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KANSAS STATE COLLEGE OF AGRICULTURE
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IDENTIFICATION OF THE EGGS OF MID-WESTERN GRASSHOPPERS



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FOREWORD

This report records work done on Project No. 115 of the Kansas Agricultural Experiment Station. The first work of this nature to come to the writers' attention was a thesis for the master's degree at the South Dakota State College of Agriculture and Mechanic Arts, prepared by Raymond Bushland in 1934, at the suggestion of Dr. H. C. Severin and under his direction. Mr. Bushland continued this work at the Kansas State College of Agriculture and Applied Science during the school year of 1934-1935, but was unable to finish the work. It was undertaken by the senior author in the fall of 1938 and completed as a master's degree thesis in June, 1939.

This report was prepared from the senior author's thesis. Dr. H. C. Severin has identified all the grasshoppers discussed in this report.

Acknowledgment is made to Doctor Severin for his original contribution through Mr. Bushland's work and for the identifications; to R. C. Bushland, Menard, Texas, for permission to use his unpublished manuscript, his prepared slides and preserved material; to Dr. J. R. Parker for supplying a number of eggs of known species not available in Kansas for study; to the Kansas Academy of Science for a research award of \$25 which was used to pay for practically all of the negatives of illustrations; to Floyd J. Hanna for the microphotographs; and to various members of the staffs of the Departments of Zoology and Entomology for eggs and for suggestions.

IDENTIFICATION OF THE EGGS OF MID-WESTERN GRASSHOPPERS BY THE CHORIONIC SCULPTURING¹

By J. B. Tuck² and Roger C. Smith³

INTRODUCTION

The identification of grasshopper eggs during the fall surveys has been based in the past on comparative size, color, pods, characteristic time and place of oviposition, and consequently has been somewhat indefinite. The need for a method by which the classification of grasshopper eggs could be definitely and accurately determined has been apparent for a number of years. This bulletin records brief diagnostic descriptions of the external features, especially chorionic sculpturing, of 48 species of grasshoppers from Kansas and the Great Plains, a microphotograph of the egg of many of the species and a key for their identification.

Uvarov (1928) apparently was the first to suggest that the eggs of grasshoppers might be identified on the basis of the chorionic sculpturing. He pointed out that the reticulations of the eggs of many of the Locustidae (Acrididae) might be of systematic importance.

The first attempt to identify eggs on the basis of the chorionic sculpturing was made by Bushland (1934). He described the eggs of 18 South Dakota grasshoppers and constructed a key for their differentiation. He emphasized the variations, particularly in the sculpturing, of the cap and made photographs which included little of the sculpturing of the body or central portion of the egg. In Bushland's key, however, he used the sculpturing on the body of the egg as well as on the cap for purposes of differentiation.

Ratanov (1935) described the egg pods, but not the individual eggs of 55 species of Siberian grasshoppers. Though he considered the color, shape, and sculpturing of the eggs to some extent, he was primarily interested in the pods. His work did not include a key for differentiating the pods as to species of grasshoppers.

Materials and Methods

Eggs were obtained in four ways for this study: (1) From observed ovipositions in the field; (2) by collecting at random and then rearing adults from a portion of the eggs; (3) by dissection of eggs from dried and preserved females in collections; and (4) by

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confining gravid females in jars. The third method mentioned, which is original, was developed during the course of this investigation. The eggs were removed from pinned insects in the museum by making a median longitudinal incision along the abdominal sternites and lifting the eggs out with fine forceps and dissecting needles. It was necessary to soften dried specimens, which was accomplished by boiling the insect for from 15 to 20 minutes in a solution of 200 c.c. water, 15 c.c. glycerine and 5 c.c. of glacial acetic acid. Softening of the internal structures was hastened if the incision was made as soon as the exoskeleton became pliable enough to permit cutting.

Confining gravid females in jars for oviposition was, however, the chief source of eggs used in this study. Individual females were placed in ordinary pint fruit jars containing about two inches of moist, firmly packed sand and were fed daily. The sand was examined once each week for egg pods which, when found, were numbered and placed in vials for storage. The insects were pinned, numbered and the identification checked. No preservative was used if the eggs were soon to be studied. The eggs became distorted and the chorion brittle if allowed to remain dry for a considerable period. It was found that if such eggs were boiled gently for about five minutes in the water-glycerine-glacial acetic acid solution previously mentioned, they would return to their normal shape and the chorion would become soft. Eggs that had been dry for four years were successfully prepared in this manner.

Those eggs which were to be kept permanently were placed in a preserving fluid. A series of tests to determine the best preservative, in which 70 percent methyl alcohol, 70 percent ethyl alcohol, and 10 percent formalin were used, showed that none of these reagents caused the eggs to shrink within measureable limits, but that 10 percent formalin preserved the color better than the alcohols.

Quarter sections of the choria were mounted on microscope slides in order to permit detailed study of the chorionic pattern. When this phase of the work was started, it immediately became apparent that the usual method of dehydration with ethyl alcohol would be a tedious and time-consuming task. Dehydration was accomplished more quickly with dioxane or tertiary butyl alcohol. Dioxane proved to be quite unsatisfactory as well as dangerous, because of the poisonous fumes. Absolute tertiary butyl alcohol, however, gave excellent results. The technique used in making the slides was as follows:

1. The eggs were cut longitudinally into quarters by means of a small scalpel, with the aid of a binocular dissecting microscope.
2. The quarters were boiled for about five minutes in a 0.5 percent solution of potassium hydroxide to remove the egg contents and the vitelline membrane, after which they were washed in tap water.
3. Each section was placed on a microscope slide in a drop of water and dehydrated by flooding the slide with absolute tertiary butyl alcohol. The process of dehydration required about ten seconds.

4. The excess alcohol was removed with blotting paper balsam applied and the coverslip put in place and pushed down to flatten the section. The slide was then labeled with the species name of the egg and the number of the female which laid it.

In some cases, the sections of the choria curled when boiled in the potassium hydroxide solution. These curled sections usually straightened out when placed for a few minutes in water to which a little tertiary butyl alcohol had been added. Occasionally, also, a section would curl slightly when the slide was flooded for dehydration, but they could usually be flattened out with dissecting needles.

General Consideration of Grasshopper Eggs

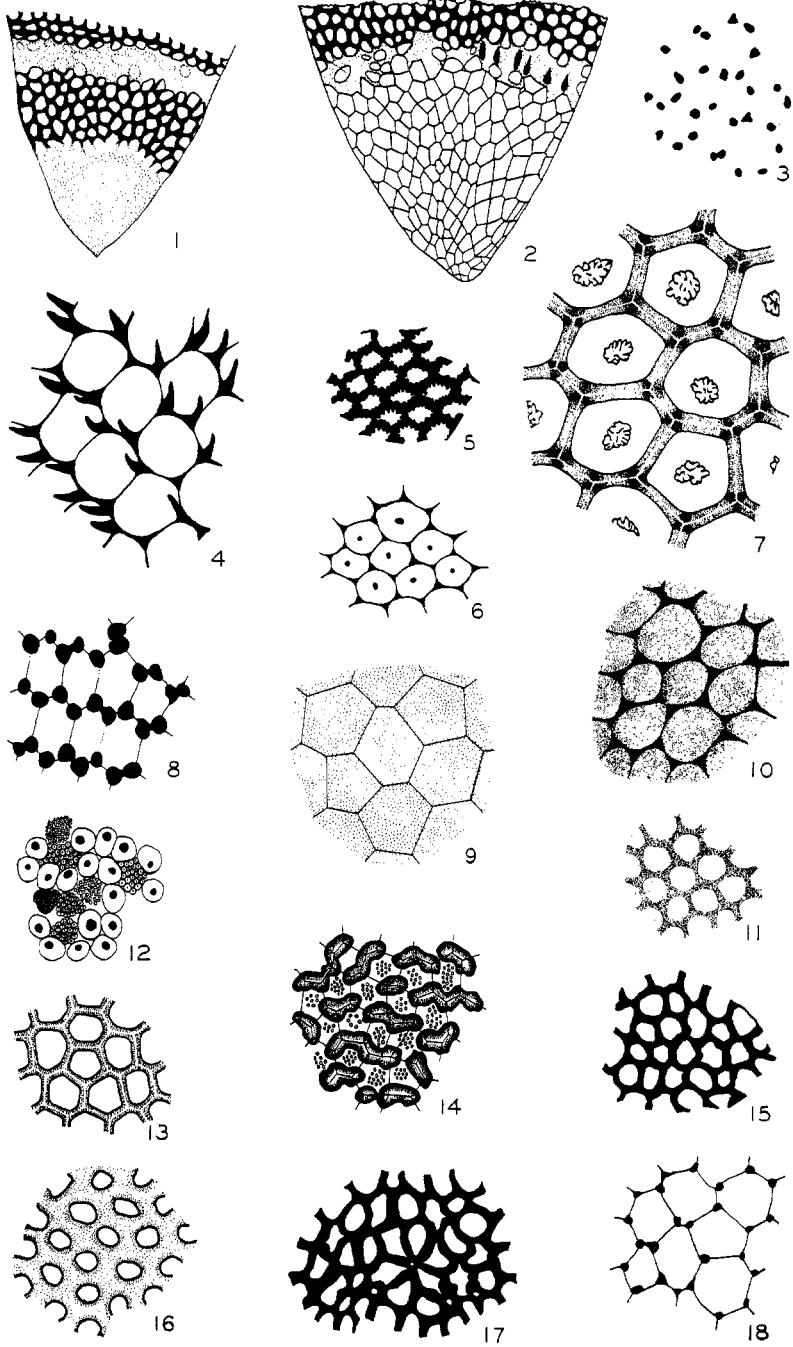
(Plate 1)

Grasshopper eggs are oblong in shape and vary in size from about 2.5 mm. x 0.75 mm. in the eggs of the Acrydiinae to about, 10 mm. x 2.5 mm. in those of *Brachystola magna*. They are produced in a panoistic type of ovary and are invariably covered with a shell or chorion. The substance of which the chorion is composed is tough, semitransparent and closely resembles chitin, though, according to some writers as Slifer (1934) and Snodgrass (1935), the chorion is invariably nonchitinous. The eggs are usually yellow or brown in color, often having a greenish tinge. The eggs of *Schistocerca lineata* are wine-red in color, and the pigment is soluble in alcohol to some extent.

