvula of the female are close to *P. amplus* (DeLong and Davidson). A specimen from Yellowstone Park, Fry Pan Lake, appears to be intermediate between *obesus* and *beirnei*, the aedeagus resembling *beirnei* in lateral aspect but resembling *obesus* in caudodorsal aspect.

Psammotettix beirnei, new species

FIGURE 20

Psammotettix cephalotes.—Beirne, 1956, p. 103.

Psammotettix obesus.—Beirne (not Knull), 1956, p. 103.

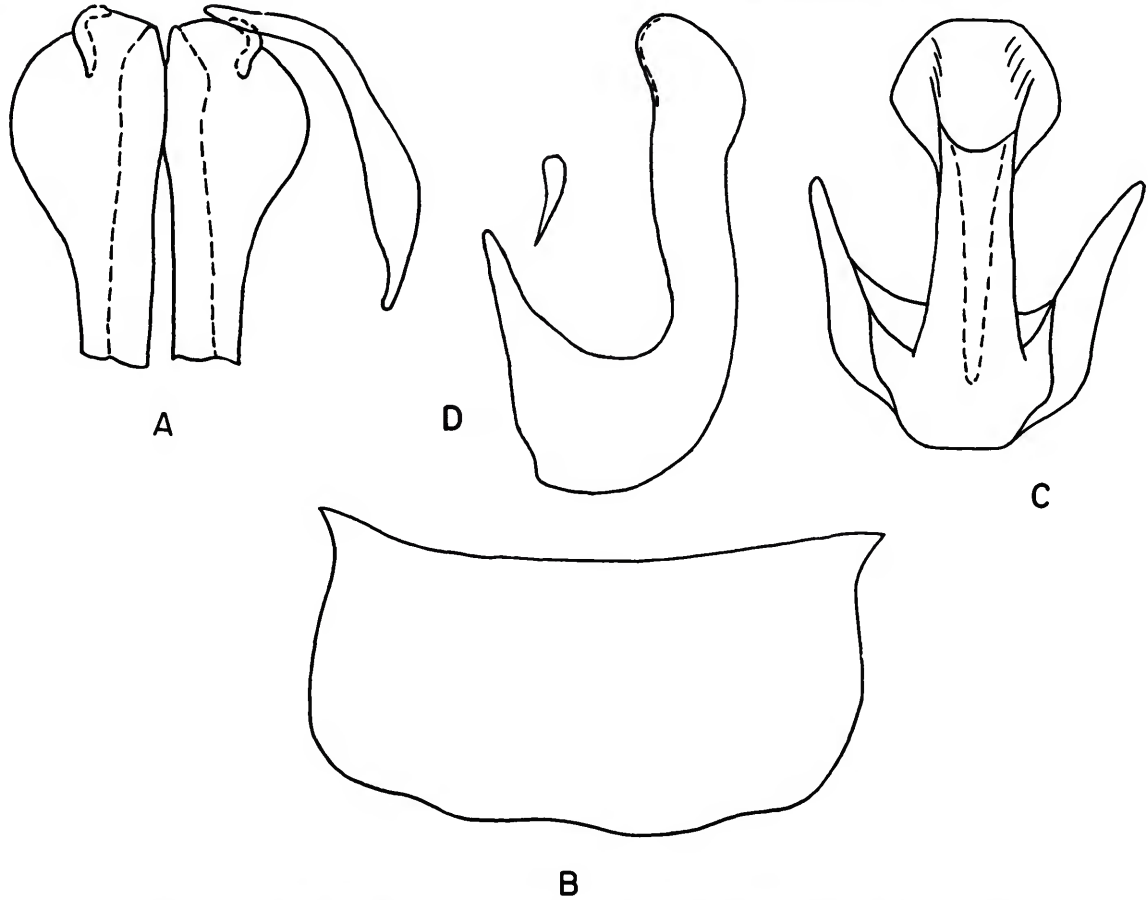


FIGURE 19.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix obesus* Knull: A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

Length of male 2.80 to 3.10 mm, of female 3.24 mm, width of head, including eyes, of male 0.93 to 1.00 mm. Crown with median length 1.20 to 1.41 length next to eye, with median sulcus extending anteriorly from 0.64 to 0.73 median length. Ground color of head, pronotum, wings, and scutellum varying from light cream to cinereous. Crown and pronotum marked with brown as in *P. totalus* (DeLong and Davidson). Almost all cells of front wings marked with some brown. Hind wings transparent, some veins darkened. Scutellum with two anterior median spots partly overlaid by pronotum and triangular spot behind transverse suture, brown. Abdomen with all terga black, often with transverse creamy band on posterior edge of each segment.

