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THE EGG OF *HOFMANNOPHILA PSEUDOSPRETELLA* (OECOPHORIDAE): FINE STRUCTURE OF THE CHORION[1]

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ABSTRACT. The egg of *Hofmannophila pseudospretella* (Stainton) was studied by scanning and transmission electron microscopy. The egg is usually obovoid but varies to ellipsoid or subcylindrical (0.58 × 0.41 mm). The basic pattern of sculpturing consists of low-lying longitudinal ridges joined by indistinct transverse ridges with the ridge intersections slightly elevated. This pattern is sometimes poorly developed, but the slight prominences formed by intersecting ridges are always evident. The surface of the chorion has a wrinkled or granular texture. There are 3 to 5 micropylar canals opening into an anterior pit which is surrounded by a rosette of rather short, petal-shaped primary cells. The primary cells are in turn partially or completely surrounded by series of secondary and tertiary cells. The aeropyles open on slight prominences near the anterior and posterior ends of the egg. Openings are quite abundant in these areas, but there are none elsewhere. Typically, the openings are funnel-shaped and may or may not be surrounded by collars. The chorion averages 4.23 μm thick, and in general structure is similar to that of other lepidopteran eggs.

The brown house moth, *Hofmannophila pseudospretella* (Stainton), is a cosmopolitan, household, mill, and storage pest. The larvae are omnivorous scavengers and attack a wide range of plant and animal products. In North America, *H. pseudospretella* is found from California north to British Columbia and east to Manitoba; there are isolated eastern records from Pennsylvania and southwest Greenland (Hodges, 1974). It has been recorded from cantaloupe seed, celery seed, fish meal, grain, mixed feed, lima beans, and milo in California (Strong & Okumura, 1958; Okumura & Strong, 1965). In Europe, *H. pseudospretella* is a common pest of stored products. Woodroffe (1951) reported that it is widely distributed in Britain, where it occurs in dwellings, stores, and mills as well as outdoors in bird nests. It occasionally becomes a major pest attacking bulk wheat, bagged flour, and other stored commodities. In the home, it is most often important as a clothes

[1] Mention of a proprietary product in this paper does not constitute an endorsement of the product by the USDA.

moth. It is common and generally distributed in New Zealand where it is most often a pest of carpets (Somerfield, 1981).

Woodroffe (1951) gave an account of the life-history of *H. pseudospretella*, including a brief description of the egg. However, there have been no detailed studies of its chorionic structure. The study reported here was conducted as part of a project to characterize the eggs of stored-product insects and to facilitate their identification. The only other oecophorid egg that has been studied is that of the white-shouldered house moth, *Endrosis sarcitrella* (L.) (Arbogast et al., 1983).

MATERIALS AND METHODS

Laboratory cultures of *H. pseudospretella* were established with adults that emerged from food packets (Strong, 1970) placed in an old shed and an old barn near Castroville, California. Voucher specimens have been deposited in the U.S. National Museum of Natural History. The moths were reared in the laboratory at 25 ± 1°C on 950 ml quantities of cracked wheat in 3.79 l jars. Cultures were maintained in a room at 60 ± 5% RH, but additional moisture was provided by a watering device in each jar. This consisted of a plastic vial (6 cm deep × 4 cm inside diameter) filled with water and covered with a piece of 11 cm filter paper that served as a wick. The filter paper was held in place by the vial's snap-on cap, which had a hole 25 mm in diameter cut in its center. The vial was placed in an inverted position on the bottom of the jar, and wheat was poured on top of it.

Eggs were collected by confining moths in 0.95 l jars without food. Each jar was covered with screen secured by a screw-type lid, and each contained a piece of pleated black construction paper to provide a resting place. Jars containing moths were held in a desiccator over a saturated solution of KNO_3, which provided an RH of ca. 92%. The moths oviposited freely in this situation, and the eggs, which adhered very lightly or not at all to the surfaces on which they were deposited, were collected by shaking them onto a piece of paper. After they were collected, the eggs were washed by gentle agitation or sonication for ca. 5 min in a 1% solution of Triton X-100®, rinsed in distilled water and air dried.

