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STRUCTURAL FEATURES OF COCKROACH EGG CAPSULES. III. THE OOTHECA OF *EURYOTIS FLORIDANA* (ORTHOPTERA: BLATTIDAE)[1]

FRED A. LAWSON

Department of Zoology and Entomology
The University of Tennessee, Knoxville, Tennessee

The structural features of the ootheca of *Eurycotis floridana* (F. Walker) are described in this paper, the third in a series dealing with these investigations. The descriptions are based on capsules from a laboratory culture developed from females taken on a collecting trip near Tampa, Florida.

E. floridana, the large florida roach (Blatchley, 1920), is the biggest and heaviest of the native North American species of Blattinae; adults of some of the *Periplaneta* group may, by including the wings, exceed this species in length but cannot match it in breadth of body and generally robust build. The egg case is mentioned briefly by Blatchley (1920).

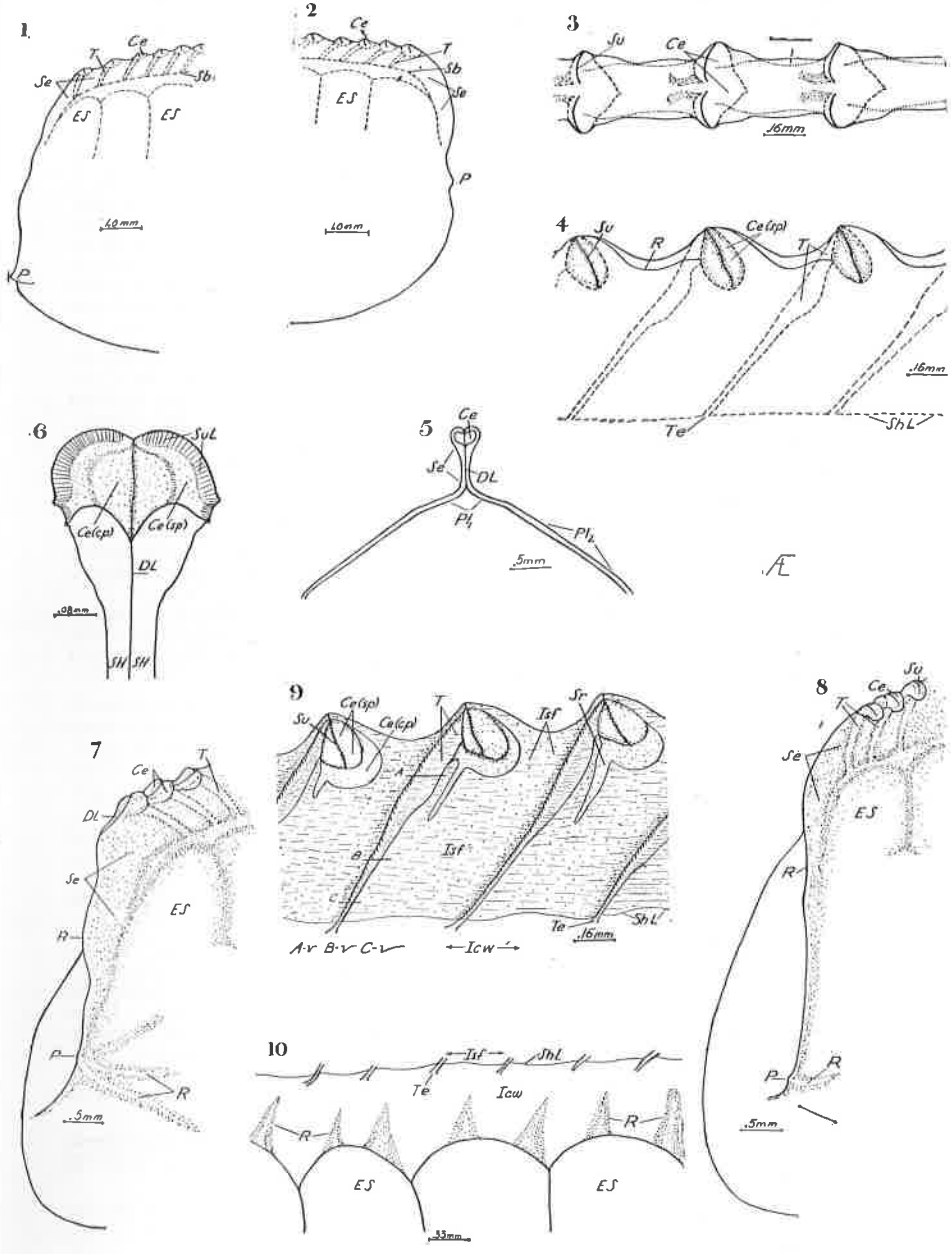
EXTERNAL FEATURES

Side View. This is the largest of the series of egg capsules of Blattinae studied thus far; the average size is 13 mm. in length by 8 mm. in depth, and about 5.5 mm. through at the point of greatest lateral divergence. The normal capsule is oblong-rectangular in shape, with top and bottom surfaces almost parallel and with the ends only slightly rounded. The body of the ootheca is dark chocolate brown in color, while the keel is conspicuously lighter. The side walls just beneath the seam base extend outward and slightly downward (*Pl*$_1$, Fig. 5) to a level slightly below the escalloped border which marks the dorsal margin of the egg seats within (*ES*, Fig. 1). Here the capsule walls bend into a second flattened plane, after which they flare roundly outward and curve evenly downward and around to form the lower surface. The second plane of the capsule wall is divided vertically into a series of broad, slightly concave ridges separated by vertical, more or less groove-like impressions. Each such broad ridge is topped dorsally by an inverted "U" curvature; these ridges and grooves are terminated ventrally in a somewhat similar manner along the line at which capsule wall arches outward to round out the lower two-thirds of the capsule. This implies that the dorsal portion of each egg is tightly bound into place by the upper parts of the capsule walls as they converge toward the seam base; such is borne out by an examination of the interior of the ootheca.