Pronotum with round pits as in *P. totalus* (DeLong and Davidson). Scutellum with transverse suture undulate. Macropterous form with fore wings at rest exceeding apex of abdomen. Hind wings at rest shorter than abdomen, not reaching distal end of central anteapical cell of fore wings.

Aedeagus similar to that of *P. alexanderi*, new species, differing as discussed above. Median longitudinal distance from gonopore to apex greater than greatest width of apex of shaft in caudodorsal aspect. Apex appearing elongate in caudodorsal aspect. Posterior end of connective strongly sclerotized and bifid at articulation with aedeagus (Figure 20c).

Female seventh abdominal sternum relatively

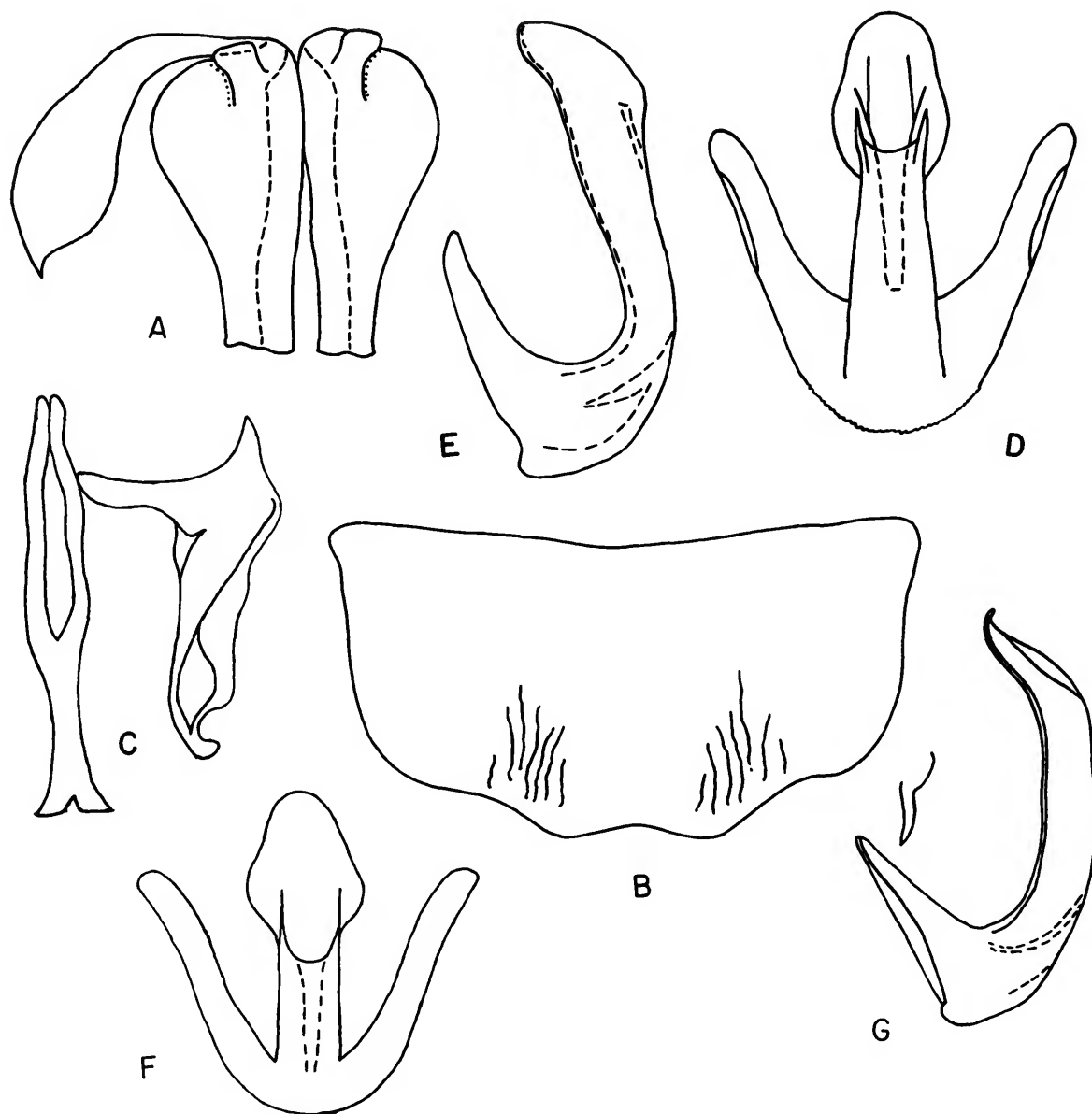


