

Development of Angoumois Grain Moths in Kernels of Wheat, Sorghum, and Corn as Affected by Site of Feeding¹

B. P. KHARE and ROBERT B. MILLS^{2, 3}

Department of Entomology, Kansas State University, Manhattan

ABSTRACT

Larvae of the Angoumois grain moth, *Sitotroga cerealella* (Olivier), which entered 0.34-mm holes predrilled near germ or into endosperm of wheat, sorghum, and corn kernels, developed at different rates. Larval-pupal periods in germ-drilled kernels averaged 32.5, 30.1, and 37.2 days in wheat, sorghum, and corn, respectively and 49.4, 50.2, and

72.5 days in endosperm-drilled kernels. X-ray techniques were used to study larval development. Number of instars as determined by larval mandible counts were 4 and 5 in germ-drilled kernels and 5-9 in endosperm-drilled kernels.

Various investigators have reported that the length of the larval-pupal period (L-P) varies widely among individual Angoumois grain moths even when reared under similar conditions. Mills (1965) suggested that differential feeding on various parts of wheat kernels may influence the length of the L-P period. The

same phenomenon, suspected in sorghum and corn kernels (Mills and Wilbur 1967), was investigated in this study using these grains and wheat.

MATERIALS AND METHODS.—The insects were from stock cultures of the Department of Entomology, reared at 27°C and 70% RH. All kernels were placed in the rearing room until moisture content reached an equilibrium with the relative humidity. The moisture contents were determined with a Motomco Moisture Meter to be 13.6, 13.4, and 13.5, respectively, in wheat, sorghum, and corn.

To establish a larva in germ or endosperm, a 0.34-mm-diam hole was drilled into a kernel either at the junction of the germ and endosperm or into the endosperm at the greatest distance from the germ (Fig. 1). A larva, 0-24 hr old, was placed with each kernel in a no. 00 or 000 gelatin capsule. Larvae usually entered the drilled holes.

Success of larval entry was determined by frass and silk filling the opening of the hole. Twenty infested kernels with holes in the germ and 20 with holes in endosperm were selected for each type of grain. The kernels were held in a fixed position for daily X-raying by gluing the capsule to a plastic sheet. Upon emergence of adults, the larval-pupal period, sex, longevity, and weight of each insect were determined. Daily radiographs provided evidence of the day-to-day development.

RESULTS AND DISCUSSION.—Based on the "F" test, the L-P periods of insects that entered holes at the germ in all grains studied were significantly shorter than periods for those that entered endosperm some distance from the germ (Table 1). Selected X-ray radiographs (Fig. 2, 3) clearly show more rapid development of those that fed early in the germ area. L-P periods of early endosperm feeders varied more, perhaps from varied feeding in different parts of the endosperm and on inner bran layers. MacMasters et al. (1964), reviewing research on composition of

¹ Contribution no. 935, Department of Entomology, Kansas Agricultural Experiment Station, Kansas State University, Manhattan. Supported in part by USDA, Market Quality Research Division, Cooperative Agreement 12-14-100-8404(51). Accepted for publication November 1, 1967.

² The authors gratefully acknowledge the assistance of Mr. R. P. Goswami, Statistician, Experiment Station, U. P. Agricultural University, Pantnagar, India.

³ AID Participant in Department of Entomology, now with U. P. Agricultural University, Pantnagar, India; and Assistant Professor, Kansas State University, respectively.

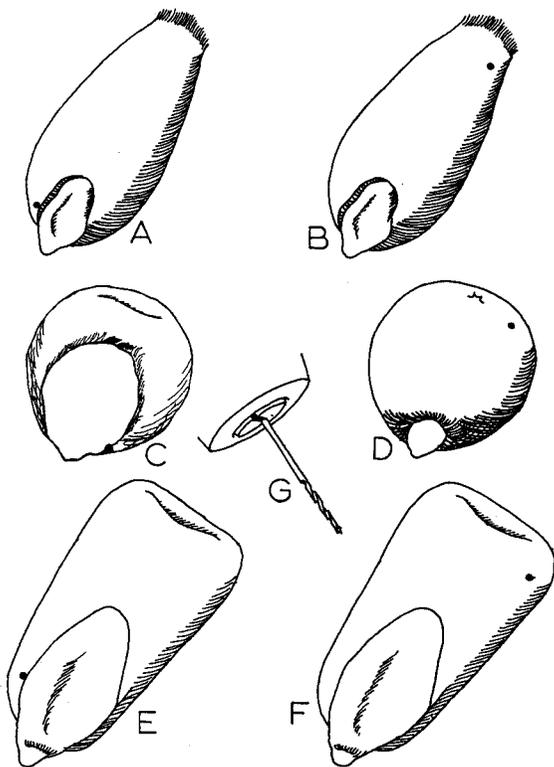


FIG. 1.—Location of drilled holes in wheat, sorghum, and corn kernels for entry of Angoumois grain moth larvae. A, C, E—near germ; B, D, F—into endosperm. G—0.34 mm-diameter drill bit used.