For examination in the scanning electron microscope (SEM), the eggs were mounted with double-sided tape on SEM stubs and sputter-coated with gold. They were examined with an International Scientific Instruments, M-7® SEM at 15 kV. Approximately 250 eggs selected arbitrarily from groups laid by ca. 30 females were examined. Length and width were determined from a sample of 33 eggs. Measurements were made on the display screen of the microscope at a magnification

of ×150. The diameter of 18 aeropylar openings was determined from micrographs at either ×15,000 or ×20,000. The openings measured were on 13 different eggs. Counts of primary cells were made on a sample of 20 eggs, either from the screen or from micrographs. All measurements and counts are given as mean ± standard deviation (S.D.). The terminology used in describing the structural features of the chorion is the same as used by Arbogast et al. (1980).

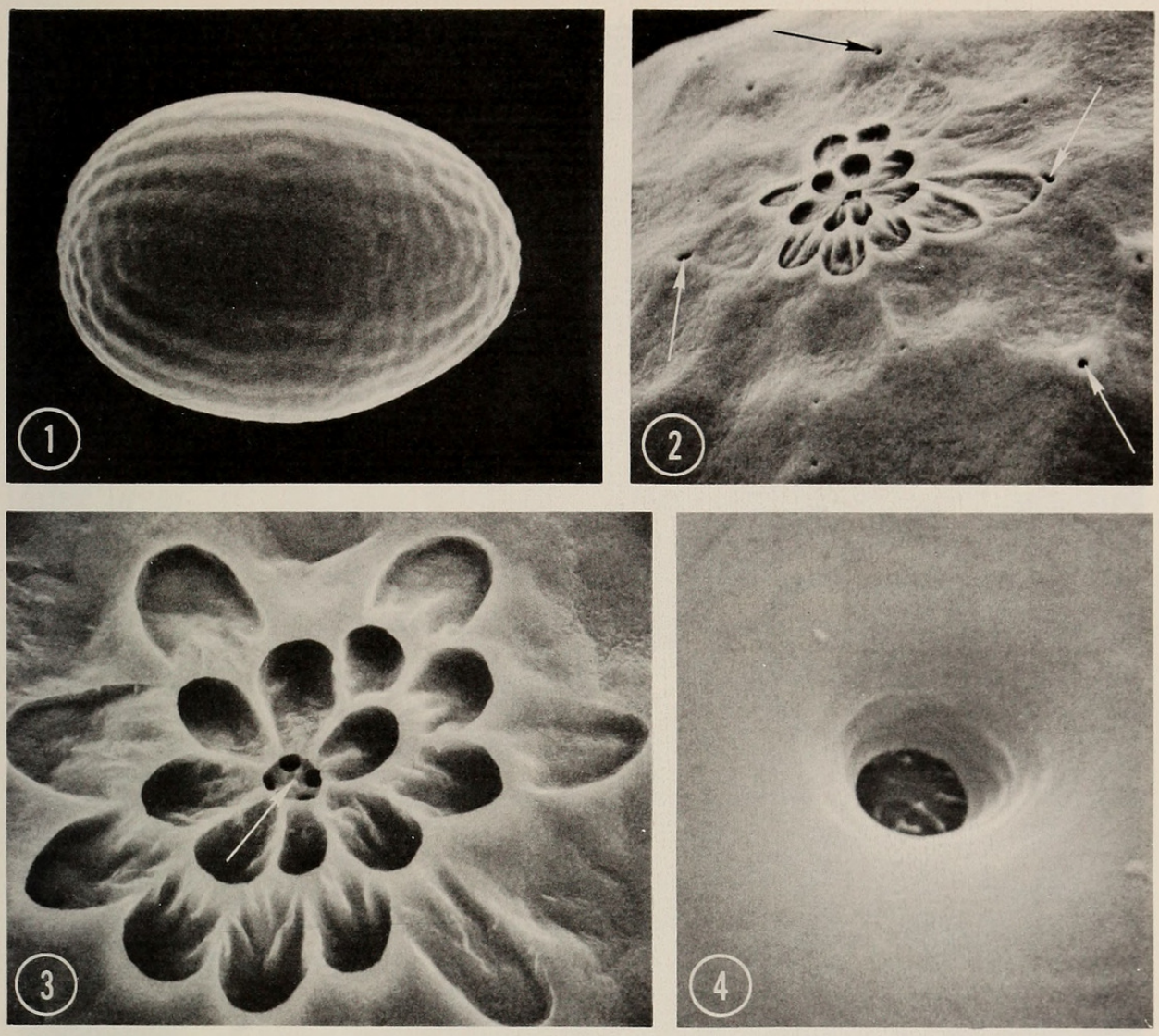
For examination by transmission electron microscope, the eggs were punctured with a minuten pin, fixed overnight in cold glutaraldehyde (5% in Millonig's buffer, pH 7.4), rinsed in Millonig's buffer, and post-fixed overnight in osmium tetroxide (1% in Millonig's buffer, pH 7.4). After fixation, the eggs were rinsed in Millonig's buffer and dehydrated in a graded series of water-ethanol solutions followed by ethanol and propylene oxide. Initial infiltration in a 1:1 mixture of propylene oxide and embedding resin (Araldite 6005®) overnight was followed by infiltration overnight in a 1:2 mixture of propylene oxide and resin and infiltration for three days in pure resin. After infiltration, the eggs were transferred to resin which was then cured at 48°C overnight. Sections were cut using a glass knife on a Porter Blum MT-2B® ultramicrotome and stained by flotation of grids on a 1% solution of uranyl acetate in water for 7.5 min followed by flotation on Reynold's lead citrate for 2.5 min. The sections were examined in a Phillips EM-200®. The thickness of the chorion and each chorionic layer is given as mean ± S.D. All means are based on measurements of 14 sections taken from a total of four eggs that were selected arbitrarily from a group laid by 36 females.