FIGURE 20.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix beirnei*, new species, and aedeagus of *P. cephalotes* (Herrich-Schaeffer): A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, connective and style in dorsal aspect; D, aedeagus of *P. beirnei*, new species, in caudodorsal aspect; E, same in lateral aspect; F, aedeagus of *P. cephalotes* (Herrich-Schaeffer) in caudodorsal aspect; G, same in lateral aspect.

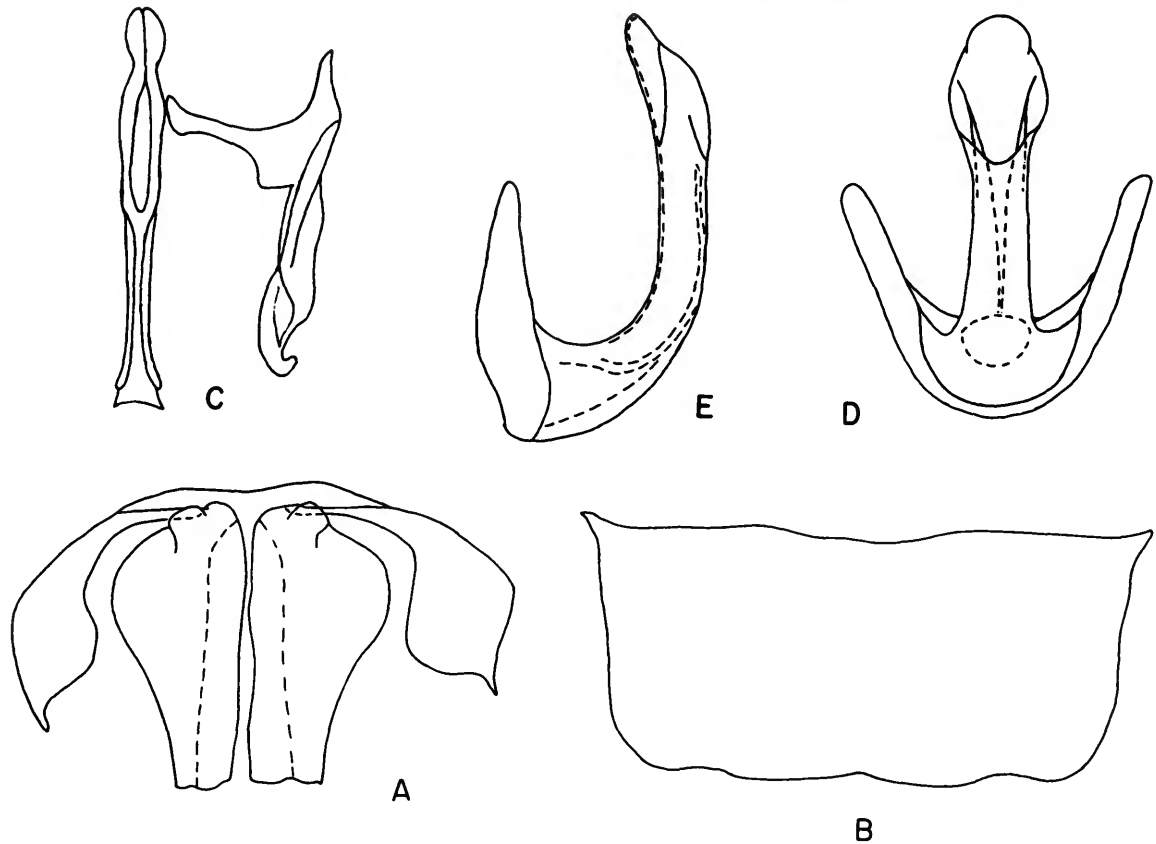


FIGURE 21.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix alexanderi*, new species: A, first valvulae and first valvifers in ventral aspect; B, seventh sternum in ventral aspect; C, connective and style in dorsal aspect; D, aedeagus in caudodorsal aspect; E, same in lateral aspect.

