TB 1482 (1974) USDA TECHNICAL BULLETINS UPDATA
COMPARATIVE BIOLOGIES OF ORYZAEPHILUS SURINAMENSIS AND O. MERCATOR
CURTIS, C.E. CLARK, J.D. 1 OF 1

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Washington, D.C. Issued November 1974

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Stock No. 0100-03201

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Technical Bulletin No. 1488

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

COMPARATIVE BIOLOGIES OF *ORYZAEPHILUS SURINAMENSIS* AND *O. MERCATOR* (COLEOPTERA: CUCUJIDAE) ON DRIED FRUITS AND NUTS

By C. E. CURTIS, *research entomologist*, and J. D. CLARK, *research technician*, *Agricultural Research Service, Fresno, Calif.*

ABSTRACT

The sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), and the merchant grain beetle, *O. mercator* (Fauvel), are pests of dried fruits and tree nuts. They infest unprocessed commodities in storage and processed products. Biology tests at 30° C and 20-, 50-, and 80-percent relative humidity (RH) on four foods showed that *O. surinamensis* usually did better than *O. mercator* on rolled oats, raisins, and prunes. The reverse was generally true on almonds.

The egg stage of *O. surinamensis* was 4.1, 3.8, and 3.9 days, and the egg stage of *O. mercator* was 4.5, 4.2, and 4.1 days at 20-, 50-, and 80-percent RH, respectively.

Both beetle species generally had four larval instars. For all the various food-RH combinations, the total percentages of *O. surinamensis* having fourth and fifth instars were 90 and 6 percent, respectively; comparable values for *O. mercator* were 96 and 17 percent. Moreover, 2 percent of *O. mercator* had a sixth instar. *O. mercator* consistently had a shorter pupal stage than did *O. surinamensis*.

O. surinamensis generally had a shorter life cycle and a greater percentage survival than did *O. mercator* on oats, raisins, and prunes. The reverse was generally true for almonds. At the three RH conditions, individual rearings for both beetle species showed the life cycle (egg deposition to pupal eclosion) to be shortest on rolled oats (23.9, 21.1, and 21.5 days for *O. surinamensis* and 26.9, 23.1, and 22.4 days for *O. mercator*); longer on almonds (40.6, 28.2, and 26.3 days for *O. surinamensis* and 38.2, 28.0, and 25.3 days for *O. mercator*); longer still on raisins (no survivors for either species at 20-

percent RH, 40.4 days at 50-percent RH and 42.7 days at 80-percent RH for *O. surinamensis* and 56.4 days at 50-percent RH and 43.5 days at 80-percent RH for *O. mercator*); and longest on prunes (no survivors for either species at 20-percent RH, 54.0 days at 50-percent RH, and 40.8 days at 80-percent RH for *O. surinamensis* and 67.2 days at 50-percent RH and 43.8 days at 80-percent RH for *O. mercator*).

O. mercator adults from larvae reared on the four foods always had a mean weight greater than *O. surinamensis*. For example, rearings on rolled oats at 50-percent RH showed *O. mercator* weights of 0.64 mg for males and 0.72 mg for females, and *O. surinamensis* weights of 0.47 mg for males and 0.55 mg for females. Females of both species always weighed more than males. Adults from larvae reared on oats were heavier than adults from almonds. Adults from larvae reared on prunes were lighter than adults from other foods at 20- and 50-percent RH, but were heavier than adults from raisins at 80-percent RH. Both sexes of both species generally weighed more on a given food as RH increased.

Both beetle species laid more eggs as RH increased. For example, rearings on rolled oats showed average egg production per female to be 32, 257, and 422 for *O. surinamensis* and 80, 256, and 338 for *O. mercator* at 20-, 50-, and 80-percent RH, respectively. *O. surinamensis* laid more eggs on oats than on the other three foods at all three RH conditions. *O. mercator* laid more eggs on almonds at 20-percent RH, more on oats at 50-percent RH, and more on raisins at 80-percent RH than on the other three foods available at each RH condition.

In single species rearings, with 10 adult pairs per cage at the four food and three RH combinations, *O. surinamensis* had the greatest increase in numbers in 5 of the 12 possible food-RH combinations (or cases). This was true in only one case for *O. mercator*. The amount of increase or lack of increase was nearly equal for the two species in six cases. When both species were reared together, *O. surinamensis* had the greatest increase in two cases, whereas *O. mercator* had the greatest increase in eight cases. Both species had zero increase in two cases. *O. mercator* populations grew to much higher numbers in interspecies rearings than in intraspecies rearings in 9 of the 12 possible food-RH combinations.

INTRODUCTION

The sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), and the merchant grain beetle, *O. mercator* (Fauvel), are important pests of dried fruits and tree nuts in storage. These include both the unprocessed commodities and marketing channels of the packaged final products. Most of the previous work on these two species was related to stored grain; however, positive identification of the two species, especially in publications prior to 1953, is questionable. For a discussion of the distinguishing characteristics of these two species, see Howe (*1953*), Slow (*1958*), and Frey (*1962*).[1]

The present research was initiated in 1967 to study the influence of four foods (rolled oats, almonds, raisins, and prunes), three relative humidities (RH) (20, 50, and 80 percent), and an initial test temperature of 30° C on the biologies of *O. surinamensis* and *O. mercator.*

O. surinamensis has been reported from many parts of the world as a pest of a wide variety of stored-food products. Back and Cotton (*1926*) stated that dried fruits stored for long periods invariably became infested. Very heavy infestations are known to have occurred in packing plants throughout the raisin producing area of California (Hamlin and Reed *1926*), when raisins were stored in sheds with metal roofs and open sides. Howe (*1953, 1956*) presented records for produce in commercial storage and at British ports. He found *O. surinamensis* to be prevalent in whole grains and cereal produce, but *O. mercator* was much more common in nuts, palm products, cottonseed produce, and various oilseed cakes. Frey (*1962*) found *O. mercator* in 42 percent and *O. surinamensis* in only 8 percent of 26 cargos of oilseed products examined.

Howe (*1956*) investigated the biology of both *O. surinamensis* and *O. mercator* on wheatfeed at several combinations of constant temperature and humidity. Cottonseed meal, coconut meal, and groundnuts held at 30° C and 70-percent RH were also included in these studies. Most other studies only concerned *O. surinamensis* reared on various grains and grain products.

Prior to 1926, the brief notes of Chittenden (*1896*) were about the only published quantitative ones that pertained to the biology of *O. surinamensis*.

Chittenden (*1897*) published brief notes on the commodities attacked by and distribution of *O. mercator*. Back and Cotton (*1926*) studied the biology of *O. surinamensis* on split maize, but did not control the temperature and humidity during their tests. Thomas and Shepard (*1940*) found that *O. surinamensis* larvae developed slowly on walnuts and much slower on raisins than did larvae reared on rolled oats and wheatfeed at various controlled combinations of constant temperature and humidity.

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[1] The author's name followed by the date in italic refers to Literature Cited, p. 19.

Similarly, Fraenkel and Blewett (*1943*) reared *O. surinamensis* on several foods at 25° C and found development was much slower on dried fruits (figs, currants, and dates) than on cereal derivative (wheatmeal flour). Lergenmüller (*1958*) conducted comprehensive ecological study of *O. surinamensis* on rolled oats at several temperatures and humidities. Ciesielska (*1966*) used both individual and population cultures to study the ecology of *O. surinamensis* on semolina. He also studied the effect of varied diets (rolled oats, rice, buckwheat grits, barley grits, and millet grits) on the ecology and body size of the beetles.

MATERIALS AND METHODS

Rearing Beetles

Test insects were taken from inbred cultures maintained since 1963 in the Stored-Product Insects Research Laboratory rearing room at Fresno, Calif. Stock cultures were reared on 95-percent rolled oats plus 5-percent dried yeast at 27° C and 60-percent RH. A 14-hour-light—10-hour-dark cycle was used.