The chorion of most eggs is marked with minute lines and ridges which form more or less regular pentagonal and hexagonal cells. (Pl. 1, fig. 13.) These cells vary widely among species, but are relatively constant within a species. In some eggs, the boundaries of these cells are definite, while in others they are quite indefinite. (Pl. 1, figs. 3 and 13.) In some species, the corners of the cells contain thickenings (Pl. 1, figs. 8 and 18) and in others there are thickenings in the centers of the cells (Pl. 1, fig. 6) or the cells lose their pentagonal and hexagonal shape, becoming circular (Pl. 1, fig. 16.1) According to Snodgrass (1935), when the egg is fully developed the follicular epithelium secretes the chorion. The chorionic sculpturing is molded by the epithelial cells that secreted the chorion.

The eggs of the Locustidae, with the exception of the Acrydiinae, are divisible into two areas—the cap and body. The cap is on the posterior end of the egg and the remainder of it has been designated as the body. The cap is bounded by the micropyles, which are arranged in a row around the egg, and generally by a more or less clear area formed by an interruption of the sculpturing. The cap is directed caudad while the egg is in the ovary of the female and is pointed downward in the pod. When the young nymph hatches, it bursts the chorion at the anterior end of the egg by swallowing air (Kunkel d'Hercule, 1890) and crawls out, leaving the cap undisturbed. The cap is neither analagous nor homologous

PLATE 1



EXPLANATION OF PLATE 1

Some types of sculpturing characteristic of the grasshopper eggs included in this account. (x 3600 except figs. 1 and 2 which are x 1200. All drawings by the senior author.)

FIG.

1. Posterior pole or egg cap of *Hesperotettix v. praetensis*.
2. Same of *Dactylotum pictum*.
3. Characteristic sculpturing of the body of the egg of
Dissosteira longipemis.
4. Same of *Hippiscus rugosus*.
5. Cap cells of *Trachyrachis kiowa kiowa*.
6. Body cells of *Dicromorpha viridis*.
7. Body cells of *Bradynotes obesa*.
8. Body cells of *Arphia pseudonietona*.
9. Body cells of *Hadrotettix trifasciatus*.
10. Body cells of *Arphia xanthoptera*.
11. Body cells of *Dactylotum pictum*.
12. Body cells of *Orchelimum vulgare*.
13. Body cells of *Aeoloplus turnbulli plaqosus*.
14. Body cells of *Mestobregma, P. plattei*.
15. Cap cells of *Hypochlora alba*.
16. Body cells of *Mermiria neomexicana*.
17. Cap cells of *Melanoplus packardii*.
18. Body cells of *Dissosteira carolina*.

to the operculum of the egg of some insects. The eggs of the Acrydiinae and Tettigoniidae have no cap. Tettigoniid eggs are sculptured uniformly over the entire surface and the micropyles are scattered promiscuously over the chorion. The anterior end of the eggs of the Acrydiinae is attenuated into a spurlike structure, which is characteristic of the eggs of this group.

The eggs of the Tettigoniidae are deposited singly, while those of the Locustidae are deposited in pods. The eggs in a pod are surrounded by a frothy substance which is highly visicular. This substance often adheres closely to the chorion of the eggs and is insoluble in any reagent which would not also dissolve the egg. (Plate 2, fig. 1.)

Descriptions of the Sculpturing

The descriptions of the egg patterns were made from photographs and microscope slide mounts. The photographs were sufficient for studying the general characteristics of the eggs, but not for making detailed studies of the sculpturing. The patterns were studied with both the low and high power objectives of a compound microscope. The body is that portion anterior to the micropyles and comprises the greater portion of the egg. The general appearance of the egg, the type of sculpturing, the prominence of the reticulations and micropyles, and the variation in the sculpturing over the egg were utilized for diagnostic purposes. The frothy substance previously mentioned remained attached to the sections of many of the mounted sections and appears in the photographs as a prominent irregular network superimposed on the true sculpturing of the egg. It has been disregarded in making the descriptions, since it apparently is not distinctive, and should not be confused with the sculpturing.

The size and color of the eggs given in the description are characteristic of the normal untreated eggs. The color of the chorion in slide mounts generally is faded. The cell pattern on the egg, where it occurs, is typically pentagonal and hexagonal. The terms "proximal" and "distal" are used in descriptions of the cap cells in the sense of basally or towards the center of the egg and apically or away from the center, respectively. The micropyles vary in size and visibility. In general, they are funnel-shaped canals which extend from the outer surface downward through the chorion to the inner surface.

KEY FOR THE IDENTIFICATION OF THE EGGS

(The figures indicated are on Plate 1)

- | | |
|--|---------------------------------------|
| 1. Egg differentiated into body and cap areas..... | 5 |
| Egg not so differentiated..... | 2 |
| 2. Anterior end of egg bearing a slender spurlike structure..... | 4 |
| Anterior end of egg without such a structure..... | 3 |
| 3. Chorionic cells of the egg of uniform structure..... | <i>Pediodesctes nigromarginata</i> |
| Cells of egg not of uniform structure (fig. 12)..... | <i>Orchelimum vulgare</i> |
| 4. Body of egg entirely covered with cells..... | <i>Tettigidea parvipennis pennata</i> |
| Body of egg not entirely covered with cells..... | <i>Apotettix eurycephalus</i> |

Identification of Grasshopper Eggs

5. Body of egg sculptured.....	12
Body of egg not sculptured but often with granules.....	6
6. Cap sculptured.....	10
Cap not sculptured but often with granules.....	7
7. Tip of cap distinctly pigmented.....	9
Tip of cap nearly unpigmented or with some brown clouding.....	8
8. Pigmented area with some large granules.....	<i>Aeropedallus clavatus</i>
Pigmented area with small granules.....	<i>Ageneotettix deorum</i>
9. Cap with granules.....	<i>Syrbula admirabilis</i>
Cap without granules.....	<i>Chortophaga viridifasciata</i>
10. Cells only on proximal portion of cap.....	<i>Orphulella pelidna</i>
Cells only on median portion of cap.....	<i>Encoptolophus costalis</i>
Cells only on distal portion of cap.....	11
11. Cells faintly outlined.....	<i>Philobostoma quadrimaculatum</i>
Cells well defined.....	<i>Encoptolophus sordidus</i>
12. Egg unusually large (length about 10 mm. and faintly sculptured), <i>Brachystola magna</i> Egg not unusually large and sculpturing plainly visible.....	13
13. Cells on body of egg with thickenings in their corners (fig. 10).....	14
Cells on body of egg without thickenings in their corners (fig. 13).....	24
Few cells on the body; sculpturing consisting largely of short ridges which at the anterior end of the egg unite to form long ridges arranged in a pattern re- sembling brain coral.....	<i>Mestobregma plattei plattei</i>
14. Thickenings appearing to occur in pairs (fig. 8).....	<i>Arphia pseudonietona</i>
Thickenings occurring at all the intersection angles of pentagonal and hexagonal cells.....	15
15. Cells of the body of the egg with distinct dots in their centers (fig. 6).....	16
Cells of the body of the egg without such dots (fig. 18).....	17
16. Cap cells all uniformly developed; tip of cap pigmented.....	<i>Trimerotropis citrina</i>
Cap cells poorly developed proximally; tip of cap usually not pigmented <i>Dieromorpha viridis</i>	
17. Cap cells without thickenings at the intersections.....	18
Cap cells with thickenings at the intersections.....	21
18. Boundaries of body cells well developed (fig. 13).....	19
Boundaries of body cells weakly developed or absent (figs. 9 and 3).....	20
19. Three rows of flattened, irregularly shaped cells, just above or anterior to micropyles <i>Schistocerca obscura</i> No such cells anterior to micropyles; egg wine-red in color.....	<i>Schistocerca lineata</i>
20. Thickenings regularly arranged over all or most of the body of the egg (fig. 18) <i>Dissosteira carolina</i> Thickenings irregularly distributed over most of the body of the egg (fig. 3) <i>Dissosteira longipennis</i>	
21. Thickenings of the body cells of the egg pronounced (fig. 4) and with spinelike projections equal to about one-half of the diameter of the cells, <i>Hippiscus rugosus</i> Thickenings of body cells not pronounced and without projections.....	22
22. Thickenings developed such that the cells appear to be formed by the fusion of their points (fig. 10).....	<i>Arphia xanthoptera</i>
Thickenings not so developed.....	23
23. Cells at tip of cap distinct.....	<i>Spharagemon equale</i>
Cells at tip of cap more or less obscured by development of their boundaries and by pigmentation.....	<i>Spharagemon collare</i>
24. Body cells of egg angular (fig. 13).....	27
Body cells of egg circular (figs. 16 and 11).....	25
25. Cap cells circular.....	26
Cap cells angular.....	<i>Melanoplus bowditchi bowditchi</i>
26. Micropyles appear bifid anteriorly with a sharp projection posteriorly <i>Mermiria neomezicana</i> Micropyles appear bifid anteriorly or not; if bifid with no sharp posterior pro- jection.....	<i>Mermiria maculipennis macclungi</i>
27. Tip of cap without cells (fig. 1).....	35
Cap entirely covered by cells (fig. 2).....	28