strongly produced posteriorly with shallow concave median emargination (Figure 20b). First valvula with basidorsal median lobe well developed and sclerotized, not extending as far cephalad as the articulating lobe, which is well defined mesally and laterally, appearing to arise and diverge from median basidorsal lobe (Figure 20a).

Holotype male and allotype from First Summit Mt. Harry, N.W.T., 7600' 20 August 1952 (G. J. Spencer) in Canadian National collection.

Psammotettix beirnei is named in honor of B. P. Beirne. It was determined as *P. cephalotes* (Herrich-Schaeffer) by Beirne (1956). This species differs from specimens of *P. cephalotes*, from Germany, in color, body form, and shape of aedeagus. The Eu-

ropean specimens are elongate with both fore and hind wings exceeding the apex of abdomen when at rest position; the Canadian specimens are short with fore wings exceeding the apex of abdomen and hind wings shorter than abdomen when at rest position. The European specimens are a uniform creamy ivory color with few markings; the Canadian specimens vary from a ground color of creamy to cinereous heavily marked with brown. There is a definite difference in size and in the lateral profile of the aedeagus between the European and Canadian specimens (Figures 2c, e, and c). The stem of the connective is bifid posteriorly in the Canadian specimens, not bifid in the European specimens. The published illustrations of the aedeagus

of *P. cephalotes* (Herrich-Schaeffer) differ from the Canadian specimens, and in a personal communication Dr. R. Remane, Marburg, Germany, expressed the opinion that these were two different species. In view of the above differences the Canadian form is being treated as a new species.

Psammotettix beirnei, new species, is closely related to the lapponicus group, possessing the characteristic elliptically expanded or flanged aedeagal shaft apex. This species is very closely related to *P. alexanderi*, new species, as has been previously discussed.

The shape of the posterior edge of the female seventh abdominal sternum of *P. beirnei* is close to *P. attenuens* (DeLong and Davidson). The wing lengths of *P. beirnei*, new species, are close to those of *P. alexanderi*, new species, *P. obesus* Knull, *P. lapponicus* (Ossiannilsson), *P. excavatus* (Oman), *P. shoshone* (DeLong and Davidson), and *P. cahuillus* (Van Duzee). In the characters at the base of the first valvula, *P. beirnei*, new species, is close to *P. amplus* (DeLong and Davidson), *P. lapponicus* (Ossiannilsson), and *P. alexanderi*, new species. In its darkened veins in the hind wing, this species is closely related to *P. lapponicus* (Ossiannilsson) and *P. dentatus* Knull.

Psammotettix alexanderi, new species

FIGURE 21

Length of male 2.6 to 2.84 mm, of female 2.85 to 3.25 mm; width of head, including eyes, of male 0.93 to 0.95 mm, of female 1.00 to 1.08 mm. Crown with median length 1.23 to 1.50 length next to eye, with median sulcus extending anteriorly from 0.56 to 0.65 median length.

Color of crown and pronotum varying as in *P. totalis* (DeLong and Davidson). Ground color of crown, pronotum, scutellum, wings, and abdomen as in *totalis*. Wings unmarked or with apical cells very lightly marked with brown. Scutellum unmarked. All abdominal terga heavily marked with black medially except eighth.

Pronotum with round pits as in *P. totalis* (DeLong and Davidson). Scutellum with transverse suture straight. Males macropterous with fore wings exceeding apex of abdomen, hind wings at rest shorter than abdomen, not exceeding tip of brachial cell of fore wings. Females subbrachypterous with

front wings at rest not attaining apex of abdomen, hind wings as in male.

Aedeagus with shaft tubular throughout length to gonopore; apex of shaft expanded into lateral flanges in caudodorsal aspect (Figure 21d). Greatest width of tip in caudodorsal aspect five-eighths or more the longitudinal distance from gonopore opening to tip (Figures 21b and e). Some specimens with tubercles ventrad of flanges. Connective weakly concave in ventral aspect at articulation with aedeagus.