Under rearing room conditions, the authors found that temperatures within the rearing media had a mean of 29.5° C and a high of 31.8° for *O. surinamensis* and a mean of 29.4° and a high of 31.8° for *O. mercator* cultures. This was one of the reasons 30° was chosen as the initial test temperature for the present research.

Obtaining Larvae of Known Age

Media and adult beetles (about 7 days old) were dumped from a culture jar into a pan equipped with an electronic insect barrier (Clark and Curtis *1970*). The adults were aspirated from the barrier pan with a low vacuum which just barely picked up the beetles without slamming them against the interior of the aspirator vial. About 1,000 beetles were placed in each of three oviposition chambers (gallon jars containing a 5-mm layer of a white flour and dried yeast mixture that had been passed through a No 100 U.S. Standard sieve). The adults were preconditioned to the oviposition chambers at rearing room conditions for about 14 days. The oviposition media and adults were separated from eggs and larvae, and returned to the oviposition chambers. This was accomplished with No. 30 and 40 U.S. Standard sieves to retain adults, a No. 60 U.S. Standard sieve to retain eggs and small larvae, and a pan to catch oviposition media. Eggs of known age were then collected at 4-hour intervals and held at rearing room conditions. Larvae (usually $\pm$ 0.1 day old) were used to set up individual and multiple rearing studies.

Obtaining Adults of Known Age

Late instar larvae and media were dumped from a culture jar onto a No. 14 U.S. Standard sieve, and the larvae were allowed to crawl down through the sieve and fall onto an enamel pan. The pan was placed on an incline so that individual larvae could be lightly tapped with a brush to transfer them to a gelatin capsule containing a small piece of rolled oat. The capsules were capped and mounted on trays covered with masking tape with its sticky side up. These pupation chambers (capsules) were held at rearing room conditions until adults of known age (usually $\pm$ 0.1 or 0.2 day old) were obtained. Individual adults were sexed while in the capsules without being anesthetized. These adults were used in individual and multiple rearing studies.

Cages for Individual Rearings

Cages for rearing individual larvae to adults and for studying single pairs of adults were constructed using 5-dram clear plastic snapcap vials.[2] A 27/64-inch-diameter hole was drilled in the cap and bottom of each vial. Screens (120 mesh/in) were cut for the bottoms and were fitted on the outside of the vial and sealed into place with heat. Screens for the caps were cut for a snug fit.

Cages for Multiple Rearings

Cages for rearing 10 larvae together were constructed from 15-dram clear plastic snap-cap vials. A 19/32-in-diameter hole was drilled in the bottom, and 14/16-in holes were cut in the caps with a cork borer. Screens were cut for the bottoms and caps and mounted as in construction of the 5-dram vial cages.

Cages for multiple rearings of adults in intraspecific and interspecific competition studies were constructed from 1/2-pt tapered glass jars closed with a filter paper and screw band.

Cage Holding Racks

Racks for holding 5-dram vial cages were 12- by 18- by 1-in styrofoam sheets with 9 rows and 12 columns of 7/8-in holes. Racks for 15-dram vial cages were 12- by 18- by 1-in styrofoam sheets with 6 rows and 10 columns of 1-3/8-in holes. These were hung in the test chamber so that the long axis of the vial cages was parallel to the floor.

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[2] Owens-Illinois Plastainer Plastic Vials.

Test Chamber

A controlled environment room [3] was used to maintain 30° C and 20-, 50-, and 80-percent conditions within ±0.5° and ±5-percent RH.

Media

A mixture of 95 percent rolled oats plus 5 percent dried yeast was used as a control medium because this is the diet commonly used to rear *Oryzaephilus* spp. Natural unprocessed nonpareil almond kernels, natural unprocessed Thompson seedless raisins, and unprocessed dehydrated French prunes were used as representatives of tree nuts and dried fruits. These foods were from the 1966 crop year.

The foods were held in a refrigerator at 4° C until required for tests. All were checked for pesticide residues and found to be unadulterated.

Foods were sometimes altered by cutting to give beetle larvae or adults a better chance to survive. This was especially true at 20-percent RH where the almonds, raisins, and prunes became so dry that young larvae and adults could not feed on whole fruits.

Two weeks before initiation of a test, foods needed for the tests were exposed to the temperature-humidity condition being studied to equilibrate the moisture of the foods. Moisture was checked at the start of a test and periodically thereafter. Table 1[4] shows the moisture content of test media for a given number of weeks after the end of the preconditioning period.

Testing Beetles

Moisture Testing

An Ohaus Moisture Determination Balance was used for almonds and oats using the manufacturer's recommended procedure.

The moisture content (percent weight per weight) of raisins and prunes was usually determined by a moisture testing device developed for the dried fruit industry of California.[5] The fruit was ground to form a paste which was packed into a plastic cylinder. The electrical conductivity of the paste was measured by making readings of a scale marked off in arbitrary units and of a thermometer inserted into the paste. The data from the readings were then used to

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[3] Lab Room Controlled Environmental Room 912A-HD, Lab Line Instruments, Inc., Melrose, Ill.

[4] All tables are grouped in the Appendix, beginning on p. 21.

[5] Developed by Dried Fruit Association (DFA) of California and C.D. Fisher, Fresno, Calif.

obtain percent moisture from a table comprised of values derived from an oven-drying method like the one in the following paragraph. The DFA Moisture Tester was not accurate for moisture contents greater than 25 percent. It was hard to grind the fruit and pack it into the plastic cylinder if the moisture content of the fruit was below 10 percent.

When moistures were too high or low to be measured on the DFA equipment, moistures for raisins and prunes were determined by using a vacuum oven (Fisher, personal commun., 1969) as follows: Install a 3/16-in thick aluminum shelf in a Precision Thelco (Model 10) vacuum oven. Affix a bolt through the shelf such that it extends one-half inch above shelf, and can be drilled out to serve as a thermometer well. Operate oven at absolute pressure (<35 mm Hg) and shelf temperature of 70° C. Place 1.5 to 2.5 g ground raisins or prunes without pits in a thin layer in an aluminum drying dish. Run triplicate samples. Dry for 6 hours. Replace lids on drying dishes on removal of samples from oven. Cool in desiccator for 15 minutes and then weigh. Store dishes in desiccator after washing. Mark lids and dishes with a stamp so that the same dish-lid combination is always used and tare weights remain constant. Use trap flask filled with desiccant between oven and vacuum pump.

Time Clock Used in Recording Data

Readings of biological tests were recorded on a modified Cramer running time meter. The durations of various stages in the life cycle were calculated to the nearest 0.01 day for individuals, and means were then calculated to the nearest 0.1 day.

Weighing Adult Beetles

Live adults were weighed individually in 1/2-g shell vials to the nearest 0.01 mg.

RESULTS AND DISCUSSION

Beetle Stages and Development

Egg Stage

Humidity had some effect on the duration of the egg stage (table 2). Comparing 20- and 80-percent RH, we found that the egg stage of *O. surinamensis* and *O. mercator*, respectively, was about 5 and 10 percent longer at the lower humidity. *O. mercator* spent 5 to 10 percent more time in the egg stage at the various humidities tested than did *O. surinamensis*. We did not study the influence of temperature; however, Ciesielska (*1966*) and Lergenmüller (*1958*) found temperature to be the main controlling factor for the duration of the egg stage. Howe (*1956*) agreed with this and added that he found no difference between the two beetle species for the egg incubation period. Various authors list anywhere from 3 to 5 days as the duration of the egg stage at 30°C.

Larval Stage

Both beetle species generally had four larval instars (table 3). At the various food-RH combinations tested, some individuals had only three larval instars and some had as many as six instars.