28.	Body cells with heavy boundaries.....	81
	Body cells with faint boundaries.....	29
29.	Cap cells angular.....	30
	Cap cells circular.....	<i>Hadrotettix trifasciatus</i>
30.	Proximal cells of cap more heavily outlined than the distals....	<i>Melanoplus confusus</i>
	Distal cells of the cap more heavily outlined than the proximals,	
	<i>Melanoplus bivittatus</i>	
31.	Body cells of egg large, with sharply defined angles; cap cells with heavy bound- aries (fig. 7).....	<i>Bradynotes obesa</i>
	Not as above.....	32
32.	Boundaries of all cap cells equally developed or nearly so.....	33
	Six or seven proximal rows of cells with heavier boundaries than the distals,	
	<i>Melanoplus augustipennis</i>	
	Distal cells of cap more heavily outlined than the proximals....	<i>Schistocerca lineata</i>
33.	Sculpturing distinct over the entire cap.....	34
	Sculpturing somewhat obscured at tip of cap.....	<i>Melanoplus differentialis</i>
34.	Proximal cells larger than distals; all cells of cap outlined by fine ridges (fig. 2),	
	<i>Dactylotum pictum</i>	
	Proximal cells of cap outlined by wavy ridges (fig. 5)....	<i>Trachyrachis kiowa kiowa</i>
	Three rows of flattened irregularly shaped cells just anterior to the micropyles,	
	<i>Schistocerca obscura</i>	
35.	Body cells with heavy boundaries.....	37
	Body cells with faint boundaries.....	36
36.	Five proximal or basal rows of cap cells with heavier boundaries than the distals,	
	<i>Campylacantha olivacea olivacea</i>	
	Five or six rows of proximal cells on the cap with heavy boundaries beyond which are three rows of less heavily developed cells.....	<i>Melanoplus gladstoni</i>
37.	Proximal cells of cap with heavier boundaries than the distals.....	40
	All cells of cap with equally developed boundaries.....	38
38.	Eight or nine rows of complete cells on basal portion of cap.....	39
	Five rows of cells on basal portion of cap (fig. 1)....	<i>Hesperotettix viridis praetensis</i>
	Three rows of cells on basal portion of cap.....	<i>Acolopus turnbulli plagosus</i>
39.	Cap cells more or less regularly shaped (fig. 15).....	<i>Hypochlora alba</i>
	Cap cells irregularly shaped (fig. 17).....	<i>Melanoplus packardii</i>
40.	All cap cells more or less regularly shaped.....	42
	Some of proximal cells irregularly shaped.....	41
41.	Four proximal rows of irregularly shaped, heavily outlined cells on cap, beyond which are three rows of lighter, more regularly shaped cells,	
	<i>Melanoplus foedus foedus</i>	
	Three proximal rows of irregularly shaped cells on cap, beyond which are five rows of regularly shaped cells.....	<i>Phoetaliotes nebrascensis</i>
42.	Five proximal rows of cells on cap with heavy boundaries.....	43
	Six or seven proximal rows of cells on cap with heavy boundaries, beyond which are two rows of lighter cells.....	<i>Melanoplus femur-rubrum femur-rubrum</i>
43.	Two rows of lighter cells on cap beyond the heavily bounded proximal cells,	
	<i>Melanoplus lakinus</i>	
	Three rows of lighter cells on cap beyond the heavily bounded proximal cells....	44
44.	Proximal cells on cap heavily bounded and irregularly arranged,	
	<i>Melanoplus occidentalis occidentalis</i>	
	Proximal cells on cap heavily outlined and more or less regularly arranged,	
	<i>Melanoplus mexicanus mexicanus</i>	

LIST OF SPECIES STUDIED

Arranged after Hebard (1931)

Locustidae (Acrididae)

ACRYDINAE

- Apotetox eurycephalus* Hancock
- Tettigidea parvipennis pennata* Morse

ACRIDINAE

- Aeropedallus clavatus* (Thomas)
- Ageneotettix deorum* (Scudder)
- Dicromorpha viridis* (Scudder)
- Mermiria maculipennis macclungi* Rehn
- Mermiria neomexicana* (Thomas)
- Orphullela pelidna* (Burmeister)
- Philobostroma quadrimaculatum* Thomas
- Syrbula admirabilis* (Uhler)

OEDIPODINAE

- Arphia pseudonietana* (Thomas)
- Arphia xanthoptera* (Burmeister)
- Chortophaga viridifasciata* (De Geer)
- Dissosteira carolina* (Linnaeus)
- Dissosteira longipennis* (Thomas)
- Encoptolophus costalis* (Scudder)
- Encoptolophus sordidus* (Burmeister)
- Hadrotettix trifasciatus* (Say)
- Hippiscus rugosus* (Scudder)
- Mestobregma plattei plattei* (Thomas)
- Spharagemon collare* (Scudder)
- Spharagemon equale* (Say)
- Trachyhachis kiowa kiowa* (Caudell)
- trimeropis citrina* Scudder

BATRACHOTETRIGINAE

- Brachystola magna* (Girard)

CRYPTACANTHACRINAE

- Aeoloplus turnbulli plagosus* (Scudder)
- Bradynotes obesa* (Thomas)
- Campylacantha olivacea olivacea*
(Thomas)
- Dactylotum pictum* (Thomas)
- Hesperotettix viridis praetensis* (Scudder)
- Hypochlora alba* (Dodge)
- Melanoplus augustipennis* (Dodge)
- Melanoplus b. bowditchi* Scudder
- Melanoplus bivittatus* (Say)
- Melanoplus confusus* Scudder
- Melanoplus differentialis* (Thomas)
- Melanoplus femur-rubrum femur-rubrum*
(De Geer)
- Melanoplus foedus foedus* Scudder
- Melanoplus gladstoni* Scudder
- Melanoplus lakinus* (Scudder)
- Melanoplus m. mexicanus* (Sauesure)
- Melanoplus o. occidentalis* (Thomas)
- Melanoplus packardii* Scudder
- Phoetaliotes nebrascensis* (Thomas)
- Schistocerca lineata* Scudder
- Schistocerca obscura* (Fabricius)

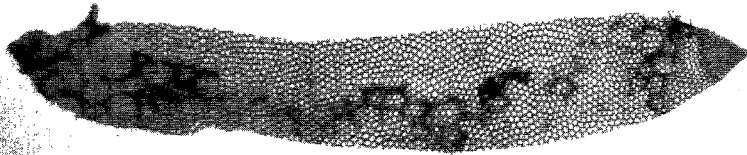
TETTIGONIIDAE

CONOCEPHALINAE

- Orchelimum vulgare* Harris

DECTICINAE

- Pediocetes nigromarginata* (Caudell)



2



3

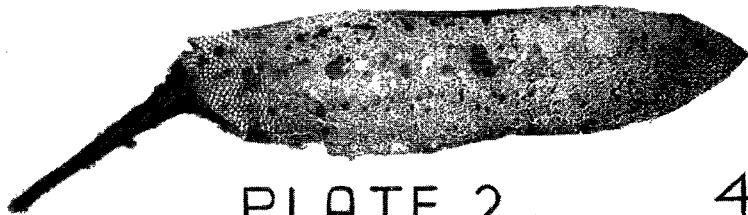


PLATE 2

4

Description of the Eggs

The order of listing is alphabetical, first by genus, then by species within the genus.

Aeoloplus turnbulli plagosus (Scudder)

(Plate 2, fig. 2)

Color: Light brown. Average size: 4.20 mm. x 1.08 mm.

Sculpturing: The entire body of the egg of this species is marked with pentagonal and hexagonal cells (Plate 1, fig. 13). The reticulation in the central portion of the body is well developed, while at the anterior end of the egg the boundaries are narrower. Three rows of more or less oblong cells, wider and darker walled, occur on the proximal portion of the cap. This series ends abruptly and the remainder of the cap is smooth but brownish pigmented. The micropyles are scarcely, if at all, visible.

Aeropedallus clavatus (Thomas)

Color: Light brown. Average size: 4.86 mm. x 1.5 mm.

Sculpturing: Both the body and the cap are devoid of sculpturing. The tip of the cap is more deeply pigmented than the rest of the egg and a few large granules may be seen. The micropyles are fairly prominent.

Ageneotettix deorum (Scudder)

(Plate 2, fig. 3)

Color: Pale yellow. Average size: 5.17 mm. x 1.57 mm.

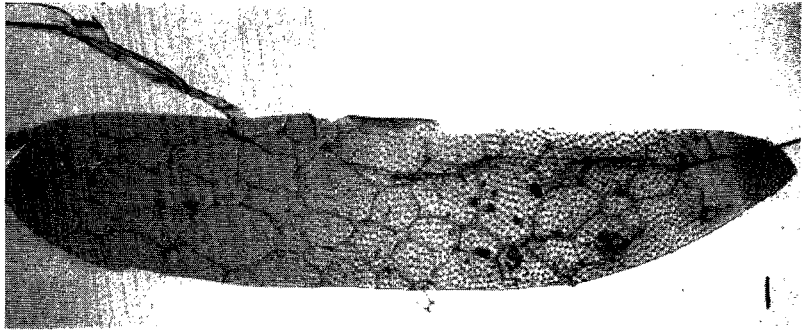
Sculpturing: The chorion is entirely devoid of sculpturing. The micropyles are funnel-shaped, nearly hyaline, but readily seen. The extreme tip of the cap is a light-brown color. Numerous small granules occur around the proximal border of this pigmented area and a few more granules occur over the remainder of the area. This species can be distinguished from the previous one by the pigmented tip of the cap, the clearly visible micropyles and the greater number of minute granules in the cap region.

Apotettix eurycephalus Hancock

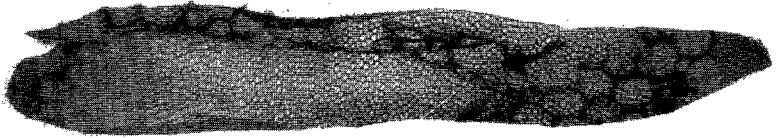
(Plate 2, fig. 4)

Color: Gray to grayish brown. Average size: 2.53 mm. x .73 mm.