Female seventh abdominal sternum almost truncate apically, with weak median and two lateral emarginations of approximately equal size (Figure 21b). First valvula with median basidorsal lobe and articulating lobe as in *P. obesus* Knull; the articulating lobe not as strongly folded laterad as in *obesus* and with its mesal border distinct cephalad.

Holotype male, White Mts., New Hampshire, U.S.A., 23 August 1935 (C. P. Alexander); allotype, Kings Ravine, White Mts., New Hampshire, U.S.A., 26 August 1935 (C. P. Alexander). These and eighteen paratypes are in the National Museum of Natural History.

This species is named in honor of the collector, C. P. Alexander. *Psammotettix alexanderi*, new species, is close to other members of the previously mentioned lapponicus group. The male is very close, in external characters, to *P. beirnei*, new species. The female can usually be distinguished from *beirnei*, new species, and *Psammotettix lapponicus* (Ossiannilsson) by the subbrachypterous wings.

The aedeagus of the male is very similar to the aedeagus of *P. beirnei*, new species. The tip of the aedeagal shaft of *P. cephalotes* (Herrich-Schaeffer) is curved anteriorly at an angle to the axis of the shaft in lateral aspect. The tip of the aedeagal shaft of *P. alexanderi*, new species, is not curved at any appreciable angle to the axis of the shaft in lateral aspect. The connective of *P. alexanderi* is not bifid at articulation with aedeagus as is that of *P. beirnei*. Based on the posterior edge of the female seventh abdominal sternum, *P. alexanderi* is closely related to *P. lapponicus* (Ossiannilsson).

Psammotettix lapponicus (Ossiannilsson)

FIGURE 22

Deltocephalus lapponicus Ossiannilsson, 1938, p. 6.
Psammotettix lapponicus.—Ribaut, 1938, p. 166.