O. mercator generally had fewer larval instars than *O. surinamensis* on the various foods tested at 20-percent RH; however, the reverse was true at 50- and 80-percent RH. Howe (*1956*) found that *O. surinamensis* tended to have fewer and slightly shorter larval periods (especially the first) than did *O. mercator*.

The first larval instar was consistently shorter for *O. surinamensis* than for *O. mercator* on oats, raisins, and prunes, but the reverse was so on almonds. *O. mercator* consistently had shorter second, third, and fourth instars on almonds than did *O. surinamensis*. The same was true for prunes at 80-percent RH. This may have been due to mold growth on the prunes providing some additional nutrients that benefited *O. mercator* more than *O. surinamensis*. *O. mercator* had four cases with a shorter larval instar for every three cases for *O. surinamensis* in all the possible food-RH combinations tested.

When *O. surinamensis* had only three larval instars at 50- and 80-percent RH, the duration of the third instar was in the upper part of its range (about 5 days on oats and about 10 days on almonds); however, it was in the lower part of the range (about 2 days on oats and about 4 days on almonds) when four larval instars were present in the life cycle. This same pattern was true when comparing the fourth and fifth larval instars. No such pattern was found for *O. mercator* on almonds and raisins.

The standard deviations showed much less variation for the durations of the various larval instars on oats and almonds than on raisins and prunes. The ranges for standard deviations were 0.3 to 1.4 on oats, 0.2 to 2.9 on almonds, 0.9 to 8.5 on raisins, and 0 to 12.4 on prunes. This indicates that oats and almonds were better diets than raisins and prunes for the two beetle species.

Pupal Stage

O. surinamensis (table 3) consistently had a longer pupal period at 20- or 50-percent RH than at 80-percent RH on the various foods (7 percent longer for oats, 5 percent for almonds, 0 to 29 percent for raisins, and 24 percent for prunes). No such consistent results were obtained for *O. mercator*. Data from studies at 50- and 80-percent RH indicated that the pupal period for *O. mercator* was 4 percent longer on oats and almonds, 0 to 4 percent shorter on raisins, and 10 percent longer on prunes at the higher relative humidity.

O. surinamensis had a longer pupal period than did *O. mercator* in most cases, regardless of relative humidity, (9 to 17 percent for oats, 5 to 13 percent for almonds, 10 to 12 percent for raisins, and 2 to 39 percent for prunes). In all cases, the smallest percentage differences between the two species were at 80-percent RH. The largest percentages were at 20-percent RH for oats and at 50-percent RH for other foods because neither species survived to the pupal stage at 20-percent RH on raisins and prunes, and only *O. mercator* survived on almonds at 20-percent RH. Here, as with eggs, Ciesielska (*1966*), Lergenmüller (*1958*), and Howe (*1956*) found temperature as the main controlling factor for the duration of the pupal stage.

Period From Egg Deposition to Adult Emergence

Three of the various tests made were useful in determining the life cycle from the time the egg was laid until the adult emerged from the pupal stage: (1) Individual rearings, which were examined repeatedly to determine the duration of various stages in the life cycle (table 3); (2) individual rearings, which were only examined repeatedly after the pupal stage was reached (table 4); and (3) multiple rearings, which were examined repeatedly after the pupal stage was reached (table 5).

The duration of the life cycle for males and females was almost equal for any given humidity on oats. There was no consistent difference on almonds. Males had a shorter life cycle on raisins at 20-percent RH, whereas the reverse was generally so at 50- and 80-percent RH for *O. mercator*. Males had a shorter life cycle on sound prunes, whereas females had a shorter life cycle on damaged prunes at all humidities where beetles survived to adults.

The individual rearings which were repeatedly examined generally resulted in a life cycle of equal or greater duration than the one found for individual rearings, which were repeatedly examined only after the pupal stage was attained. Exceptions to this were found for both species on sound raisins at 50-percent RH and damaged raisins at 80-percent RH, and for *O. mercator* on damaged raisins at 50-percent RH and damaged prunes at 80-percent RH. Here, again, mold growth on raisins and prunes may have been beneficial to *O. mercator*. More mold was present on the damaged raisins and damaged prunes that were repeatedly handled than on those fruits that were seldom or never handled. No explanation can be offered for the repeatedly examined individuals doing better than the ones that were handled to a much lesser extent for raisins at 50-percent RH.

Stanley and Slatis (*1955*) stated that disturbance in rearing studies lengthened the life cycle of *Tribolium confusum*. They found this when they compared results from hand rearing studies with results from their rearings using an automated sampling device.

In most cases, mortality for both beetle species in individual rearings (table 4) was equal to or less than mortality in the multiple rearings (table 5). The reverse of this was true for *O. surinamensis* on sound raisins and damaged almonds and for *O. mercator* on sound almonds at 80-percent RH.

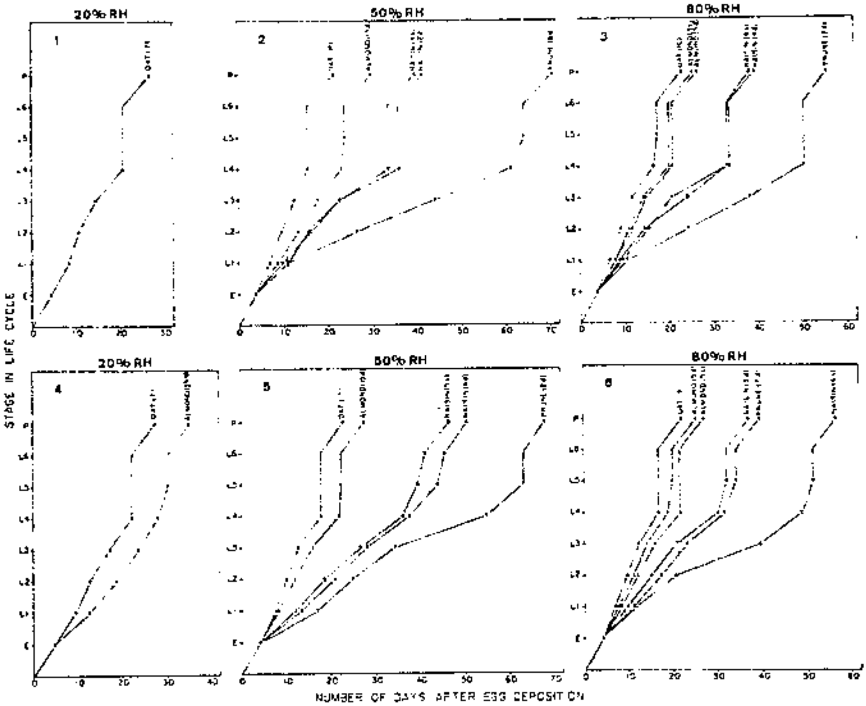
Freshly hatched larvae generally did not survive on sound almonds, raisins, and prunes at 20-percent RH. They had difficulty surviving on sound almonds at 50-percent RH.

Cannibalism was frequently observed in both species in the multiple rearings at 20- and 50-percent RH. Generally, late instar larvae of *O. surinamensis* fed on pupae when reared on oats, almonds, and raisins; *O. mercator* attacked pupae when reared on oats and almonds. Lergenmüller (*1958*) found that *O. surinamensis* larvae became cannibalistic when deprived of normal food, but did not survive on animal food alone. Similarly, Crombie (*1943*) found that larvae and adults of *O. surinamensis* cannibalized eggs and pupae when crowded.