Eggs from adults collected in France, near Rennes, were also studied by the same methods.

Results and Discussion

We found no differences between eggs of California *H. pseudospretella* and those collected in France. The eggs is usually obovoid but varies to ellipsoid or subcylindrical, 0.58 ± 0.04 mm long × 0.41 ± 0.02 mm in diameter at its broadest point (Fig. 1). Woodroffe (1951) described the egg as hard and shiny, oval and tapering toward one end. He noted that the eggs vary considerably in size and color and was able to distinguish two extreme types: (1) small and white, averaging 0.490 mm long and (2) large and yellow, averaging 0.595 mm long. Although Woodroffe stated that these differences persist throughout the incubation period, we were unable to distinguish such distinct types among the eggs we examined.

The egg is not boldly marked. Its basic pattern of sculpturing consists of low-lying longitudinal ridges joined by indistinct transverse ridges,



FIGS. 1–4. Egg of *Hofmannophila pseudospretella*. **1,** Lateral view of whole egg, anterior pole on left (×80). **2,** Anterior end showing micropylar area and aeropyles (arrows) (×570). **3,** Micropylar area showing central pit (arrow) with four micropylar canals opening on its periphery and rosette of cells surrounding the pit (×1140). **4,** Aeropyle near posterior end of egg (×8590); the inner layer of chorion, which forms the floor of the trabecular layer, is visible at the bottom of the opening.

the junctures being slightly elevated. This pattern is sometimes poorly developed and the ridges almost imperceptible, but the slight prominences formed by intersecting ridges are always evident, especially near the poles of the egg. The surface of the chorion has a wrinkled or granular texture (Figs. 2 & 3).