[1]Departmental contribution No. 57.

PLATE I. Fig. 1. Distal end of capsule, side view. Fig. 2. Proximal end of capsule, side view. Fig. 3. Top view of seam. Fig. 4. Side view of seam. Fig. 5. Section through seam and upper portions of capsule. Fig. 6. Section through cell, enlarged. Fig. 7. Proximal end of capsule, oblique view, enlarged. Fig. 8. Distal end of capsule, oblique view, enlarged. Fig. 9. Inside face of seam, side view, enlarged. Fig. 10. Inside face of capsule and top of egg seats, side view, enlarged. *Abbreviations Used*: *Ce*—Cell, *cp*—central pocket of cell, *DL*—Dehiscence line (hatching line), *ES*—Egg seat, *Icw*—Inner capsule wall, *Isf*—Inner seam face, *P*—Point, *Pl*$_1$ and *Pl*$_2$—Planes of upper capsule wall, *R*—Ridge, *Sb*—Seam base, *Se*—Seam, *SH*—Seam half, *ShL*—Shoulder line, *sp*—Side pocket of cell, *Sr*—Spur, *Su*—Suture, *Su L*—Suture lip, *T*—Tube, *Te*—Tube ending.

The profile of the ends of the egg-case are noticeably different and are designated as distal and proximal according to the sequence of formation; the distal is formed first. Either can be identified by keel termination differences



as well as by the direction of the slope of the tubes, which extend distally and downward from the cells through the seam.

The distal end (Fig. 1) is slightly pointed in general outline, with the reversal of curvature occurring at about ¾ the depth of the capsule. The seam termination extends down the end-face as a thin, usually somewhat sinuate ridge of gradually diminishing height (*Se*, Fig. 1); it may be nearly absent from about the half-depth level, but usually continues as a very faint, slightly elevated ridge extending to the point of reverse curvature. The ending here is abruptly marked in most capsules by a somewhat more elevated and sharply defined triangular point.