O. surinamensis generally had a shorter life cycle (egg deposition to adult emergence) and a greater percentage of adult survival than did *O. mercator* on oats, raisins, and prunes. The reverse was generally true for almonds. *O. surinamensis* had a shorter life cycle than did *O. mercator* on sound almonds in two instances. *O. mercator* had a shorter life cycle than did *O. surinamensis* on repeatedly examined raisins and prunes at 80-percent RH— probably due to mold growth.

The larvae of both species burrowed into almonds and raisins and sometimes into the prunes. At 80-percent RH, larvae sometimes became enmeshed in a sticky sirup produced by both the raisins and the prunes.

O. surinamensis completed development only on oats and *O. mercator* completed development only on oats and almonds at 20-percent RH (figs. 1 and 4). The developmental periods for *O. surinamensis* (fig. 2) and *O. mercator* (fig. 5) at 50-percent RH increased with the progression from oats: damaged almonds: sound raisins: damaged raisins: damaged prunes. This same order was true for *O. surinamensis* at 80-percent RH (fig. 3), except that a test on sound almonds was also run. The developmental time on the latter fell between those for oats and damaged almonds. The order of developmental times (from shortest to longest) for *O. mercator* (fig. 6) at 80-percent RH was oats, damaged almonds, sound almonds,



FIGURES 1-6. — Mean accumulative time of development of *O. surinamensis* (figs. 1-3) and *O. mercator* (figs. 4-6) at 30° C and 3 relative humidities. Name of food, number of individuals surviving to adult, and condition of food (s=sound, d= damaged) given at top of each line graph. Individuals not having a given stage in the life cycle were included in calculations as having a zero-days duration in that stage. Individuals not completing development to the adult stage were not included in calculations.

damaged raisins, damaged prunes, and sound raisins. The slightly shorter developmental time for damaged compared with sound almonds, and especially the much shorter time for damaged compared to sound raisins, may have been due to a greater mold growth on damaged fruits.

Fraenkel and Blewett (*1943*) found that *O. surinamensis* developed much more slowly on figs, currants, and dates than on wheatmeal flour. Howe (*1953*) found that *O. surinamensis* did not develop on cottonseed cake at low RH, but that it did develop on wheatfeed. *O. mercator* developed on both cottonseed cake and wheatfeed at low RH.

Both species had the lowest mortality on oats. Mortality was greater on damaged almonds, still greater on sound almonds, and greater still on damaged raisins. It was greatest for sound raisins or prunes, depending on the species, relative humidity, and rearing method.

The observation that mold growth on the various foods at 80-percent RH seemed to benefit *O. mercator* more than *O. surinamensis* has been mentioned several times. No attempt was made to identify these molds. *O. surinamensis* generally did better than *O. mercator* on raisins and prunes at 20- and 50-percent RH. The reverse was often true at 80-percent RH. One possible explanation is that mold growth developed on the raisins and prunes (especially damaged ones) at 80-percent RH. More mold was present on the damaged raisins and damaged prunes which were handled repeatedly than on those fruits that were seldom or never handled.

Sinha (*1968*) reared six species of grain-infesting beetles and 10 species of grain-infesting mites on 23 species of fungi and one actinomycete. Of the beetles tested, *O. mercator* completed development on 18 fungal species. *O. surinamensis* reportedly completed development on 10 fungal species. This suggested to Sinha that *O. mercator* is less specialized than *O. surinamensis*, and, therefore, exhibits a more flexible and generalized condition. Sirokowski (*1964*) worked with three beetle species and five *Aspergillus* species and found that *O. surinamensis* could complete development only on *A. versicolor*.

Adult Weight

O. mercator adults from larvae reared on various foods always had a mean weight greater than the one for *O. surinamensis* (table 6 and fig. 7). Generally, the ranges for the weight of the two species overlapped one another, but there was no overlap for females on raisins at 50- and 80-percent RH and only a slight overlap for males on almonds and prunes at 80-percent RH and for females on almonds at 80-percent RH. Howe (*1956*) stated the adult weight for both species of *Oryzaephilus* was about 0.3 to 0.5 mg, but presented no definite data to confirm this. Slow (*1958*) found that *O. mercator* was larger than *O. surinamensis* as determined by adult body length, but her measurements overlapped.

Males always had a mean weight less than the one for females of both species. The ranges for the two sexes of both species always overlapped one another. Howe (*1956*) found that the average weight of females was greater than that of males. The weight of adults from larvae reared on different foods decreased as follows: oats > almonds > raisins.

Neither species survived on raisins or prunes at 20-percent RH. *O. surinamensis* males weighed about the same on prunes and raisins at 50-percent RH. In contrast, females weighed more on prunes than on raisins. One male and no females of *O. mercator* survived on prunes at 50-percent RH.

Both sexes of both species weighed more on prunes than on raisins at 80-percent RH, and generally weighed more on a given food as RH increased. This agrees with the findings of Howe (*1956*) that weight decreased at low humidities and high temperatures.

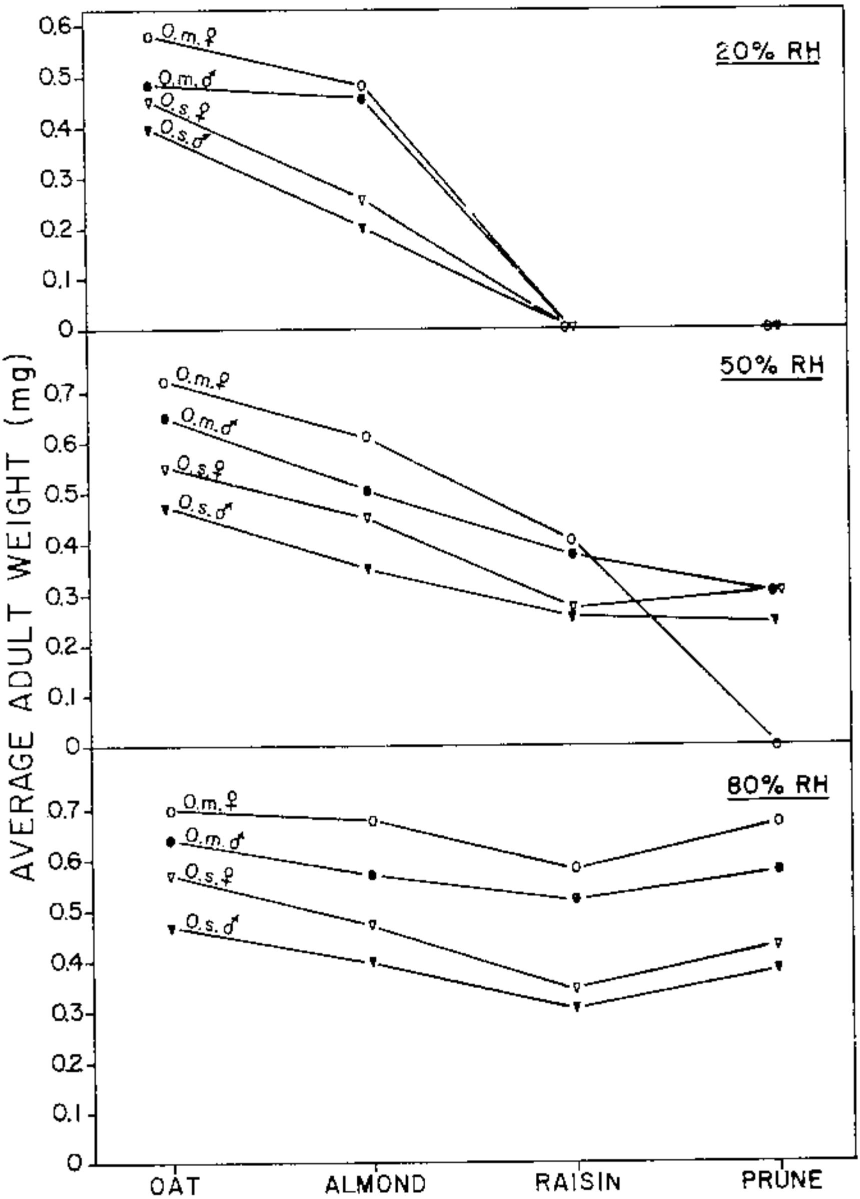


FIGURE 7. — Weight of *Oryzaephilus* spp. males and females in various diet and humidity conditions at 30° C.