There are 3 to 5 micropylar canals opening into a central micropylar pit at the anterior pole of the egg (Figs. 2 & 3). The pit is surrounded by a rosette of 5–8 (6.9 ± 0.9) rather short, petal-shaped primary cells, which are in turn partially or completely surrounded by series of secondary and tertiary cells. The primary cells, and usually the secondary cells as well, are outlined by prominent carinae, and often carinal spurs extend into the cell discs. The tertiary cells, on the other hand, are

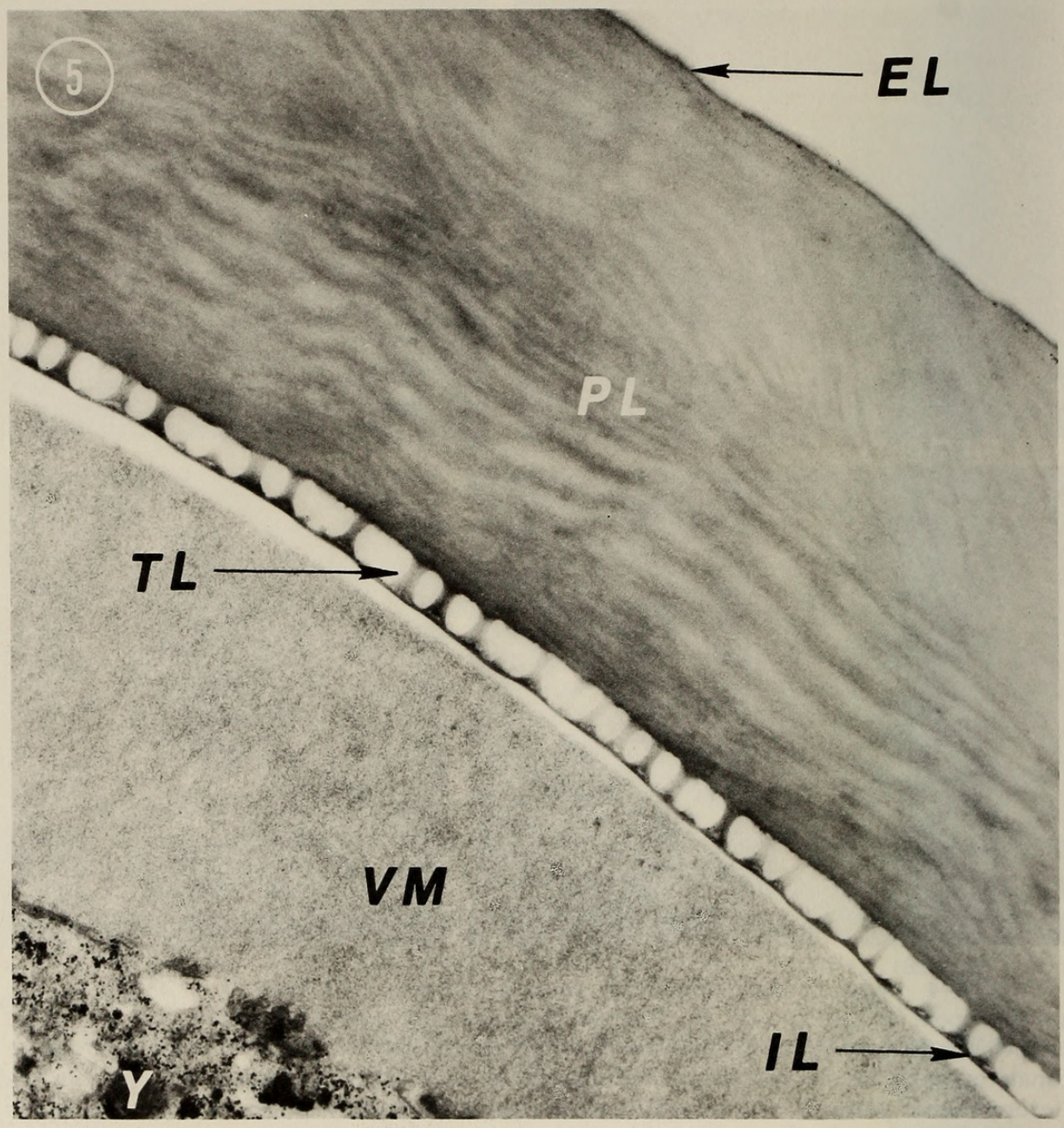


FIG. 5. Egg of *Hofmannophila pseudospretella*: thin section through the chorion and underlying membranes. **EL,** external layer of chorion; **IL,** internal layer of chorion; **PL,** principal layer of chorion; **TL,** trabecular layer of chorion; **VM,** vitelline membrane; **Y,** yolk material. (×13,340).

often outlined only by low-lying ridges and are thus poorly defined (Fig. 2).