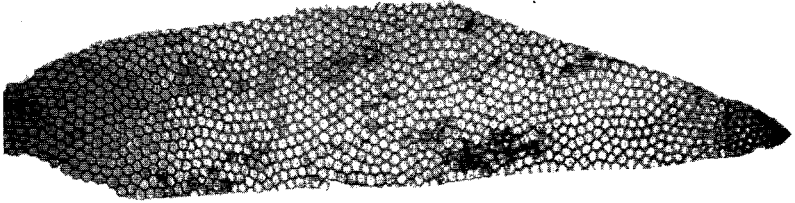
Sculpturing: The anterior end of the egg is attenuated, forming a spurlike structure, which feature serves to distinguish the eggs of the grouse locusts. The posterior end of the egg does not bear a cap. Well-developed reticulations forming pentagonal and hexagonal cells occur anteriorly around the base of the spur and at the posterior end. These cells become progressively less well defined towards the body of the egg which is corered with minute granules or spots without regular form or pattern.



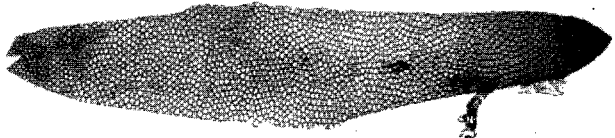
1



2



3



4

PLATE 3

Arphia pseudonietana (Thomas)

(Plate 3, fig. 1)

Color: Light brown. Average size: 4.86 mm. x 1.5 mm.

Sculpturing: The body of the egg is characterized by faintly outlined pentagonal and hexagonal cells with prominent triangular thickenings in their corners. (Plate 1, fig. 8.) The opposite sides of the majority of the cells have become greatly shortened so that the thickenings appear to occur in pairs. A narrow band at the micropyles is devoid of thickenings and cells. The cap is completely covered with fairly well-defined cells with triangular thickenings, but the cells lose their identity near the tip. The prominent micropyles are funnel-shaped with narrow tubes.

Arphia xanthoptera (Burmeister)

(Plate 3, fig. 2)

Color: Dark brown. Average size: 5.55 mm. x 1.57 mm.

Sculpturing: The sculpturing is characterized by clearly outlined pentagonal and hexagonal cells with well developed triangular thickenings at the boundary intersections (Plate 1, fig. 10). The thickenings merge into the narrow cell boundaries such that they are somewhat less prominent than in the above species. The cells are more or less rounded and appear to be formed by the junction of five or six of these thickenings. The thickenings at the anterior end of the egg are more pronounced, forming smaller cells. The cells on the basal half of the cap resemble those at the anterior pole of the egg while those on the remainder of the cap are smaller and more elongate. The micropyles are rather faint and suggest hair-pins in appearance. The body cells in the micropylar band fade out gradually.

Brachystola magna (Girard)

Color: Dark brown. Average size: 10.09 mm. x 2.44 mm.

Sculpturing: The egg is heavily pigmented, and the sculpturing is largely obscured, particularly at the ends, which are nearly black. The boundaries of the pentagonal and hexagonal cells are heavy. The cap is indefinite, but its cells resemble those on the body. The large size of this egg distinguishes it from the others included in this study.

Bradynotes obesa (Thomas)

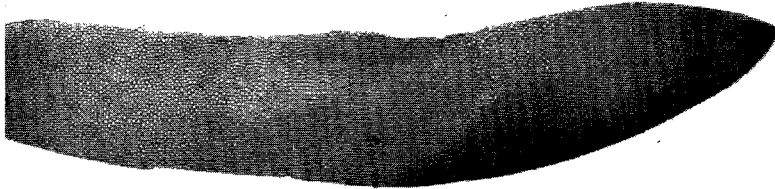
(Plate 3, fig. 3)

Color: Brown. Average size: 5.87 mm. x 1.63 mm.

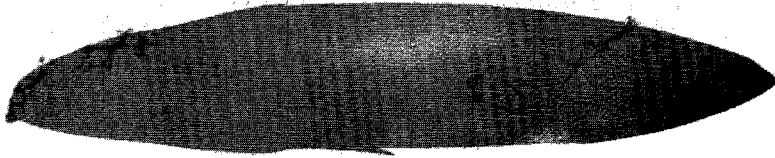
Sculpturing: The body of the egg is uniformly covered with a prominent network forming clean-cut pentagonal and hexagonal cells (Plate 1, fig. 7), separated by heavy ridges. The sculpturing is slightly heavier at the anterior end of the egg. The cap is completely covered with a heavy reticulation in which somewhat irregu-



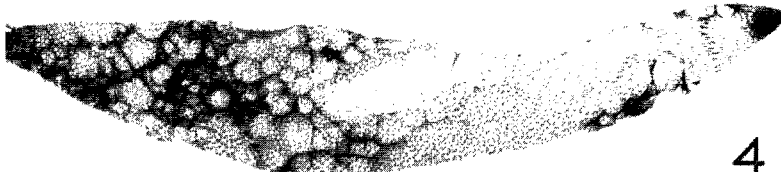
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PLATE 4

larly shaped cells are enclosed within broad boundaries. The micropyles are nearly cylindrical and prominent.

Campylacantha olivacea olivacea (Scudder)

(Plate 3, fig. 4)

Color: Yellowish brown. Average size: 4.17 mm. x 0.9 mm.

Sculpturing: The body of the egg is completely covered with a reticulation enclosing pentagonal and hexagonal cells in narrow but distinct boundaries. The thickness of the boundaries or ridges is uniform over the entire body of the egg. There are five complete rows of cells on the basal portion of the cap which are more crowded and have wider boundaries than the body cells. The tip of the cap is smooth and brown. The micropyles appear as long, narrow funnels and are prominent.

Chortophaga viridifasciata (De Geer)

(Plate 4, fig. 1)

Color: Light brown. Average size: 3.97 mm. x 0.93 mm.

Sculpturing: Both the body and cap are completely devoid of sculpturing, but minute granulations are present. The micropyles are prominent. The cap is more granular than the body cells and brown at the tip.

Dactylotum pictum (Thomas)

(Plate 4, fig. 2)

Color: Brown. Average size: 5.18 mm. x 1.69 mm.

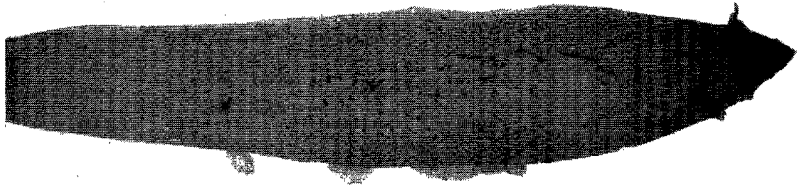
Sculpturing: The body of the egg is covered with a uniform reticulation which is definitely granular in appearance. The boundaries form pentagonal and hexagonal cells (Plate 1, fig. 11). The reticulations on the cap closely resemble those on the body, except that the cell boundaries are slightly finer. The cells are larger and longitudinally attenuated, especially toward the tip of the cap. The micropyles appear as oblong funnels with slender tubes.

Dicromorpha viridis (Scudder)

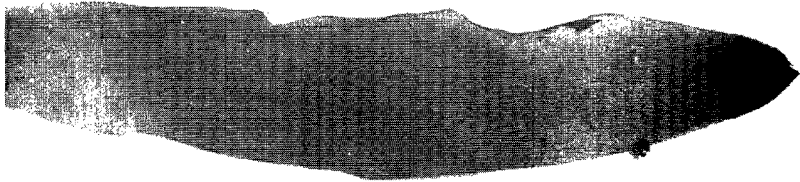
(Plate 4, fig. 3)

Color: Light brown. Average size: 4.96 mm. x 1.19 mm.

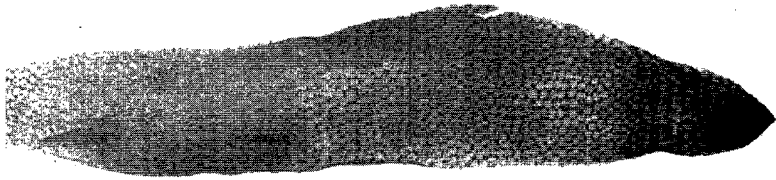
Sculpturing: The reticulation on the body of the egg is characterized by pentagonal and hexagonal cells separated by narrow boundaries (Plate 1, fig. 6) at the angles of which moderately well-developed triangular thickenings occur. Well-developed nodules appearing as dots occur in the centers of the majority of the cells. Immediately before the micropyles is a smooth area about as wide as seven rows of body cells. A narrow area at the basal portion of the cap is smooth while the remainder is covered by somewhat irregular oblong cells whose boundaries are distinctly heavier than are those of the body cells. The micropyles are broadly conical, close together and prominent.



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PLATE 5

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Dissosteira carolina (Linnaeus)

(Plate 4, fig. 4)

Color: Light brown. Average size: 5.58 mm. x 1.08 mm.

Sculpturing: The entire body of the egg is marked with a faint reticulation forming pentagonal and hexagonal cells (Plate 1, fig. 18). Small but clearly visible triangular thickenings rather uniformly distributed occur at boundary intersections. Immediately before the prominent narrowly conical micropyles, the chorion is devoid of sculpturing. The cap is entirely covered with poorly defined, irregular cells.

Dissosteira longipennis (Thomas)

(Plate 5, fig. 1)

Color: Light brown. Average size: 5.50 mm. x 1.25 mm.

Sculpturing: The sculpturing of the body consists largely of triangular thickenings (Plate 1, fig. 3). All linear reticulations or cell boundaries are obscure except that a pentagonal and hexagonal cellular pattern occurs on the anterior end of the egg. The thickenings over most of the body are irregularly and fragmentally arranged. A band devoid of sculpturing occurs before the distinct, numerous medicine dropper shaped micropyles. The basal two-thirds of the cap is characterized by well-defined cells with thickenings, while those on the distal third are smaller, brown and more heavily outlined.