The proximal end (Fig. 2) is shaped up after the last of the eggs has been placed and bears an impression of certain portions of the ovipositor. The variously sinuate flange-like termination of the seam extends for only a short distance down the end and blends rather abruptly with the darker capsule wall material (*Se*, Fig. 2). This is usually followed by a slight to moderately pronounced cupping in the profile, after which the end curvature blends roundly into the lower margin. The cupped area is usually crossed by a comparatively broad and but slightly elevated ridge which ends as a point having rather broad and faintly raised arms; these extend laterally and slightly caudally to blend into the surface.

End Views. The general end view of this species of ootheca reveals an almost evenly rounded lower margin which rounds into the sides; these are smoothly but less extensively rounded as they extend upward. The smooth upward curvature continues about one-half of the total depth of the capsule, then turns smoothly inward toward the center line. At a point about two-thirds up the sides, the gradual inward curvature ceases and the walls extend almost straight toward the seam base on a line making an approximately forty-five degree angle with the horizontal. A slight change of angle, to about thirty degrees, is found just laterad of the seam base, from which point the capsule walls extend toward the center line. From here the opposing sides of the capsule wall extend upward with their inner faces closely appressed, thus forming the seam.

The two end-faces (Figs. 7, 8) present a variety of differences, which includes both those from the differing terminations of the seam and those from the sculpturings left by the ovipositor and other parts which helped shape up the ootheca.

Distal. The extremity of the seam merges into a thin ridge which extends down the end face; this ridge is tall and narrow and maintains about the same elevation down the thinner upper portion of the capsule. On the rounder, wider part of the end-face, the ridge rapidly loses altitude but has a wider base. It is slightly sinuate, especially in the lower third. This structure terminates in a pronounced, pointed elevation having an expanded triangular base (Fig. 8). The lower corners of the triangle are widespread and extend outward as they lose height. A faint line continues outward from the extremes of each of these basal corners and then blends into the curving face of the capsule. The ventral wall curves roundly backward from the base of the point.

Proximal. The seam drops off rather abruptly on this end (Fig. 7); the ridge into which it merges has a broad base but only a slight degree of elevation. The cupped portion of the profile is traversed by this nearly flat ridge, which then terminates in a well-defined point of greater height. From this point broad and nearly flat laterals extend outward and slightly downward; these often are not exactly paired in position on the capsule wall, since one or the other may leave the central point at a different angle. They frequently will vary in degree of definition as well, with some quite distinct and others so poorly developed as to be indicated only by lines. A variety of faint, radiating ridges is usually found on the end-face immediately above each longer basal ridge; these vary from specimen to specimen, both in number and in position.

Seam. The seam represents the closing (and ventilating) device of the egg capsule and is located dorsally above the line of mesal contact of the

eggs below; it occupies about ¾ mm. of the total depth of the egg case. Using transmitted illumination, it is seen as a light reddish brown, semi-transparent structure extending from one end of the ootheca to the other.

Side View. The general top line or crest is notably straight in most specimens; in a few, however, a slightly "sway-backed" curvature is found. With the exception of the end portions, the dorsal margin of the seam proper is regularly produced upward in a series of tooth-like projections (Fig. 4). The spaces between teeth are rather asymmetrical V-shaped indentations of the crest; the proximal face (of the notch) slopes downward rather abruptly into the usually obtusely angled trough, from which the distal notch-face slopes more gradually upward and backward. The proximal top portion of each tooth slopes toward the sides as well as downward; the lower edge of this slope generally ends in a small but sharply defined ridge which extends down the tooth, across the notch, and up to its lower-level termination on the distal face of the preceding tooth.

Each tooth contains a hollow space which is designated the cell; each is composed of two lateral outpocketings (*sp*, Fig. 4) and a centrally placed, more vertically disposed median pocket (*cp*, Fig. 9). The side pockets are the more noticeable in the external side view; they are seen as conspicuously lighter areas occupying the upper portion of the tooth in which located. Each is oval, slightly deeper than wide, and usually is constructed in such manner that the ventral extremity is slightly proximal to the dorsal, thus forming a noticeable angle with the seam vertical. The deeper central pockets usually, but not always, are seen as less conspicuous areas of low color density located proximally and ventrally of the side pockets.