Adult Lifespan

Neither males nor females lived very long on sound almonds or sound raisins at 20-percent RH (tables 9 and 10). The lifespan was usually less than 10 but no more than 30 days for both species. *O. mercator* consistently lived longer than *O. surinamensis*, at 20-percent RH. Both sexes of both species lived about equally as long on prunes, but none lived more than 70 days.

O. surinamensis generally lived longer than *O. mercator* at 50-percent RH. *O. mercator* females on damaged almonds however, did live longer than *O. surinamensis* females.

Little difference was found in the duration of the adult stage for both species at 80-percent RH, because many adults were still alive at the end of the test (90 days).

Preoviposition Period

O. mercator generally had a shorter preoviposition period (table 7) than did *O. surinamensis*. The one exception was on almonds at 80-percent RH, where *O. mercator* had a slightly longer preoviposition period than did *O. surinamensis*.

The preoviposition period was shortest on oats and almonds for both species at all humidities. There was little difference in the duration of the preoviposition periods at the various combinations except that those for *O. surinamensis* on oats and almonds at 20-percent RH were two to three times longer than at other humidities and two to three times longer than those for *O. mercator*. The preoviposition period was three to eight times longer on raisins and prunes than on oats and almonds for both species.

Adults of both species generally died before ovipositing within 8 to 12 days on sound almonds and sound raisins at 20-percent RH. Both species had longer preoviposition periods on sound than on damaged raisins at 80-percent RH.

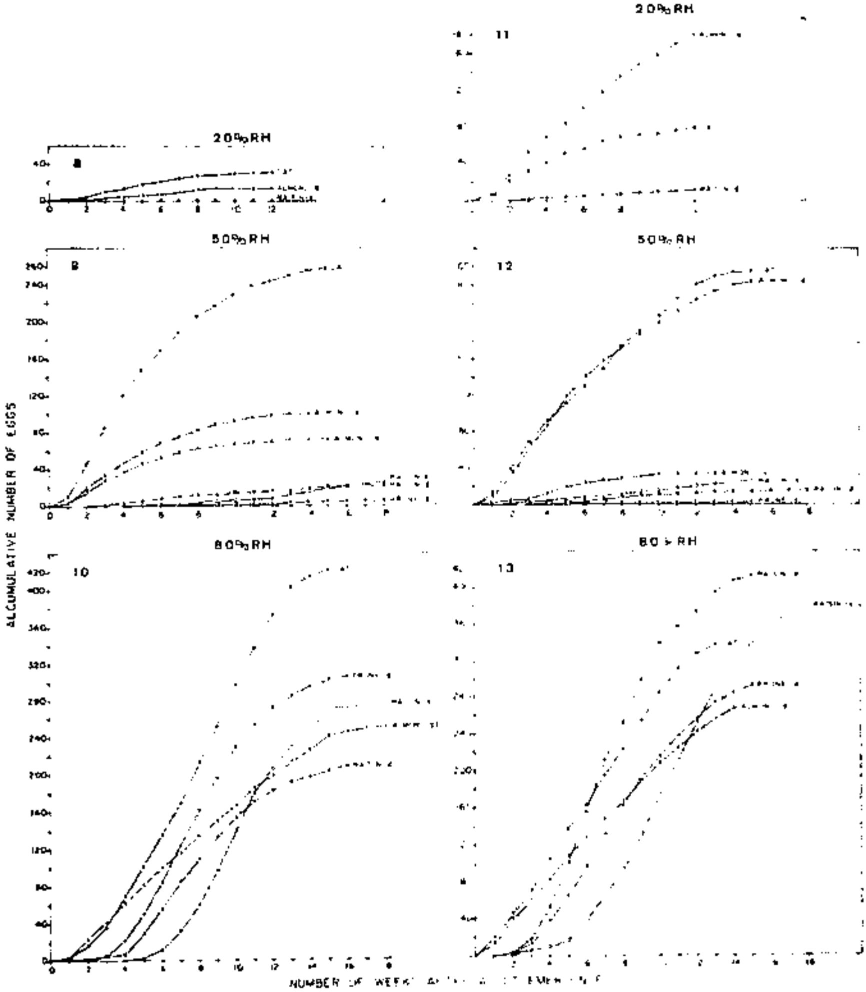
Oviposition Period

O. mercator generally had a longer oviposition period (table 8) than did *O. surinamensis*. One exception was on sound almonds at 50-percent RH, where 60 percent of the *O. mercator* females died without laying eggs. Another exception was on prunes at 50-percent RH, where the oviposition period for *O. mercator* was 0 to 30 days long and 0 to 73 days long for *O. surinamensis*.

The oviposition period was generally longer for both species as the RH increased. These tests were ended after 70 to 100 days of taking records, so maximum oviposition periods were not determined.

Oviposition

O. mercator laid more eggs on oats, damaged almonds, and damaged raisins than did *O. surinamensis* at 20-percent RH (fig. 8, 11). All females of both species died within 2 weeks on sound raisins and within 9 weeks on damaged prunes without laying eggs.



FIGURES 8-13. — Mean accumulative number of eggs produced by *O. surinamensis* (figs. 8-10) and *O. mercator* (figs. 11-13) at 3 relative humidities. Each mean was based on 5 to 10 adult pairs from individual rearings. Name of food and condition of food (s=sound, d=damaged) given for each line in graph. Females that died or quit ovipositing during the period of study were included in calculations as producing zero number of eggs.

Similarly, *O. surinamensis* females died within 2 weeks on sound almonds without ovipositing. No tests were made with *O. mercator* on sound almonds at 20-percent RH.

O. mercator laid most eggs on almonds, less on oats, and least on raisins at 20-percent RH. *O. surinamensis* laid most eggs on oats, less on almonds, and least on raisins.

Both beetle species laid about the same number of eggs on oats at 50-percent RH (fig. 9, 12). *O. mercator* laid more eggs on damaged almonds and sound raisins than did *O. surinamensis*. The reverse was true for sound almonds, damaged raisins, and prunes.

O. mercator and *O. surinamensis* laid a few more eggs on oats than on damaged almonds at 50-percent RH. Both species laid a much smaller number of eggs on raisins and prunes than on oats and almonds.

O. mercator laid more eggs than *O. surinamensis* on damaged almonds and on sound and damaged raisins at 80-percent RH (fig. 10; 13). *O. surinamensis* laid more eggs than did *O. mercator* on oats and prunes over a 13-week period, but *O. mercator* was ahead of *O. surinamensis* in egg production during the first 8 weeks of adult life. No tests were made with either beetle species on sound almonds at 80-percent RH.

Both beetle species laid many more eggs on oats than on almonds at 80-percent RH. The relative abundance of eggs laid by *O. mercator* on the foods tested was as follows: damaged raisins > oats > sound raisins > prunes > almonds. The relative number of eggs laid by *O. surinamensis* was as follows: oats > prunes > sound raisins > almonds > damaged raisins.

O. surinamensis laid many more eggs on oats than on the other foods at all three RH's. The second largest number of eggs was laid on almonds at 20- and 50-percent RH. *O. surinamensis* laid more eggs on sound almonds than on damaged almonds at 50-percent RH and more eggs on sound raisins than on damaged raisins at 50- and 80-percent RH.

Both beetle species laid the greatest number of eggs at 80-percent RH and the least number of eggs at 20-percent RH.