Encotolophus sordidus costalis (Scudder)

Color: Light brown. Average size: 4.1 mm. x 0.9 mm.

Sculpturing: The body of the egg is devoid of sculpturing. The basal third of the cap and the tip are without well-defined cells. Several rows of faintly outlined pentagonal and hexagonal cells occur in the middle third of the cap. The tip of the cap is brownish. The micropyles are broadly conical and somewhat obscure.

Encotolophus sordidus sordidus (Burmeister)

Color: Light brown. Average size: 4.32 mm. x 1.18 mm.

Sculpturing: The body of the egg is devoid of sculpturing. The cap is strongly granular and the distal half is faintly marked with pentagonal and hexagonal cells, but the tip of the cap is smooth and brownish. The micropyles are small, conical, but fairly prominent.

Hadrotettix trifasciatus (Say)

(Plate 5, fig. 2)

Color: Russet brown. Average size: 7.17 mm. x 2.08 mm.

Sculpturing: The greater part of the body of the egg is faintly marked with a fine reticulation forming pentagonal and hexagonal cells (Plate 1, fig. 9). The reticulation at the anterior end of the

egg is decidedly more pronounced. The cells are barely visible in a band near the micropyles. The cap is much more deeply pigmented than the body of the egg and is completely covered by heavily outlined rounded cells. The cap has a granular appearance, the granules being visible even in the heavy reticulation. The micropyles are distinct and wishbone-shaped.

Hesperotettix viridis praetensis (Scudder)

Color: Light brown. Average size: 4.66 mm. x 1.14 mm.

Sculpturing: The body is uniformly marked with a well-developed reticulation forming pentagonal and hexagonal cells with boundaries of medium width. The cap has in the area next to the micropyles five rows of pentagonal and hexagonal cells which tend to be more rounded and their boundaries heavier than the body cells (Plate 1, fig. 1). Beyond these five rows the cap is smooth but slightly brownish. The micropyles are not prominent.

Hippiscus rugosus (Scudder)

(Plate 5, fig. 3)

Color: Brown. Average size: 6.51 mm. x 1.8 mm.

Sculpturing: The entire body of the egg is covered by hexagonal and pentagonal cells separated by narrow boundaries (Plate 1, fig. 4). Triangular thickenings with distinctive spinelike projections about half the diameter of the cells occur at the boundary intersections giving the egg a spiny appearance. The boundaries of the cap cells and the triangular thickenings are heavier than those forming the body cells. The entire cap is covered with cells, those near the tip being heavier than those at the base. The micropyles are broadly conical and fairly prominent and the region is indicated by a band, but the cellular pattern is not obliterated.

Hypochlora alba (Dodge)

(Plate 5, fig. 4)

Color: Light brown. Average size: 4.9 mm. x 1.26 mm.

Sculpturing: The reticulation on the body of the egg consists of uniform clearly outlined pentagonal and hexagonal cells whose boundaries are moderately wide. Immediately before the fairly prominent, narrowly conical micropyles the cells are somewhat compressed, forming a narrow light band. There are eight or nine rows of irregularly shaped pentagonal and hexagonal cells on the cap, whose boundaries are more strongly developed than are those of the body cells. The tip of the cap is smooth and brownish pigmented.

EXPLANATION OF PLATES 2 TO 11, INCLUSIVE

PLATE 2

- FIG. 1. Eggs of *Melanoplus differentialis* (Thomas) from a broken pod to show the shape and froth adhering to the eggs.
 FIG. 2. *Aeoloplus turnbulli plagosus* (Scudder).
 FIG. 3. *Agenotettix deorum* (Scudder).
 FIG. 4. *Apotettix eurycephalus* Hancock.

PLATE 3

- FIG. 1. *Arphia pseudonietona* (Thomas).
 FIG. 2. *Arphia xanthoptera* (Burmeister).
 FIG. 3. *Bradynotes obesa* (Thomas).
 FIG. 4. *Campylacantha olivacea olivacea* (Scudder).

PLATE 4

- FIG. 1. *Chortophaga viridifasciata* (De Geer).
 FIG. 2. *Dactylotum pictum* (Thomas).
 FIG. 3. *Dicromorpha viridis* (Scudder).
 FIG. 4. *Dissosteira carolina* (Linnaeus).

PLATE 5

- FIG. 1. *Dissosteira longipennis* (Thomas).
 FIG. 2. *Hadrotettix trifasciatus* (Say).
 FIG. 3. *Hippiscus rugosus* (Scudder).
 FIG. 4. *Hypochlora alba* (Dodge).

PLATE 6

- FIG. 1. *Melanoplus augustipennis* (Dodge).
 FIG. 2. *Melanoplus bivittatus* (Say).
 FIG. 3. *Melanoplus bowditchi bowditchi* Scudder.
 FIG. 4. *Melanoplus confusus* Scudder.

PLATE 7

- FIG. 1. *Melanoplus differentialis* (Thomas).
 FIG. 2. *Melanoplus femur-rubrum femur-rubrum* (De Geer).
 FIG. 3. *Melanoplus foedus foedus* Scudder.
 FIG. 4. *Melanoplus gladstoni* Scudder.

PLATE 8

- FIG. 1. *Melanoplus lakinus* (Scudder).
 FIG. 2. *Melanoplus mexicanus mexicanus* (Saussure).
 FIG. 3. *Melanoplus occidentalis occidentalis* (Thomas).
 FIG. 4. *Melanoplus packardii* Scudder.

PLATE 9

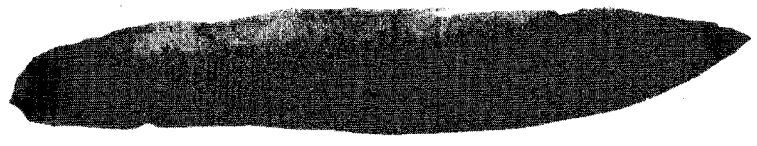
- FIG. 1. *Mermiria maculipennis macclungi* Rehn.
 FIG. 2. *Mestobregma plattei plattei* (Thomas).
 FIG. 3. *Orphullela pelidna* (Burmeister).
 FIG. 4. *Orchelimum vulgare* Harris.

PLATE 10

- FIG. 1. *Pediocetes nigromarginata* (Caudell).
 FIG. 2. *Phoetaliotes nebrascensis* (Thomas).
 FIG. 3. *Schistocerca lineata* Scudder.
 FIG. 4. *Schistocerca obscura* (Fabricius).

PLATE 11

- FIG. 1. *Spharagemon collare* (Scudder).
 FIG. 2. *Spharagemon equale* (Say).
 FIG. 3. *Syrbula admirabilis* (Uhler).
 FIG. 4. *Trachyrachis kiowa kiowa* (Caudell).



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PLATE 6

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Melanoplus augustipennis (Dodge)

(Plate 6, fig. 1)

Color: Cream yellow. Average size: 4.79 mm. x 1.33 mm.

Sculpturing: The body of the egg is covered by a well-developed reticulation which forms pentagonal and hexagonal cells. The boundaries are fairly broad but become definitely broader near the anterior end of the egg, but, the extreme anterior tip is smooth. Next to the indistinct micropyles, six or seven rows of more heavily outlined, laterally compressed cells occur but beyond these the cells become progressively fainter until the smooth, brownish tip is reached.

Melanoplus bivittatus (Say)

(Plate 6, fig. 2)

Color: Olive to brownish yellow.

Average size: 4.45 mm. x 1.2 mm.

Sculpturing: The body is marked with a definite pentagonal and hexagonal reticulation, the boundaries becoming more heavily outlined at the anterior end of the egg. The entire chorion has a fine granular texture. The cap is nearly completely covered by a heavily outlined reticulation with elongated and somewhat pointed cells suggesting fish scales. The cells become progressively less distinct toward the smooth, darker brown tip of the cap. The micropyles are fairly prominent.

Melanoplus bowditchi bowditchi Scudder

(Plate 6, fig. 3)

Color: Light brown. Average size: 4.22 mm. x 1.08 mm.

Sculpturing: The entire body of the egg is uniformly covered by well-developed reticulations with rounded cells. The cellular space appears under high magnification to be bounded partly or wholly with a distinctive dark thickened area. Four rows of elongated, pentagonal and hexagonal cells with thickenings inside the borders occur on the basal portion of the cap. Distad of these are three or four rows of less sharply defined cells which rarely show a thickening inside the border. The tip of the cap is smooth and brownish. The micropyles are not prominent.

Melanoplus confusus Scudder.

(Plate 6, fig. 4)

Color: Deep yellow. Average size: 4.37 mm. x 1.13 mm.

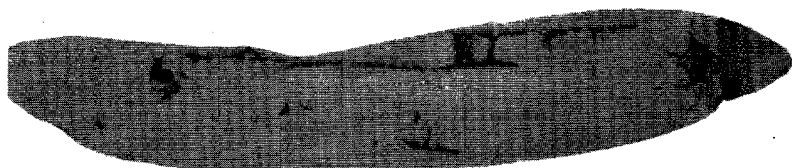
Sculpturing: The body of the egg is characterized by a uniform covering of pentagonal and hexagonal cells with faintly outlined granular boundaries. There are five rows of heavily outlined cells on the basal portion of the cap. The remainder of the cap is covered by less heavily outlined cells. The micropyles are not well differentiated.



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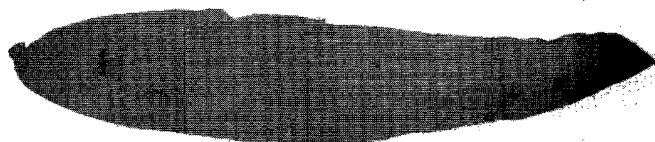


PLATE 7

4

Identification of Grasshopper Eggs

25

Melanoplus differentialis (Thomas)

(Plate 7, fig. 1)

Color: Olive and yellowish-brown

Average size: 4.49 mm. x 1.1mm.