A very dark, well defined ridge traverses upward along the lateral extremity of each side pocket (*Su*, Fig. 4); it extends around and upward from a point low on the side pocket wall to its termination on the dorsal seam face. This structural feature is composed of two closely appressed halves, between which a sutural opening is located. The opposing ridge faces are thus designated the sutural lips (*Sul*, Fig. 6). These lips are marked with regularly spaced vertical impressions; when the two lips are in the closed position, the impressions are oppositely placed in such a manner that a series of minute grooves crosses the mesal surfaces of the lips. These obviously constitute the passageway for gaseous exchange between the cell and the surrounding atmosphere.

A hollow tube (*T*, Fig. 4) originates medially on the upper distal face of each cell and extends downward and backward through the seam. The more distal margin of this tube is sharply defined and curves more or less regularly through the seam; the proximal, however, is quite irregular in outline. From its origin at the cell, it parallels the distal margin for a short distance, then bends rather abruptly downward; it curves back again to parallel the distal ridge through about one-third of the descent through the seam. From this level the proximal margin approaches the distal, so that the lower portion of the tube is slender and almost pointed.

Dorsal. The cell-bearing teeth extend laterally on each side (*Ce*, Fig. 3); the outward slope on the proximal face of each is gradual, whereas the inward angle of the sides comprising the distal face is rather abrupt. The median area of the seam just distal to the cell is sloped upward in a rather broad but short center ridge; the origin of the tube is within this structure. The suture-ridges curve around onto the dorsal surface from the sides and each then extends toward the center line in a proximally directed arc. The mesal terminations are not in contact. The median area of the top of each tooth is slightly grooved longitudinally, with the line of dehiscence at the bottom.

The seam face between teeth usually has a slightly elevated center line, with a small degree of slope to either side; in most capsules this slope flattens out laterally and merges into the sharp side ridge described above.

Internal Features

Cells. The central pocket (*cp*, Fig. 9) of each cell is made up of opposing halves engraved into the inner seam faces; they may extend comparatively

deeply into the seam but their transverse measurement is usually smaller. The proximal margin of each may originate on the roof of the cell or at some point further down the proximal mesal wall of the side pocket. From the origin, each extends proximally, then downward and backward through the seam. The ventral margin usually is curved and more or less parallels the floor of the side pockets. The lower distal area of each is usually extended downward and backward as a hollow "spur" which more or less parallels the tube. The length of these varies considerably, even within a single capsule.

The side pockets (*sp*, Fig. 9) are hollow evaginations of the seam wall material; the cell roof continues laterally to cover both of these as well as the central pocket. The floor of each curves upward, then downward to a latero-ventral depression below the end of the suture line. The proximal and distal sides converge outward and meet on the sutural line; the proximal has a greater amount of curvature so that the two sides meet on a line somewhat distal of the median plane.

Tubes. Each assembled tube is made up of two halves, or grooves, which are engraved into the inner seam face; each has a roughly triangular cross-section at a point just below the cell (*A*, Fig. 9). The base of the half-inverted triangle is the distal wall of the tube; this wall, which is engraved at right angles into the seam face, continues downward to the seam base with little change except in depth. The sides of the triangle are engraved in such manner that the triangular opening is tall and slender from just below the cell to a point about half way down the tube; at this level the proximal side begins converging toward the distal wall so that the lower portion of the tube (*C*, Fig. 9) has a smaller and more sharply outlined triangular cross section. The tube usually follows a slightly sinuate pathway down through the seam.

Inside seam face. The inside faces of the seam, where not engraved with the cell and tube parts, are smooth and appear polished; these surfaces under very high magnification exhibit minute circular impressions commonly seen in other parts of the capsule. The grooves representing the tube-halves are shining-smooth and lack the impression pattern found in the areas shaped up by the softer tissues of the female roach. Slight irregularities and roughenings on the faces are also seen at higher magnifications.