Most eggs were laid on or through the screens at the cap ends of the cages even though these screens were 120 mesh/in. The females of both species seemed to prefer the screens as oviposition sites. Eggs pushed through the screens to a position between the screen and caps did not have decreased viability. The comparative percentages of eggs laid by *O. surinamensis* on or through the cap screens at the three RH's studied were: 67 to 89 percent for oats, 81 to 95 percent for almonds, 63 to 65 percent for raisins, and 69 to 88 percent for prunes. Comparable percentages for *O. mercator* were: 89 to 96 percent for oats, 79 to 96 percent for almonds, 57 to 83 percent for raisins, and 59 to 86 percent for prunes.

Intraspecies and Interspecies Competition

Table 11 shows the changes in beetle populations during a 10-week period expressed as a percentage increase (initial number of adults in test divided into total number of dead and live adults at end of test, exclusive of those used to start the test, x100). At 20-percent RH, *O. surinamensis* had a 59-percent greater increase on oats than did *O. mercator* in intraspecies rearings, but only a 9-percent greater increase in interspecies rearings. *O. mercator* had a 100-percent greater increase than did *O. surinamensis* in intraspecies rearings and a 6,000-percent greater increase in interspecies rearings on almonds. *O. mercator* showed some increase on raisins in interspecies, but not intraspecies rearings. Neither species increased on prunes.

At 50-percent RH, *O. surinamensis* showed 34 percent (oats), 47 percent (almonds), and 47 percent (raisins) greater increases in numbers than did *O. mercator* in intraspecies rearings. *O. mercator* showed 49 percent (oats), 1,250 percent (almonds), and 1,275 percent (raisins) greater increases than did *O. surinamensis* in interspecies rearings. Neither species increased its numbers on prunes.

At 80-percent RH, *O. surinamensis* had about 0 percent (oats), about 0-percent (almonds), and 14 percent (raisins) greater increases in numbers in intraspecies rearings and 14 percent (oats) greater increase in interspecies rearings than did *O. mercator*. *O. mercator* had 252 percent (almonds) and 725 percent (raisins) greater increases in numbers than did *O. surinamensis* in interspecies rearings. *O. mercator* showed some increase on prunes in interspecies rearings but not intraspecies rearings.

The species (usually *O. mercator*) having the greatest amount of increase in the interspecies rearings for a given food-RH combination always showed a smaller amount of increase in the intraspecies rearings. For some undetermined reason, the mixture of two species seemed to benefit the species doing best in the mixed situation so that it increased to greater numbers than when reared by itself.

When single species rearings were made, *O. surinamensis* had the greatest increase in numbers for five cases. This was true for *O. mercator* in only one case. The amount of increase was nearly equal for the two species in six cases: four with zero increase (raisins at 20-percent RH, and prunes at 20-, 50-, and 80-percent RH); one with a final count of about 104 for both species on almonds at 80-percent RH; and one with a count of about 2,000 for oats at 80-percent RH.

When both species were reared together, *O. mercator* had the greatest increase in numbers in eight cases, whereas *O. surinamensis* had the greatest increase in only two cases. Both species had zero increase in two cases (prunes at 20- and 50-percent RH).

CONCLUSIONS

The biologies of the sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), and the merchant grain beetle, *O. mercator* (Fauvel), were studied at 30° C and 20-, 50-, and 80-percent RH on rolled oats, almonds, raisins, and prunes. *O. surinamensis* generally had a shorter life cycle and a greater percentage of survival than did *O. mercator* on rolled oats, raisins, and prunes, whereas the reverse was generally true on almonds.

The egg stage ranged from 3.8 to 4.1 days for *O. surinamensis* and from 4.1 to 4.5 days for *O. mercator*.

Both beetle species generally had four larval instars. *O. mercator* had a fifth instar three times more often than did *O. surinamensis*. *O. mercator* was the only species to have six instars in some tests.

O. mercator consistently had a shorter pupal stage than did *O. surinamensis*.

The life cycle for *O. surinamensis* in individual rearings ranged from 21.1 to 23.9 days on rolled oats, from 26.3 to 40.6 days on almonds, from 40.4 to 42.7 on raisins, and from 40.8 to 54.0 days on prunes. The life cycle for *O. mercator* in individual rearings ranged from 22.4 to 26.9 days on rolled oats, from 25.3 to 38.2 days on almonds, from 43.5 to 56.4 days on raisins, and from 43.8 to 67.2 days on prunes. Neither species completed its life cycle on raisins or prunes at 20-percent RH.

O. mercator adults from larvae reared on the four foods always had a mean weight greater than the one for *O. surinamensis*. Females of both species always weighed more than males. For example, rearings at 50-percent RH showed *O. mercator* males to weigh 0.64 mg on oats and 0.38 mg on raisins and females to weigh 0.72 mg on oats and 0.41 mg on raisins. *O. surinamensis* males weighed 0.47 mg on oats and 0.26 mg on raisins and females weighed 0.55 mg on oats and 0.27 mg on raisins. Both sexes of both species generally weighed more on a given food as RH increased.

O. mercator had a shorter preoviposition period than did *O. surinamensis* on all foods at all RH's except for a slightly longer one on almonds at 80-percent RH.

O. mercator generally had a longer oviposition period than did *O. surinamensis* on all foods and RH's.

Both beetle species laid more eggs as RH increased. Rearings on oats showed egg production for *O. surinamensis* to range from 32 to

422 and egg production for *O. mercator* to range from 80 to 338.

When 10 adult pairs of a single species were reared together on the various food and RH combinations, *O. surinamensis* had the greatest increase in numbers in 5 of the 12 possible combinations. This was so in only one combination for *O. mercator*. The amount of increase was nearly equal for both species in six of the combinations. When both species were reared together, *O. surinamensis* had the greatest increase in numbers in only two combinations, whereas *O. mercator* had the greatest increase in eight combinations. *O. mercator* populations increased much more in interspecies rearings than in intraspecies rearings in 9 of the 12 possible food and RH combinations.

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APPENDIX

TABLE 1. — *Moisture content of test media at 30° C at various times after a 2-week preconditioning period*

Percent RH	Week [1]	Percentage of moisture			
		Oats	Almonds	Raisins	Prunes
20	1	6.6	3.5	[2] < 9.0	15.0
	3	6.7	3.4	< 9.0	14.0
	7	6.7	3.3	< 9.0	< 13.0
	11	6.5	3.2	< 9.0	< 13.0
50	1	10.5	4.6	15.0	16.0
	3	9.9	4.8	14.0	14.5
	7	10.0	4.5	11.0	12.0
80	1	15.8	8.2	30.3	34.2
	2	15.5	8.6	33.6	35.8
	3	15.9	8.9	35.0	35.9

[1] Number of weeks after insects were placed on test media.

[2] The (<) figures were obtained from a DFA Moisture Tester before a vacuum oven was obtained to run moisture tests.