Sculpturing: The body of the egg is characterized by a complete reticulation of rounded pentagonal and hexagonal cells with well-defined boundaries. The cell borders are narrower at the anterior end of the egg, but become progressively broader and heavier near the micropylar band. The cells are more angular at the anterior pole. The cap is entirely covered with cells whose boundaries are slightly heavier than those of the body cells. The pattern is somewhat obscured at the apical end of the cap by the brownish pigmentation, though the cell boundaries can still be seen. The micropyles are not well differentiated.

Melanoplus femur-rubrum femur-rubrum (De Geer)

(Plate 7, fig. 2)

Color: Light brown. Average size: 4.37 mm. x .85 mm.

Sculpturing. The body of the egg is characterized by a reticulation enclosing pentagonal and hexagonal cells with narrow boundaries. The cells at the anterior end are smaller than those on the rest of the body. The cells are compressed near the micropyles. The cap bears six or seven basal rows of heavily outlined cells, beyond which are two rows of faintly outlined cells. The tip of the cap, while appearing smooth, shows some poorly differentiated cell boundaries largely obscured by the brownish pigmentation. The micropyles are funnel-shaped and prominent.

Melanoplus foedus foedus Scudder

(Plate 7, fig. 3)

Color: Deep yellow. Average size: 4.98 mm. x 1.16 mm.

Sculpturing: The reticulation on the body of the egg consists of moderately well differentiated pentagonal and hexagonal cells with narrow borders. The cells become faint at the extreme anterior pole and next to the inconspicuous micropyles the cells overlap. Basally, the cap has four rows of heavily outlined, irregularly shaped, narrow cells, while next to these are three rows of more regularly shaped cells. These are followed by three or four rows of faintly outlined, long, narrow cells which merge into the smooth, brownish tip.

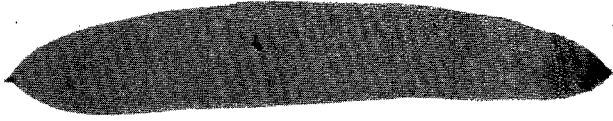
Melanoplus gladstoni Scudder

(Plate 7, fig. 4)

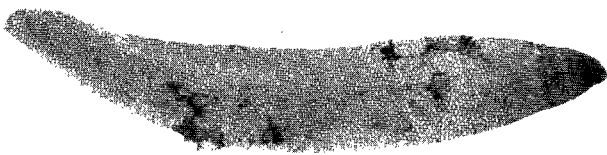
Color: Brown with greenish tinge.

Average size: 4.87 mm. x 1.04 mm.

Sculpturing: The body of the egg is marked with a distinct reticulation which forms pentagonal and hexagonal cells with narrow, fairly well-differentiated boundaries. Five or six rows of cells



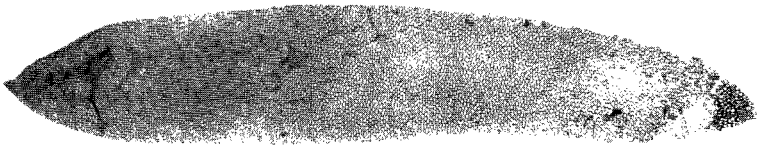
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PLATE 8

with well-developed boundaries occur on the basal portion of the cap and beyond these are three rows of less distinctly outlined cells. The tip of the cap is smooth, but faintly differentiated cell boundaries are visible nearly to the tip, which is brownish. The micropyles are poorly differentiated.

Melanoplus lakinus (Scudder)

(Plate 8, fig. 1)

Color: Light brown Average size: 4.53 mm. x 1.02 mm.

Sculpturing: The entire body, with the exception of the extreme anterior end, is covered with a prominent network of pentagonal and hexagonal cells within boundaries of medium width. A narrow band in which the cell boundaries are partly obliterated occurs at the micropyles. Seven rows of cells occur on the basal portion of the cap. The basal five rows have heavier boundaries than the two distal row. The cell boundaries are completely obliterated on the brownish tip of the cap. The micropyles are elliptical and prominent.

Melanoplus mexicanus mexicanus (Saussure)

(Plate 8, fig. 2)

Color: Yellowish-brown Average size: 4.67 mm. x 1.05 mm.

Sculpturing: The body of the egg is completely covered with pentagonal and hexagonal cells separated by moderately well-developed ridges. Five rows of overlapping cells resembling curled fish scales or with raised and somewhat turned over borders occur on the cap next to the micropylar band. This band is succeeded by three rows of flat, faintly outlined cells which merge into the smooth, brownish tip. The micropyles are indistinguishable.

Melanoplus occidentalis occidentalis (Thomas)

(Plate 8, fig. 3)

Color: Yellow Average size: 5.31 mm. x 1.24 mm.

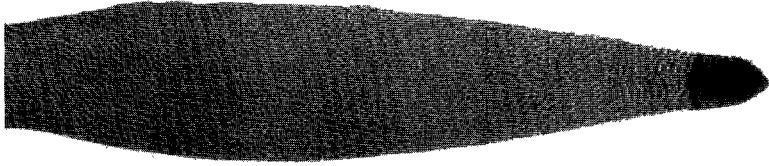
Sculpturing: The distinct reticulation on the body of the egg forms pentagonal and hexagonal cells. The cells are somewhat flattened at the anterior pole, and next to the micropyles, the anterior boundaries of the cells are less distinct than the posterior. The basal portion of the cap has five rows of complete elongated, irregularly shaped cells with heavy ridges. Distad of these are three rows of faintly outlined cells which merge into the smooth, brownish cap in which faint suggestions of some cell outlines occur. The micropyles are elongate-oval and fairly distinct.

Melanoplus packardii Scudder

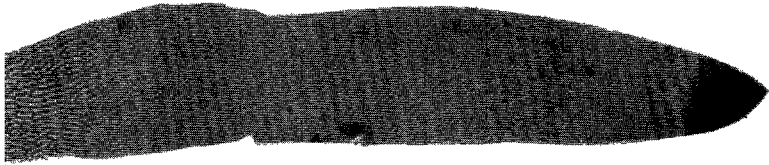
(Plate 8, fig. 4)

Color: Yellowish-brown Average size: 5.18 mm. x 1.41 mm.

Sculpturing: The reticulation on the body of the egg forms pentagonal and hexagonal cells separated by well differentiated, narrow ridges. The network is uniform and pronounced, but the



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PLATE 9

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extreme anterior tip of the egg is smooth. The entire cap, except the tip which is smooth, is covered with heavily outlined elongate cells of irregular shape (Plate 1, fig. 17). The micropyles are obscure.

Memiria maculipennis macclungi Rehn

(Plate 9, fig. 1)

Color: Purplish, with almost white longitudinal areas.

Average size: 7.33 mm. x 1.42 mm.

Sculpturing: The pattern is almost identical with that of *Mermiria neomexicana*. At the anterior end of the egg the pattern is obscured by a thick granular substance. The micropyles are prominent and appear as relatively large black dots or are bifid anteriorly. If bifid, they do not have the sharp posterior projection seen in *M. neomexicana*, so that they may be used to differentiate the egg from that of *M. neomexicana*.

Memiria neomexicana (Thomas)

Color: Purplish with white longitudinal stripes.

Average size: 7.23 mm. x 1.45 mm.

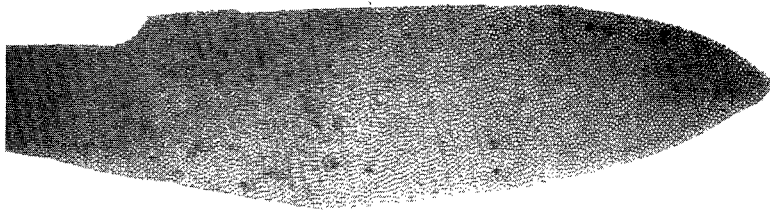
Sculpturing: The reticulations are extremely heavy so that the cells have the appearance of rounded pits or indentations in the chorion. At the extreme anterior end, the sculpturing is somewhat obscured and proximad of this the pits are connected with each other by grooves which give them a stellate appearance. The sculpturing of the proximal third of the cap closely resembles that of the body. On the distal two-thirds the sculpturing is somewhat obscured and the pits are larger and occupy relatively more of the area. The micropyles are numerous and appear as a prominent row of black spots around the egg at the anterior end of the cap. The shape of the micropyles is valuable in distinguishing the egg from that of *Mermiria maculipennis macclungi*. They appear bifid at the anterior end and sharply pointed at the posterior end.

Mestobragma plattei plattei (Thomas)

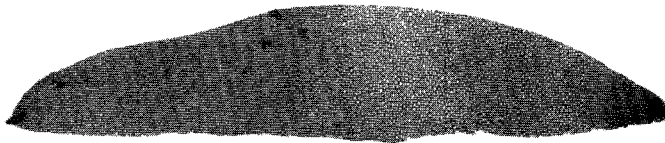
(Plate 9, fig. 2)

Color: Russet brown. Average size: 5.65 mm. x 1.35 mm.