Table 1.—Larval-pupal periods (days) of Angoumois grain moths that entered pre-drilled kernels of wheat, sorghum, or corn at the germ or endosperm.

	Entered germ			*	Entered endosperm		
	No.	Range	Avg		No.	Range	Avg
Wheat	18	30-35	32.5	*	18	37-69	49.4
Sorghum	19	25-34	30.1	**	14	31-88	50.2
Corn	14	30-46	37.2	**	6	50-114	72.5

the wheat kernel, pointed out differences in nutrient components of different areas of wheat endosperm and inner layers of bran. Similar differences likely exist in corn and sorghum kernels.

How variations in endosperm hardness affect development and survival of Angoumois grain moths is unknown. The long L-P period of some insects in endosperm-drilled corn kernels may have been related to hardness of the horny endosperm.

Only 30% of the early endosperm feeders in corn completed development, compared with 90 and 70% in wheat and sorghum. Percentages of early germ feeders completing development were 70, 90, and 95 in corn, wheat, and sorghum, respectively. Differences in longevity, weight, and sex ratios were nonsignificant.

Most of the exuviae cast by larvae within the kernels were destroyed by subsequent feeding and tunneling activities, but mandibles remained identifiable

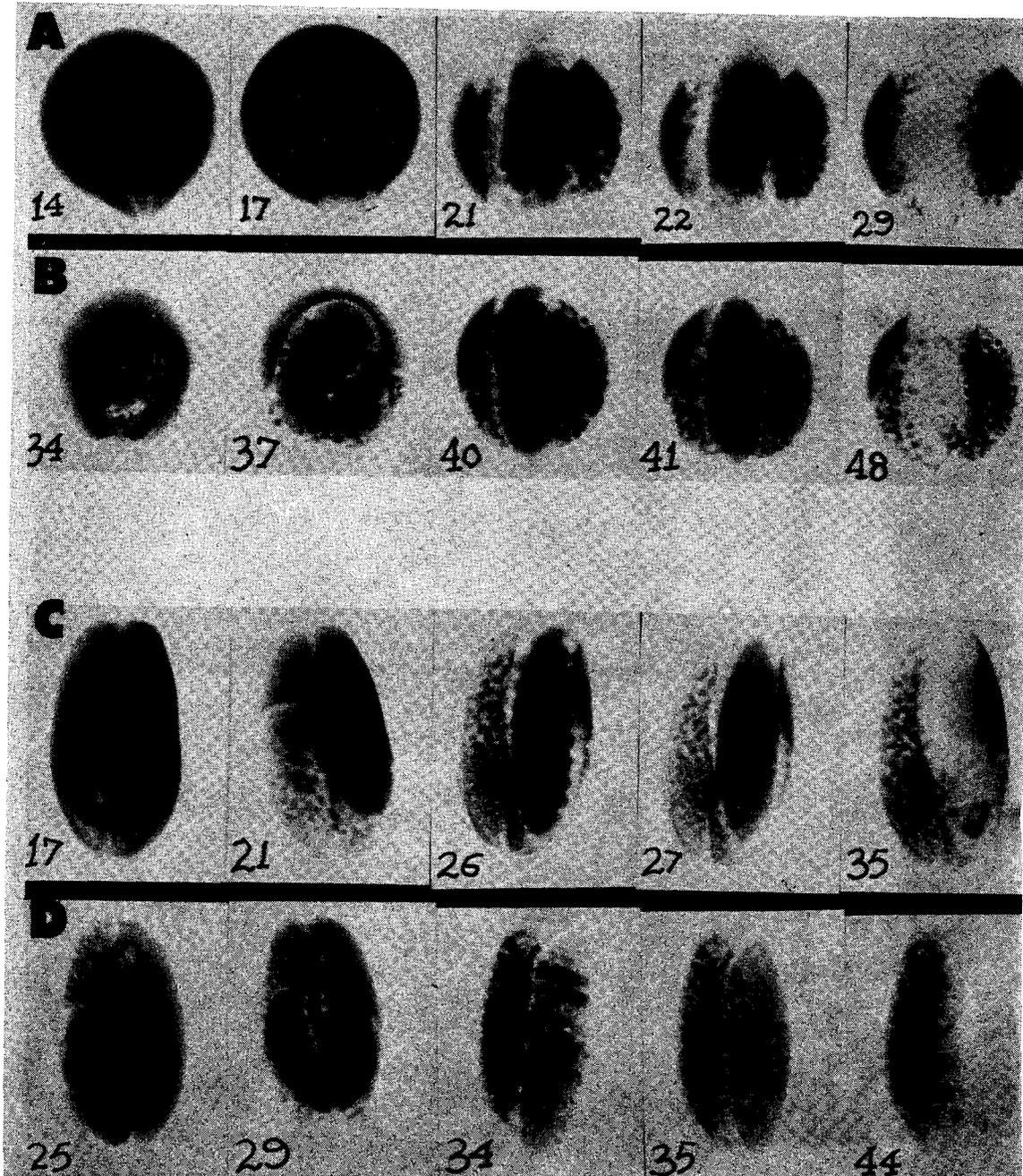


FIG. 2.—Selected X-ray radiographs of 2 sorghum and 2 wheat kernels showing different rates of development of Angoumois grain moth larvae that entered holes drilled near germ (A and C) or holes into endosperm (B and D). Numbers represent days after hatching. The 3rd, 4th, and last radiographs in each row show the prepupa, pupa, and the kernel after emergence of adult, respectively.