TABLE 2. — *Duration of egg stage and confidence interval (98 percent) for eggs which hatched at 30°C*

Percent RH	Number of eggs hatching	Duration (days)		Confidence interval (± days)
		Mean	± SD	
		Oryzaephilus surinamensis		
20	869	4.1	0.01	0.5
50	285	3.8	.02	.5
80	150	3.9	.02	.5
		Oryzaephilus mercator		
20	616	4.5	.02	.5
50	204	4.2	.02	.6
80	593	4.1	.01	.5

TABLE 3. — *Duration of stages of* Oryzaephilus *spp. at 30° C* [1]

Stage	*O. surinamensis*				*O. mercator*			
	Number tested/ number in stage	Duration (days): Mean	±SD	Range	Number tested/ number in stage	Duration (days): Mean	±SD	Range
				Oats (20-percent RH)				
E	10/10	---	----	----	10/10	---	----	----
L1	[2] 9/9	4.0	0.5	3.3-4.7	[2] 8/8	5.1	1.3	2.9-7.8
L2	9/9	2.6	.5	1.1-3.9	8/8	3.2	.7	1.0-5.2
L3	9/9	3.8	.7	1.9-6.2	7/7	4.3	1.4	1.9-8.1
L4	8/8	6.2	.9	4.0-8.1	[3] 7/6	5.8	.8	3.8-8.1
P	7/7	6.2	.2	5.1-7.3	7/7	5.3	.5	4.0-7.1
ED-PE	7/7	26.7	1.0	25.5-28.7	7/7	27.3	1.8	24.0-30.9
				Sound almonds [4] (20-percent RH)				
E	5/5	---	----	----	10/10	---	----	----
L1	1/1	10.1	----	9.1-10.9	8/8	7.7	1.7	5.8-12.1
L2	0/0	---	----	----	7/7	5.4	2.6	2.2-11.9
L3	0/0	---	----	----	6/6	5.0	1.0	3.0-7.9
L4	0/0	---	----	----	5/4	5.4	1.3	2.8-8.0
L5	0/0	---	----	----	5/2	5.6	.6	4.1-7.0
P	0/0	---	----	----	5/5	5.0	.1	3.9-6.2
ED-PE	0/0	---	----	----	5/5	35.3	3.1	30.9-39.8
				Damaged raisins [4] (20-percent RH)				
E	15/15	---	---	---	5/5	---	---	---
L1	4/4	8.2	1.4	6.1-10.8	0/0	---	---	---
L2	2/2	8.0	1.4	6.0-10.0	0/0	---	---	---
L3	2/2	21.5	6.6	15.8-27.2	0/0	---	---	---
L4	1/1	27.5	---	25.0-30.0	0/0	---	---	---
P	0/0	---	---	---	0/0	---	---	---
ED-PE	0/0	---	---	---	0/0	---	---	---
				Damaged prunes (20-percent RH)				
E	20/20	---	---	---	10/10	---	---	---
L1	2/2	7.4	2.1	5.1-9.7	0/0	---	---	---
L2	0/0	---	---	---	0/0	---	---	---
L3	0/0	---	---	---	0/0	---	---	---
				Oats (50-percent RH)				
E	15/15	---	---	---	15/15	---	---	---
L1	15/15	3.0	0.3	2.2-3.9	15/15	3.4	0.4	2.8-4.0
L2	15/15	2.7	.3	1.8-4.0	15/15	2.4	.4	1.8-3.6
L3	15/15	3.2	1.2	2.0-6.0	15/15	2.8	.5	1.3-4.2
L4	15/10	4.5	.5	3.0-5.9	15/15	4.9	.5	3.9-6.7
P	15/15	5.9	.4	5.1-7.1	15/15	5.1	.2	4.2-6.0
ED-PE	15/15	21.7	1.1	19.4-24.9	15/15	23.0	.9	21.0-25.7

See footnotes at end of table.

TABLE 3. — *Duration of stages of* Oryzaephilus *spp. at 30° C* [1] — Continued

Stage	*O. surinamensis*				*O. mercator*			
	Number tested/number in stage	Duration (days): Mean	±SD	Range	Number tested/number in stage	Duration (days): Mean	±SD	Range
	Damaged almonds (50-percent RH)							
E	15/15	---	---	---	15/15	---	---	---
L1	14/14	4.9	0.9	3.2-6.4	15/15	4.1	0.7	3.0-6.0
L2	13/13	4.6	1.9	2.8-12.0	15/15	3.7	.6	2.7-5.3
L3	13/13	4.5	1.8	2.0-11.0	15/15	4.0	.7	3.0-5.9
L4	13/12	5.9	.9	3.0-7.7	15/15	5.8	.8	4.3-8.0
L5	13/1	7.9	---	7.0-8.8	15/1	8.0	---	7.1-8.9
P	13/13	6.0	.5	4.2-7.7	15/15	5.2	.3	4.2-6.1
ED-PE	13/13	29.9	3.3	24.4-36.5	15/15	27.8	3.2	23.1-36.3
	Sound raisins (50-percent RH)							
E	5/5	---	---	---	5/5	---	---	---
L1	5/5	6.1	1.1	4.0-8.2	5/5	7.3	1.8	3.0-12.0
L2	5/5	6.9	1.4	4.0-10.0	5/5	6.5	1.1	4.0-9.0
L3	4/4	6.5	1.6	4.1-9.2	5/5	8.1	3.2	5.0-15.0
L4	4/4	11.0	2.9	5.0-15.0	5/5	9.3	1.2	7.0-12.0
L5	4/0	0	---	----	5/2	9.0	2.8	5.0-12.2
L6	4/0	.0	---	----	5/1	8.7	---	7.3-10.1
P	4/4	6.3	.5	5.0-9.0	5/5	5.4	0.6	4.0-7.0
ED-PE	4/4	39.9	4.6	31.9-33.2	5/5	46.5	9.2	35.1-60.6
	Damaged raisins (50-percent RH)							
E	10/10	---	---	---	10/10	---	---	---
L1	8/8	7.3	0.9	6.2-9.7	8/8	8.7	1.4	7.1-12.0
L2	6/6	6.7	1.8	2.3-8.7	8/8	7.3	.9	5.5-9.7
L3	5/5	7.4	1.9	4.8-10.7	6/6	7.2	2.0	5.0-10.7
L4	3/3	10.8	4.6	5.4-15.5	6/6	9.7	3.1	6.0-16.2
L5	3/1	---	---	---	6/4	9.4	3.7	5.0-17.0
L6	2/0	.0	---	---	6/1	10.0	---	9.0-10.9
P	2/2	5.5	.2	4.8-6.0	6/6	5.0	.1	3.0-6.1
ED-PE	2/2	41.6	7.4	35.7-47.7	6/6	50.6	7.8	38.5-64.6
	Damaged prunes (50-percent RH)							
E	17/17	---	---	---	15/15	---	---	---
L1	15/15	8.3	4.4	2.5-18.5	7/7	12.6	3.1	8.0-16.2
L2	13/13	12.7	9.9	4.2-39.2	4/4	8.3	3.0	4.0-11.2
L3	10/10	19.8	10.0	8.9-36.8	2/2	9.6	.0	9.0-10.3
L4	10/9	18.9	5.1	11.8-27.0	2/2	20.7	12.4	11.0-31.0
L5	9/1	23.0	---	22.0-24.0	2/1	16.5	---	15.0-18.0
P	8/8	6.8	.8	4.9-11.0	2/2	4.9	.7	2.8-6.9
ED-PE	8/8	71.1	18.1	44.9-94.1	2/2	68.3	.7	66.1-70.7

See footnotes at end of table.