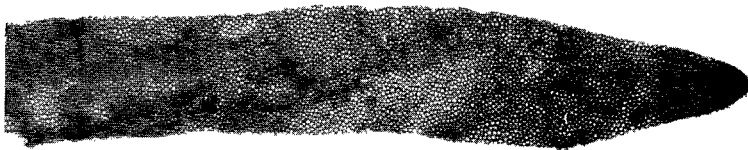
Sculpturing: There are four distinct types of sculpturing on the egg. At the anterior tip is a small number of irregularly shaped cells whose boundaries have heavy ridges. Next to this area is a band occupying about one-fourth of the egg, in which the sculpturing consists of long, heavy ridges suggesting brain coral and not enclosing cells. The ridges show under high power tuberculate lateral projections and a single line coursing along the middle of them. These lines give off short, lateral projections in such a manner as to suggest the remnants of the typical hexagonal and pentagonal cellular pattern. Except for a narrow band immediately anterior to the cap, the remainder of the egg is covered by a third



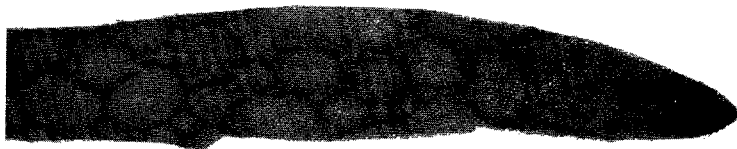
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PLATE 10

type of sculpturing (Plate 1, fig. 14). This type is composed of fragments of ridges arranged as the remnants of the boundaries of pentagonal and hexagonal cells. The fourth type of sculpturing found on the body occurs in a narrow band just anterior to the cap. The irregular ridge fragments of the previous band come close together then unite, enclosing flattened, circular cells within pentagonal and hexagonal boundaries. The cap is completely covered with pentagonal and hexagonal cells whose boundaries are somewhat broader and heavier than the ridges on the body cells. Groups of granules occur at the centers of the cells and between the ridges on the entire egg. The micropyles are cylindrical with a relatively large opening, but are not prominent.

Orchelimum vulgare Harris

(Plate 9, fig. 4)

Color: Brown. Average size: 5.90 mm. x .84mm.

Sculpturing: The egg is not differentiated into body and cap. The sculpturing at one end suggests nucleated epithelial cells (Plate 1, fig. 12) and is quite characteristic of this species. The remainder of the egg is marked by minute dots so arranged that a transparent network is produced which forms the boundaries of pentagonal and hexagonal cells. Scattered in this area at about one-fourth the distance from the end may be seen the relatively large micropyles. In the transition area between the two types of patterns, groups of small dots are replaced by larger dots in the form of "nucleated" pentagonal and hexagonal cells.

Orphullela pelidna (Burmeister)

(Plate 9, fig. 3)

Color: Light brown. Average size: 4.08 mm. x 0.95 mm.

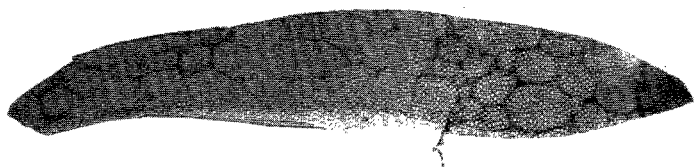
Sculpturing: The body of the egg is free from sculpturing, but presents a definite granular appearance. The basal portion of the cap is faintly marked with hexagonal cells, with irregular, dotlike centers, but on the distal two-thirds of the cap the cells are reduced to narrow spaces separated by broad, brown boundaries. The distal third of the cap is reddish-brown to black, a feature which serves to differentiate this egg from others having a smooth chorion. The micropyles appear as a long, tapering funnel and are prominent.

Pediocetes nigomarginata Caudell

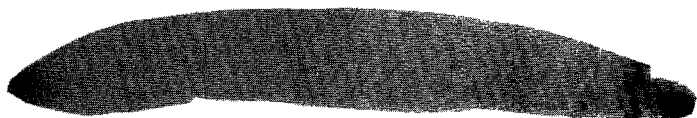
(Plate 10, fig. 1)

Color: Brown. Average size: 6.76 mm. x 2.21 mm.

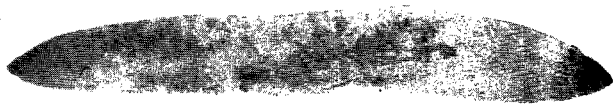
Sculpturing: The egg is not differentiated into body and cap. The entire chorion is marked by a homogenous sculpturing of pentagonal and hexagonal cells with narrow, granular boundaries, the inner faces of which have a characteristic nodular appearance which serves to distinguish the egg. The micropyles are narrowly conical and are located irregularly.



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PLATE II

Philobastoma quadrimaculatum Thomas

Color: Light brown. Average size: 4.8 mm. x 1.43 mm.

Sculpturing: The body of the egg is smooth or without a cellular pattern. The cap is reticulated only on the distal half, which is granular and sparsely covered by about 7 rows of rounded and brownish-pigmented, faintly outlined cells. The egg closely resembles that of *Encoptolophus sordidus*, but can be differentiated from it by the absence of any hexagonal cells on the cap and by the rounded tips of the cap cells which are thickened and sometimes crenated. The micropyles are cylindrical and fairly prominent.

Phoetaliotes nebrascensis (Thomas)

(Plate 10, fig. 2)

Color: Olive to brownish-yellow. Average size: 4.4 mm. x 1.1 mm.

Sculpturing: A complete reticulation of hexagonal and pentagonal cells covers the egg except the brownish tip of the cap. The cell boundaries consist of narrow ridges, which are slightly heavier at the anterior end of the egg. The cells are compressed immediately before the micropyles suggesting fish scales. A narrow band, largely devoid of cells, separates the cap from the body. The cap cells tend to be lengthened and the first four or five rows of cells are more heavily outlined and irregularly shaped than are the distals. The micropyles are broadly conical and fairly prominent.

Schistocerca lineata Scudder

(Plate 10, fig. 3)

Color: Wine-red. Average size: 6.52 mm. x 1.178 mm.

Sculpturing: The entire egg is covered with a fairly uniform reticulation of hexagonal and pentagonal cells, separated by moderately heavy boundaries. Dotlike thickenings occur at most of the cell boundary intersections. The thickenings are triangular at the anterior end of the egg. A narrow, indistinct, light band occurs at the micropyles. The micropyles are relatively inconspicuous. The red color serves to distinguish this egg.

Schistocerca obscura (Fabricius)

(Plate 10, fig. 4)

Color: Dark brown. Average size: 5.96 mm. x 1.55 mm.

Sculpturing: A sculpturing covers the entire egg and forms pentagonal and hexagonal cells. Small, dotlike triangular thickenings occur at the boundary intersections of the body cells. The thickenings are somewhat obscured by the brown pigment, of the cell boundaries. Immediately before the micropyles are three rows of more heavily outlined, irregularly shaped, somewhat flattened cells which have no thickenings in their corners. These cells serve to distinguish the egg from that of *Schistocerca lineata*. The entire

cap is covered with irregularly shaped cells with heavy boundaries in which the dotlike thickenings are obscure in the basal rows and apparently absent towards the tip. The micropyles are obscure.

Spharagemon collare (Scudder)

(Plate 11, fig. 1)

Color: Light brown; lighter longitudinal stripes.

Average size: 5.31 mm. x 1.36 mm.

Sculpturing: The body is largely covered by relatively faintly outlined pentagonal and hexagonal cells with prominent, triangular thickenings at the border intersections. These thickenings, however, are nearly or entirely absent from those cells in areas which were in close contact with other eggs in the pod. The reticulations are slightly heavier at the anterior end, and the thickenings in the corners of the cells are triangular, causing the cells to be rounded. Anterior to the micropyles, there is a smooth area about as wide as nine rows of cells in which the cell boundaries gradually fade out. The boundaries of the basal two rows of cap cells are indistinct but become progressively heavier. The entire remainder of the cap is covered with elongated cells, the first four rows of which are irregular in shape and have thickenings in their corners. The micropyles are broadly conical and prominent.

Sparngemon equale (Say)

(Plate 11, fig. 2)

Color: Light brown. Average size: 4.55 mm. x 1.18 mm.

Sculpturing: The body of the egg is covered by pentagonal and hexagonal cells with faint, narrow boundaries. There are well developed, triangular thickenings in the corners of all the cells, but at the extreme anterior end of the egg the thickenings may have short processes giving the egg a spiny appearance. Next to the micropyles, the sculpturing becomes progressively fainter, forming a clear band about six cells wide. The basal half of the cap is covered by faintly outlined cells most of which have the corner thickenings. Next to these are elongated cells with corner thickenings in broader boundaries. The distal third of the cap is characterized by narrow cells, with broad, brownish boundaries in which the thickenings are obscure or absent. The micropyles are conical and prominent.

Syrbula admirabilis (Uhler)

(Plate 11, fig. 3)

Color: Light brown. Average size: 4.39 mm. x .98 mm.

Sculpturing: The chorion is devoid of sculpturing but has a granular appearance. The granules on the cap are larger and brownish, while those on the body are small and nearly hyaline. A narrow band, almost devoid of granules, occurs just anterior to the cap. The large, brownish granules at the tip of the cap are so

arranged as to suggest an indefinite and irregular network. The micropyles are broadly conical, nearly hyaline but readily seen.

Tettigidea parvipennis pennata Morse

Color: Dark brown. Average size: 3.29 mm. x .70 mm.

Sculpturing: The egg is not divided into cap and body regions, but the anterior end is attenuated into a spurlike structure. The entire chorion is covered with a well-developed reticulation which forms pentagonal and hexagonal cells. The vitelline membrane bears numerous brown spots which may give a mounted section a spotted appearance.

Trachyrachis kiowa kiowa (Caudell)

(Plate 11, fig. 4)

Color: Brown. Average size: 5.09 mm. x 1.2 mm.

Sculpturing: The body of the egg is completely covered by a well developed almost uniform reticulation which forms pentagonal and hexagonal cells with broad ridged boundaries. The reticulation at the anterior end of the egg is slightly heavier than at the middle. Under high magnification, the sides of the ridges appear nodular and irregular while the cells are filled with minute, irregularly shaped granules. Immediately anterior to the micropyles, the cell borders are wider and the cells smaller and more rounded. The entire cap is covered by pentagonal and hexagonal cells whose boundaries are heavier than are those of the majority of the body cells, but the sides are uneven on the basal half of the cap (Plate 1, fig. 5). Near the tip they become even, but granules are present in all the cells. The micropyles are wishbone-shaped and form a brown, narrow, band around the egg. The reticulation is uninterrupted by the micropyles.

Trimerotropis citrina Scudder

Color: Brown. Average size: 5.33 mm. x 1.39 mm.