The shoulder line (*ShL*, Fig. 9, 10) is the broadly rounded area connecting the inside seam face with the capsule wall inside the egg concavity; the tips of the air tubes usually cross this line and terminate just below on the inner capsule wall. The exact shoulder area is often marked by faint longitudinal ridges which curve both upward and downward from the ending of the tube; the one distal to the tube usually is short and curved slightly upward in one arc. The proximal ridge, when present, usually is longer and exhibits a slight sigmoid curvature. This general area is at times occupied by a variety of small humps and broad flat ridges.

Inner capsule wall. The inner face, above the egg concavities and below the shoulder (*Icw*, Fig. 10), is marked by broad, slightly elevated ridges; these in most capsules slope somewhat proximally, usually maintaining about the same angle with the horizontal as exhibited by the tubes in the seam. Variably defined pairs of these elevations are found on the capsule wall above each egg seat in most capsules (*R*, Fig. 10). Each is broadest at the base (adjoining the top of the egg seat) and usually tapers to a pointed termination below the shoulder line. These paired ridges divide the top curvature of the egg seat into three parts, of which the distal and central are of about equal width and are about one-third wider than the proximal. The proximal area thus set off continues down to the point where the next egg seat adjoins. The area of inner capsule wall lying immediately above the egg depressions is likewise divided into three parts; that distal to one egg seat is continuous with that proximal to the next, thus forming a slight depression area common to both. The central area set off above each egg seat is independent, associated with only that one impression. The joint space-depression fitting down into the niche between each two egg seats is sloped backward at the same angle as that of the ridges which delineate it; in many cases this depression is hollowed out into a clearly defined, sharp pointed concavity, which suggests that

it may be the imprint of some part of the ovipositor involved in the placement of the eggs within the new capsule.

Egg placement. In relatively new capsules, it was found that the dorsal ends of the eggs were squeezed tightly into the space enclosed beneath the sloping planes of the capsule wall; the caudal ends were enclosed in the back of the capsule but were not crowded for space. The relatively deep, slightly concave egg seats extend downward in the capsule only so far as the lower margin of the second flattened plane of the walls; below this level the pressure evidently is not so great and the eggs are not squeezed into place. The eggs have been found entirely free of the back wall of the capsule and are easily dissected while the capsule is still new. The space between the capsule wall and the caudal poles of the eggs is occupied in part by quantities of a light frothy substance which dries into irregular and brittle but fragile sheet-like masses. It apparently has approximately the same origin as the capsule material, since it contains a few of the square crystals found abundantly in the walls. It also contains many circular holes, which correspond in size and distribution to the air bubbles seen in the still-white new capsules. The exact origin and function of this material has not as yet been determined.

Summary

Eurycotis floridana produces an ootheca larger but otherwise similar to those made by other roaches of the subfamily Blattinae. The eggs are enclosed in the capsule proper, which is closed dorsally and above the median line by closely appressed, vertically produced side-wall extremities; these are modified into a series of typical structures which provide for the respiratory needs of the eggs below. This closing and ventilating mechanism is known as the seam, which extends the length of the capsule. Its termination on the end-faces of the capsule is typical for both the distal and the proximal ends; characteristic sculpturings left by parts of the ovipositor and by other tissues aiding in the formation of the capsule likewise are found on each end. Egg placement and certain internal structural characteristics are also discussed.

Literature Cited

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NEWS OF TENNESSEE SCIENCE

(Continued from page 7)

from the University of Virginia, and Dr. Tom D. Norman, from Tulane University. Added to the staff of the Division of Surgery are Dr. Frank C. Wilson of Birmingham, Ala., and Dr. William A. Neely, Banks, Miss.

At Vanderbilt University: Dr. Robert Jack Neff of Johns Hopkins University and Hal H. Ramsey of the University of Texas, have received appointments in the Department of Biology, the former as Assistant Professor of Zoology, the latter as Assistant Professor of Bacteriology. Dr. Elsie Quarterman and Dr. J. J. Friauf have each been promoted from assistant to associate professors. A new division of Industrial Research, serving principally the industries of Middle Tennessee, was authorized for Vanderbilt University by its Board of Trust at its October, 1952, meeting. All of the science departments of the university will be drawn upon for the establishment of this division.

James A. Setliff, B.S. in Chemistry from Vanderbilt University, and for the

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