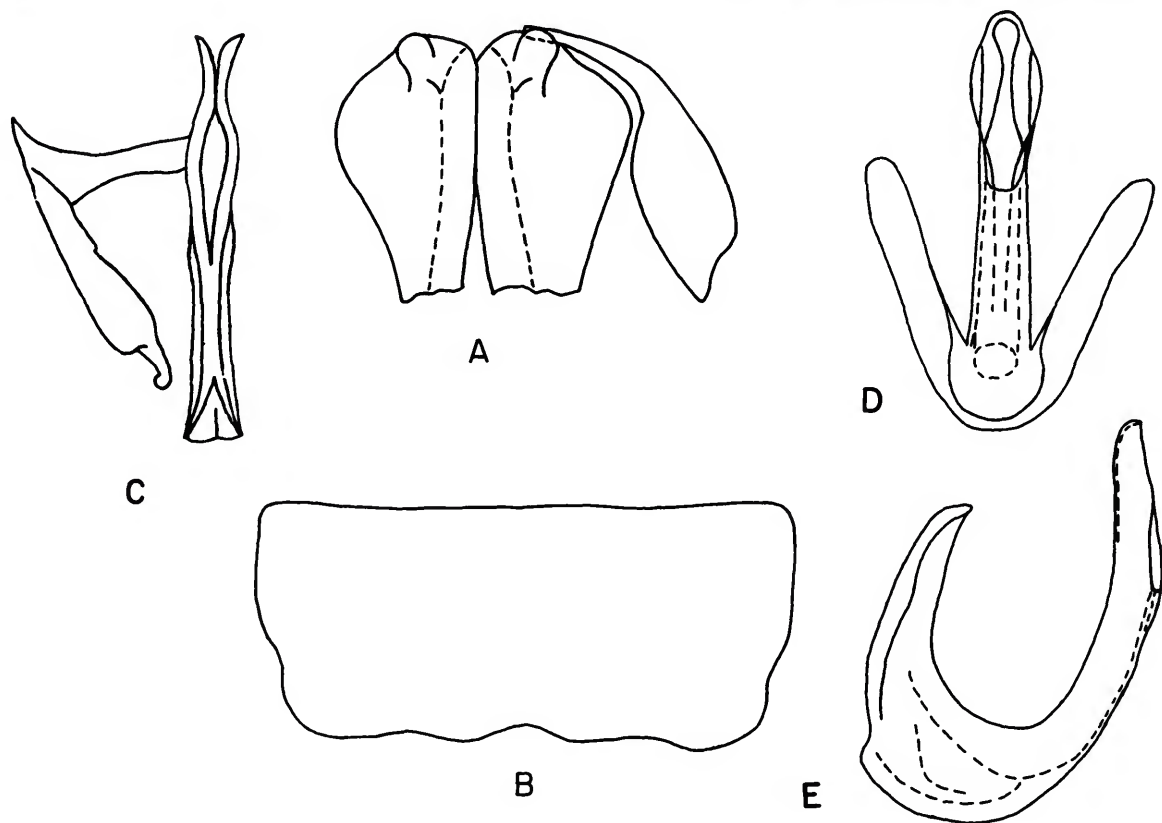


FIGURE 22.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix lapponicus* (Ossiannilsson): A, first valvulae and first valvifers in ventral aspect; B, seventh sternum in ventral aspect; C, connective and style in dorsal aspect; D, aedeagus in caudodorsal aspect; E, same in lateral aspect.

Length of male 2.5 to 2.8 mm, of female 2.7 mm; width of head, including eyes, of male 0.90 to 0.92 mm, of female 0.97 mm. Crown with median length 1.31 to 1.44 length next to eye, with median sulcus extending anteriorly from 0.64 to 0.73 median length. Ground color of head, pronotum, and scutellum cream. Crown with upper horizontal stripes of front visible from above, with two anterior stripes paralleling stripes of front, with two broad lateral longitudinal stripes and two spots anterior to eyes, brown. Pronotum with six longitudinal brown stripes. Scutellum marked as in *P. beirnei*, new species. Wings transparent, almost all cells marked with some brown. Abdomen with all terga black. Hind wings transparent, some veins darkened.

Pronotum with round pits as in *Psammotettix*

totalus (DeLong and Davidson). Scutellum with transverse suture crescentiform to straight. Macrop-terous form with wings as in *P. beirnei*, new species.

Aedeagal shaft with apex in the form of a very elongate ellipse, length from gonopore to apex 2.6 times the greatest width in caudodorsal aspect (Figure 22d). Posterior end of connective truncate, not strongly bifid at articulation with aedeagus.

Female seventh abdominal sternum not produced posteriorly, with median and two lateral emarginations of about equal size. First valvula with base as in *Psammotettix beirnei*, new species.

The holotype is in the Ossiannilsson collection. The type locality is Arvidjous, Sweden. The distribution is Sweden (Ossiannilsson, 1938), and Chesterfield, Northwest Territories (Beirne, 1954).

The specimens from the Northwest Territories (Figure 22b) have an aedeagal shaft with an apex that is more elongate and slender than is the apex of a paratype from the type locality. In lateral aspect the Northwest Territory specimens are closer to Ossiannilsson's illustration of the type than to the paratype. These specimens are similar to the paratype in external characters.

Psammotettix revae Knull

FIGURE 23

Psammotettix revae Knull, 1954, p. 57.

Length of male 2.90 mm, of female 3.20 mm; width of head, including eyes, of male 0.99 mm, of female 0.98 mm. Crown with median length 1.21 to 1.28 length next to eye, with median sulcus extending anteriorly from 0.69 to 0.73 median length. Ground color of head, pronotum, and scutellum light cream.

Crown with two apical triangles, and markings around each ocellus brown, the usual striate markings missing or very faint on other areas. Wings creamy subhyaline, very sparsely and faintly marked with brown. Hind wings transparent; veins not darkened.

Pronotum with round pits as in *P. totalis* (DeLong and Davidson). Scutellum with transverse suture straight. Macropterous form with fore wings exceeding apex of abdomen. Hind wings at rest extending only to midlength of apical cells of front wings.

Aedeagus with apex in the form of an ellipse; length from gonopore to apex 1.88 times greatest width in the caudodorsal aspect (Figure 23c, d). Posterior end of connective bifid at articulation with aedeagus, as in *Psammotettix beirnei*, new species.