The aeropyles open on slight prominences at the anterior and posterior ends of the egg (Fig. 2). Openings are relatively abundant in these areas but are absent elsewhere. Typically, the openings are funnel-shaped and may be surrounded by collars (Figs. 2 & 4). The diameter at the narrow end of the funnel ranges from less than 0.5 to more than 2.5 μm (1.0 $\pm$ 0.6 μm).

In sections (Fig. 5), the surface of the chorion appears quite smooth and devoid of mucilaginous colleterial secretions, which accounts for the failure of the eggs to adhere firmly to the substrate on which they are laid. There is no furrowing as in *E. sarcitrella* (Arbogast et al., 1983). The chorion averages 4.23 ± 0.76 μm in thickness, much thicker than the chorion of *E. sarcitrella*, which ranges from ca. 0.6 to 1.1 μm. The chorion of *H. pseudospretella* consists of four distinct layers (Fig. 5): an external layer (EL) (0.07 ± 0.03 μm), a lamellate principal layer (PL) (3.90 ± 0.72 μm), a trabecular layer (TL) (0.21 ± 0.05 μm) which consists of air held between vertical columns (trabeculae) and comprises the intrachorionic respiratory meshwork of the eggs, and an inner layer (IL) (0.06 ± 0.02 μm). Two layers can be distinguished within the principal layer by the orientation of the lamellae. These are parallel to the surface in the inner ⅖ of the principal layer but are usually oblique in the outer ⅗. This orientation as well as thickness may account for the resilience of the eggshell noted by Woodroffe (1951), who stated that "if an attempt is made to crush . . . [an egg] with a dissecting needle, . . . [it] will usually spring undamaged from beneath the needle." In the section figured, the vitelline membrane (VM) and yolk material (Y) are visible beneath the chorion. The egg from which this section was taken was newly laid; the vitelline membrane has not yet condensed, and the serosa and serosal cuticle have not developed.

The eggs of *H. pseudospretella* and *E. sarcitrella* resemble somewhat the eggs of Tineidae, but tineid eggs can be distinguished by the presence of microperforations in the surface of their chorion (Arbogast et al., 1980; Chauvin, 1977). The eggs of *H. pseudospretella* and *E. sarcitrella* have well-defined primary and secondary cells, and sometimes tertiary cells, in the micropylar area, but the remainder of the surface lacks cells, or has cells that are at best only faintly outlined and barely discernible. The eggs of all other stored-product moths that have been studied (except Tineidae) are marked by extensive reticulate patterns of well-defined cells and ridges; usually, these cover the entire surface of the egg (Arbogast et al., 1980; Arbogast & Byrd, 1981). Eggs of *E. sarcitrella* can easily be distinguished from those of *H. pseudospretella* by the maze-like pattern of closely spaced sinuous ridges that covers their entire surface and by the absence of aeropyles near their poles (Arbogast et al., 1983). In general structure, the chorion of *H. pseudospretella* is similar to most other lepidopteran eggs that have been studied (see, for example, Barbier & Chauvin, 1974; Chauvin & Barbier, 1976; Chauvin et al., 1974; Salkeld, 1973). The chorion is about the same thickness as that of *Galleria mellonella* (L.) (3.1 to 4.2

mm) (Barbier and Chauvin, 1974) but is thicker than that of *Tinea pellionella* L. (2.5 to 3.5 μm) or *Tineola bisselliella* (Hummel) (0.5 to 1.0 μm) (Chauvin, 1977).

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