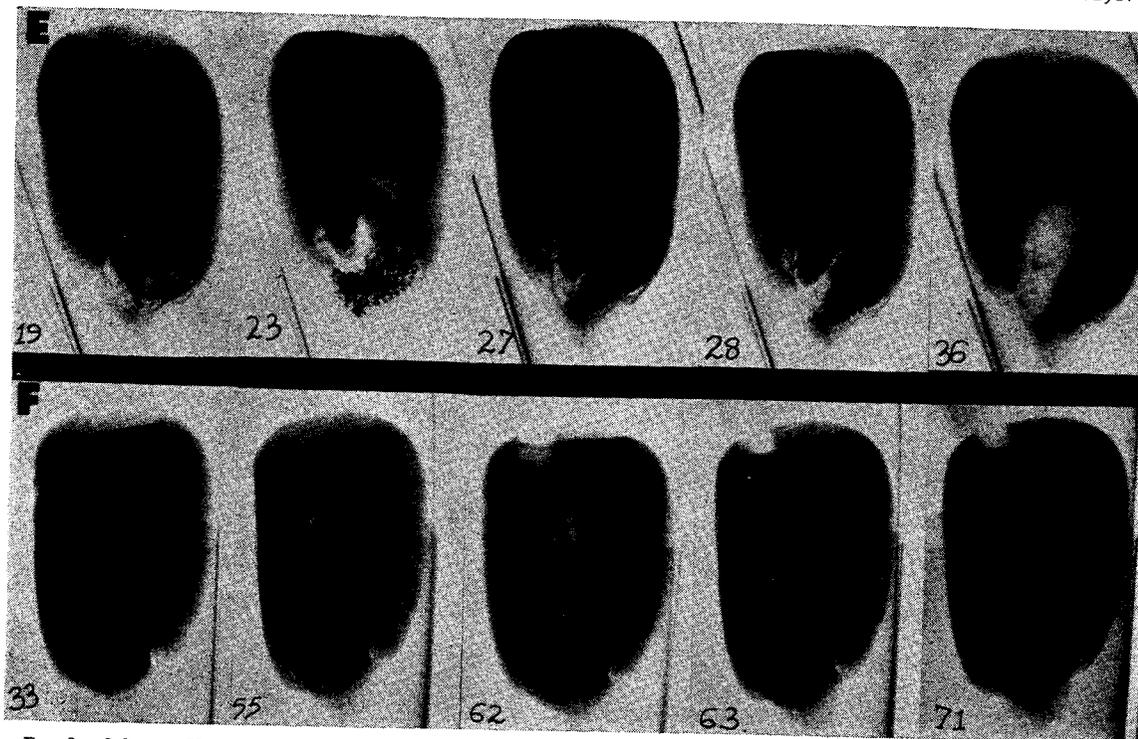


FIG. 3.—Selected X-ray radiographs of 2 corn kernels showing different rates of development of Angoumois grain moth larvae that entered holes drilled near germ (E) and holes into endosperm (F). Numbers represent days after hatching. The 3rd, 4th, and last radiographs in each row show the prepupa, pupa, and the kernel after emergence of adult, respectively.

and could usually be found. After adults emerged the kernels were dissected and larval mandibles were counted to determine the number of instars. Insects that entered germs had 4 or 5 instars in wheat, 4 in sorghum, and 4 or 5 in corn. Those entering endosperm had 4-7, 4-7, and 6-9 in wheat, sorghum, and corn, respectively (only 6 completed development in corn).

Results indicate that when larvae feed only on endosperm in sorghum or corn kernels, their development rate is slower than when germ is available. The results are similar to those obtained for wheat by Mills (1965) and in this study.

REFERENCES CITED

- MacMasters, M. M., D. Bradbury, and J. J. C. Hinton. 1964. Microscopic structure and composition of the wheat kernel, Chapter 3. *In* I. Hlynka [ed.], *Wheat Chemistry and Technology*. 3rd Monogr., Amer. Ass. Cereal Chem., St. Paul, Minn.
- Mills, R. B. 1965. Early germ feeding and larval development of the Angoumois grain moth. *J. Econ. Entomol.* 58(2): 220-3.
- Mills, R. B., and D. A. Wilbur. 1967. Radiographic studies of Angoumois grain moth development in wheat, corn, and sorghum kernels. *J. Econ. Entomol.* 60(3): 671-7.