Female seventh abdominal sternum with posterior margin as in *P. lividellus* (Zetterstedt), with median

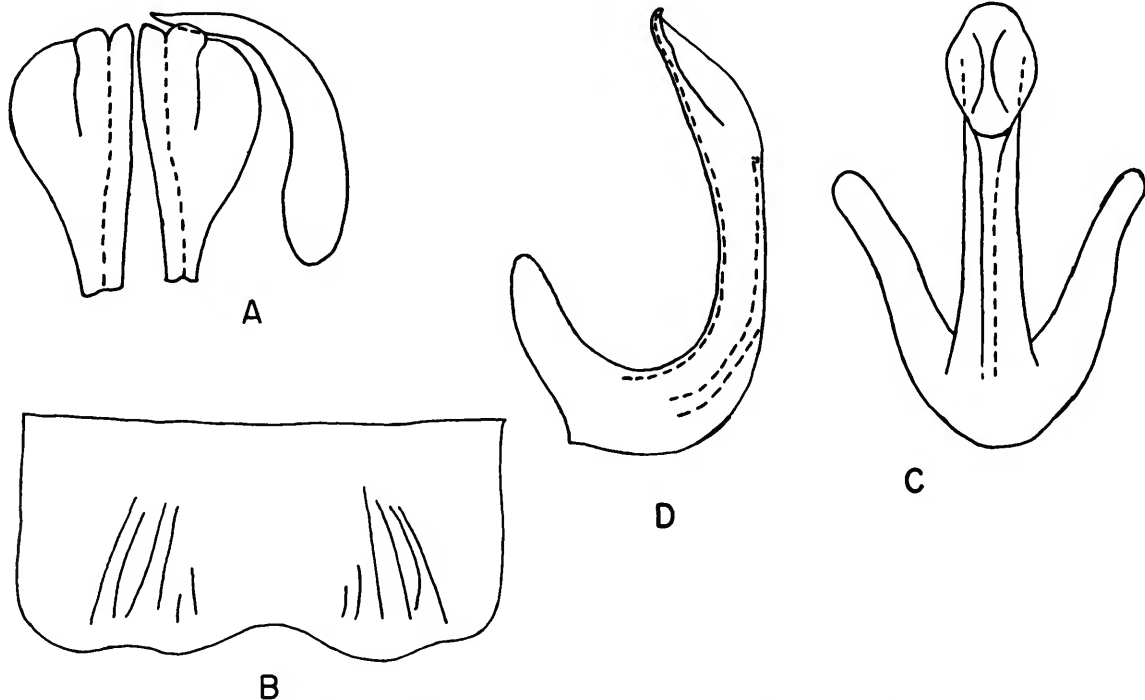


FIGURE 23.—Male and female genitalia and female seventh abdominal sternum of *Psammotettix revae* Knull: A, first valvulae and first valvifer in ventral aspect; B, seventh sternum in ventral aspect; C, aedeagus in caudodorsal aspect; D, same in lateral aspect.

emargination flanked by two smaller lateral emarginations (Figure 23B). First valvula with basidorsal median lobe well developed and sclerotized, extending about equally as far cephalad as the articulating lobe which appears to be contiguous with the basidorsal median lobe (Figure 23A).

The type series from Reva Alkali Flats, Reva, Springfield, and Buffalo, South Dakota, are in the Knull collection, Ohio State University.

Psammotettix revae Knull is very close to *P. cephalotes* (Herrich-Schaeffer), the chief distinguishing character being the notched or bifid posterior end of the connective in *revae* which is unnotched in *cephalotes*. *Psammotettix revae* appears to be closer to *cephalotes* (Herrich-Schaeffer) than *beirnei*, new species. This form is possibly a subspecies of *cephalotes* (Herrich-Schaeffer).

Psammotettix revae is a member of the lapponicus group. Based on the posterior edge of the female seventh abdominal segment and on characters at the base of the first valvula, it is close to *P. lividellus* (Zetterstedt) and *lapponicus* (Ossiannilsson). Based on wing lengths this species is close to *P. knullae*.

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Use the *metric system* instead of (or in addition to) the English system.

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In the *bibliography* (usually called "Literature Cited"), spell out book, journal, and article titles, using initial caps with all words except minor terms such as "and, of, the." (For capitalization of titles in foreign languages, follow the national practice of each language.) Under-score (for italics) book and journal titles. Use the colon-parentheses system for volume number and page citations: "10(2):5-9." Spell out such words as "figures," "plates," "pages."

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