Sculpturing: Almost the entire body of the egg is characterized by pentagonal and hexagonal cells with nodules in their centers and with pale, thin borders which have triangular thickenings in their corners. Nodules and thickenings may be missing from some cells, particularly at the points where the egg was in contact with others in the pod. Immediately anterior to the micropyles, there is a band about as wide as the cap, in which the cells become progressively obscure and there are no nodules or thickenings present. A wide, nearly clear band therefore extends before the micropyles. The entire cap is marked by a cellular reticulation whose boundaries are much more heavily developed than are those of the body cells and the cells are more irregular in shape. They are more elongated and crowded than the body cells, but the thickenings are even more pronounced but central nodules are lacking. The sculpturing at the tip is somewhat obscured by the brownish coloration. The micropyles are funnel-shaped and nearly hyaline, but fairly prominent.

Segregation of the Egg Patterns Into Groups

This study of the chorionic markings of the 48 species of grasshopper eggs has indicated some rather interesting species groupings on the basis of chorionic patterns. The present-day classification of these species according to Hebard (1931), and the regrouping according to the type of sculpturing is shown in the following tables. Just how significant this grouping is, remains to be seen. No definite conclusions can be made regarding it, but it is presented here as this study indicates. The eggs tend to segregate themselves into groups which do not coincide in all respects with the present taxonomic arrangement, which is based on adult characteristics.

Summary

1. The chorionic sculpturing of 48 species of grasshoppers has been described and a key constructed for their identification. The species studied belong in the following taxonomic groups: Family Locustidae, subfamily Acrydinae, 2; Acridinae, 9; Oedipodinae, 14; Batrachotetrigeninae, 1; Cyrtacanthacrinae, 21. Family Tettigoniidae, subfamily Conocephalinae, 1; Dectinae, 1.

2. The eggs have been photographed and the reproductions of most, of them are included herewith as a part of the discussion.

3. The chorionic pattern has not been found to vary sufficiently to cause any confusion in identification of the eggs. The key and descriptions are expected to provide means of identification during grasshopper egg surveys.

4. A method of removing mature eggs from museum specimens of dried grasshoppers has been devised and used. This makes available eggs of the less common species of grasshoppers from pinned specimens for study, and makes possible the identification of females of species which are difficult to distinguish, as for example those of *Melanoplus mexicanus* and *M. femur-rubrum*.

5. A new and rapid technique has been developed for making microscopic mounts of sections of grasshopper egg choria. Absolute tertiary butyl alcohol was used as the dehydrating agent.

6. The grouping of species on the basis of similarity in chorionic patterns differs materially from the usual taxonomic classification.

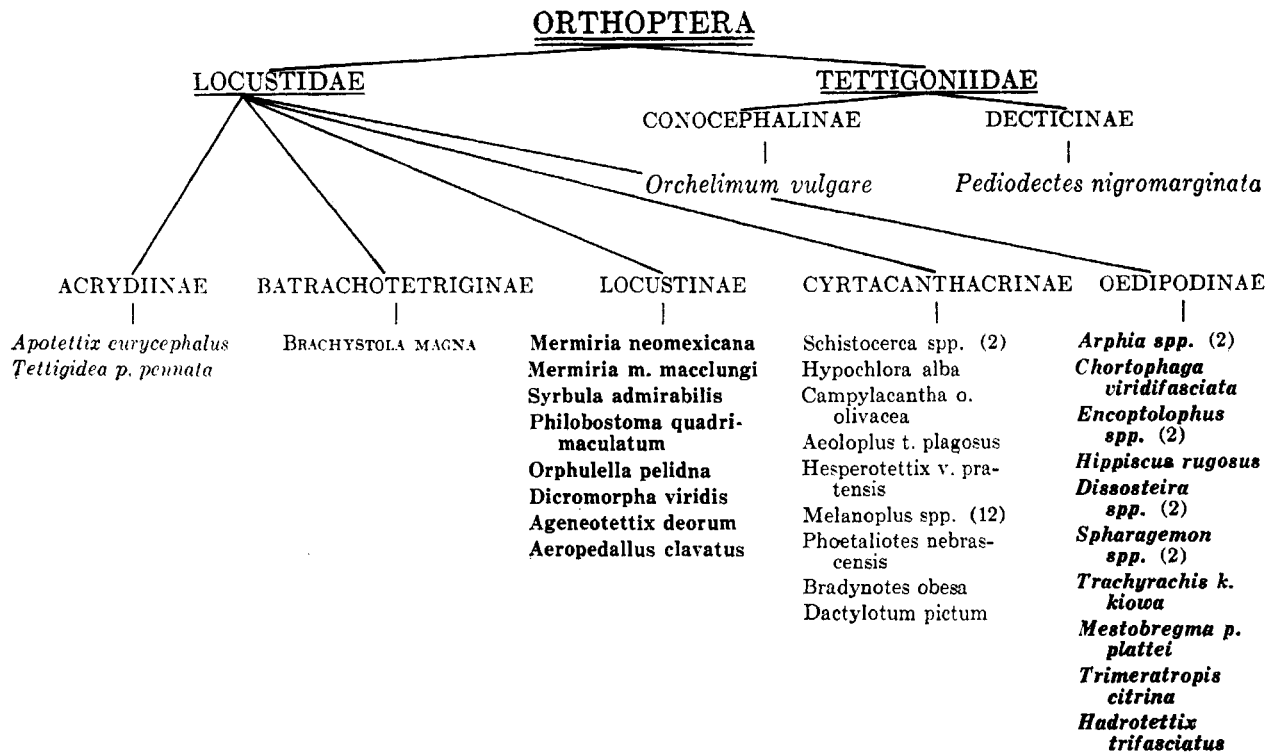


FIG. 1.—The species of grasshoppers studied arranged according to Hebard (1931).

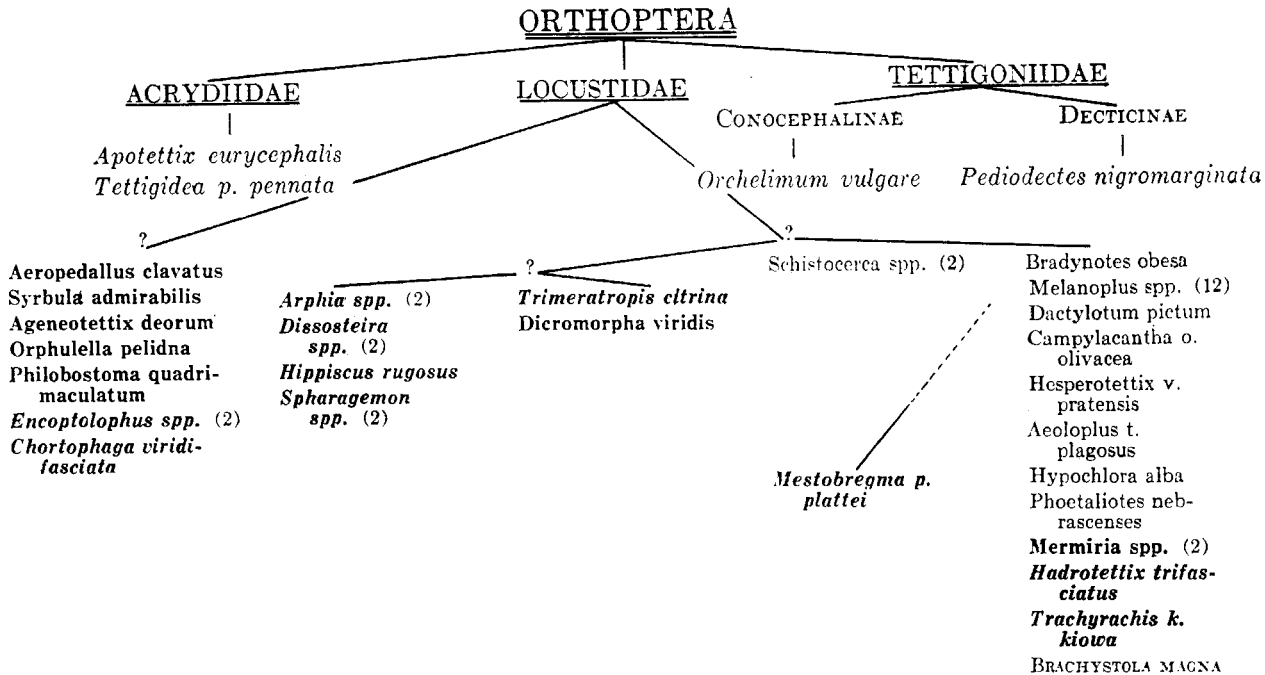


FIG. 2.—The species of grasshoppers studied arranged according to similarity of egg patterns. (The style of type of figure 1 is maintained to show the distribution of Hebard's groups through the egg groups.)

LITERATURE CITED

- BUSHLAND, RAYMOND C.
A study of the sculpture of the chorion of the eggs of eighteen South Dakota grasshoppers (Acridiidae). Unpublished thesis. South Dakota State College of Agriculture and Mechanic Arts. 31 pp., 1934.
- HEBARD, MORGAN
The Orthoptera of Kansas. Phil. Acad. Nat. Sci., Proc. 83:220-227. 1931.
- KUNKEL D'HERCULAIS, J.
Du role' de l'air dans le mecanisme physiologique de l'eclosion, des mues et de la metamorphose chez les insectes Orthopteres de la famille des Acridides. Comptes Rendus de l'Academie des Sciences, 110:809. 1890.
- RATANOV, J. N.
The description of locust egg pods. (In Russian) West Sib. Bord. Plant Protect Sta., Bul. Issue on Locusts, 30 pp. 1935.
- SLIFER, E. H.
Insect development VII. Early stages in the development of grasshopper eggs of known age with a known temperature history. Jour. Morph. 56:593-602. 1934.
- SNODGRASS, R. E.
Principles of insect morphology. New York. The MacMillan Company. 667 pp. 1935.
- UVAROV, B. P.
Locusts and grasshoppers. London. Imperial Bureau of Entomology. 273 pp. 1928.