TABLE 3. — *Duration of stages of* Oryzaephilus *spp. at 30° C* [1] — Continued

Stage	*O. surinamensis*				*O. mercator*			
	Number tested/ number in stage	Duration (days)			Number tested/ number in stage	Duration (days)		
		Mean	±SD	Range		Mean	±SD	Range
				Oats (80-percent RH)				
E	10/10	---	---	---	9/9	---	---	---
L1	10/10	2.7	0.3	2.0-3.4	9/9	2.9	0.3	2.0-3.4
L2	10/10	2.6	.3	1.9-3.7	9/9	2.8	.9	1.4-5.2
L3	10/10	2.7	1.4	1.3-7.0	9/9	2.6	.8	1.2-5.0
L4	10/9	5.3	1.5	1.2-7.7	9/8	4.9	.3	3.9-6.0
L5	10/1	7.0	---	6.2-7.8	9/0	.0	---	---
P	10/10	5.8	.3	4.9-7.0	9/9	5.3	.3	4.4-6.7
ED-PE	10/10	23.2	1.4	20.8-26.4	9/9	22.0	.7	20.7-24.1
				Sound almonds (80-percent RH)				
E	5/5	---	---	---	5/5	---	---	---
L1	5/5	4.8	0.9	3.2-6.3	5/5	4.1	0.5	3.0-5.0
L2	4/4	4.4	2.9	2.3-9.4	5/5	3.9	.9	2.2-5.3
L3	4/4	3.6	.7	2.5-5.5	5/5	3.9	1.1	2.2-6.4
L4	3/3	5.8	.2	5.2-6.6	5/5	5.7	.7	4.3-7.6
P	3/3	5.7	.5	4.2-6.7	5/5	5.4	.4	3.8-6.7
ED-PE	3/3	25.8	1.0	23.8-27.0	5/5	27.1	2.5	23.6-31.2
				Damaged almonds (80-percent RH)				
E	5/5	---	---	---	5/5	---	---	---
L1	5/5	4.1	0.5	3.2-5.0	5/5	3.7	0.2	3.0-4.2
L2	5/5	3.8	.8	2.2-5.7	5/5	3.3	.5	2.2-4.7
L3	5/5	3.2	.8	1.8-5.2	5/5	3.0	.6	1.2-4.2
L4	5/5	6.0	.9	4.3-8.1	5/5	4.7	1.5	1.5-6.7
L5	5/0	.0	---	---	5/1	6.0	---	5.4-6.6
P	5/5	5.6	.6	3.6-7.0	5/5	5.4	.5	4.0-7.1
ED-PE	5/5	26.6	2.3	23.8-31.1	5/5	25.4	1.0	23.8-27.0
				Sound raisins (80-percent RH)				
E	5/5	---	---	---	5/5	---	---	---
L1	5/5	6.0	2.4	4.2-10.4	5/5	8.2	2.3	3.8-10.0
L2	5/5	6.7	2.7	2.6-11.0	5/5	9.5	3.8	2.3-12.6
L3	5/5	11.4	6.4	4.0-20.0	5/5	21.3	8.5	7.3-32.8
L4	4/3	12.1	6.0	5.9-19.7	5/4	9.5	2.9	6.0-13.7
L5	4/0	.0	---	---	5/1	9.9	---	8.8-11.0
P	4/4	4.9	.7	4.6-6.4	4/4	[illegible]	.5	4.0-7.0
ED-PE	4/4	38.4	8.1	26.7-48.0	4/4	56.8	10.7	40.7-68.1

See footnotes at end of table.

TABLE 3. — *Duration of stages of* Oryzaephilus *spp. at 30° C* [1] — Continued

Stage	*O. surinamensis*				*O. mercator*			
	Number tested/ number in stage	Duration (days)			Number tested/ number in stage	Duration (days)		
		Mean	±SD	Range		Mean	±SD	Range
				Damaged raisins (80-percent RH)				
E	5/5	---	---	---	5/5	---	---	---
L1	5/5	5.7	1.1	3.8-7.0	5/5	5.8	1.4	3.8-8.2
L2	5/5	6.1	1.3	4.5-9.0	5/5	5.8	3.8	1.2-12.1
L3	5/5	6.0	1.3	4.7-8.8	4/4	5.2	1.4	3.1-7.3
L4	5/5	11.6	3.9	8.8-20.0	4/4	8.7	1.7	6.6-11.3
L5	5/0	.0	---	---	3/1	5.6	---	5.0-6.2
P	4/4	5.6	1.7	4.0-7.0	3/3	5.0	.4	3.6-6.1
ED-PE	4/4	39.6	6.6	33.4-51.0	3/3	37.1	4.9	30.7-41.1
				Damaged prunes (80-percent RH)				
E	10/10	---	---	---	10/10	---	---	---
L1	10/10	6.8	2.5	3.2-11.0	10/10	8.5	3.5	2.0-13.8
L2	9/9	12.7	8.8	3.3-36.5	8/8	5.6	1.2	3.6-8.3
L3	8/8	13.2	6.5	4.3-25.1	7/7	5.8	2.6	2.4-9.9
L4	8/8	11.6	8.0	4.0-26.9	7/7	8.6	4.8	3.8-18.0
L5	8/1	11.7	---	10.8-12.6	7/2	8.5	.2	7.7-9.4
P	7/7	5.5	1.1	4.0-7.0	7/7	5.4	.4	4.0-7.0
ED-PE	7/7	55.9	11.1	35.6-72.0	7/7	39.5	8.0	26.9-51.1

[1] Individual rearings - repeated examinations.

[2] Any decrease in number in test count was due to some individual(s) dying or being lost during a given stage.

[3] When number having stage count is less than number in test count, the difference between the 2 counts is the number of individuals skipping a given stage.

[4] All *O. surinamensis* died as 1st instar larvae on 5 damaged almonds and on 5 sound raisins. All *O. mercator* died as 1st instar larvae on 5 sound raisins.

TABLE 4. — *Duration of life cycle (egg deposition to adult emergence) and survival of* Oryzaephilus *spp. at 30° C* [1]

Sex (M, male, F, female)	*O. surinamensis*					*O. mercator*				
	Percentage of survival	Number tested	Duration (days)			Percentage of survival	Number tested	Duration (days)		
			Mean	± SD	Range			Mean	± SD	Range
					Oats (20-percent RH)					
M	--	20	23.8	1.3	21.5-28.2	--	21	26.8	1.5	23.7-30.3
F	--	27	23.9	1.4	20.9-27.0	--	23	27.0	1.2	23.7-30.3
? [2]	--	1	24.5	---	23.9-25.1	--	0	----	---	---
M + F	96	50	23.9	1.3	20.9-28.2	88	50	26.9	1.3	23.7-30.3
					Almonds (20-percent RH) [3]					
M	--	3	44.1	2.0	41.3-46.9	--	11	37.7	3.3	30.6-45.4
F	--	2	34.8	3.5	31.6-38.0	--	14	39.0	7.1	31.7-49.5
? [2]	--	1	42.0	---	41.3-42.7	--	1	31.0	---	30.6-31.4
M + F	12	50	40.6	5.0	31.6-46.9	52	50	38.2	4.2	30.6-49.5
					Oats (50-percent RH)					
M	--	26	20.9	1.2	18.6-24.8	--	30	23.2	0.9	21.7-25.9
F	--	22	21.3	1.2	18.6-25.8	--	19	23.0	.9	21.7-25.6
M + F	100	48	21.1	1.2	18.6-25.8	98	50	23.1	.9	21.7-25.9
					Sound almonds (50-percent RH)					
M	--	8	26.0	2.8	23.9-32.9	--	11	26.8	1.8	23.6-30.0
F	--	7	26.0	.3	24.9-27.8	--	8	26.6	1.9	23.6-30.9
M + F	62	24	26.0	2.1	23.9-33.0	76	25	26.7	1.8	23.6-30.9

					Damaged almonds (50-percent RH)					
M	--	12	28.3	2.5	24.9-35.0	--	10	27.7	1.4	24.5-30.0
F	--	12	28.1	4.3	23.6-40.0	--	12	28.2	2.2	24.5-31.7
M + F	96	25	28.2	3.5	23.6-40.0	88	25	28.0	1.9	24.5-31.7
					Sound raisins (50-percent RH)					
M	--	2	46.9	6.4	40.9-52.0	--	2	49.9	9.6	41.5-58.9
F	--	0	--	--	--	--	2	67.7	2.1	65.5-69.9
M + F	8	25	46.9	6.4	40.9-52.0	17	23	58.8	11.7	41.5-69.9
					Damaged raisins (50-percent RH)					
M	--	6	38.6	7.4	31.8-51.0	--	6	57.0	12.0	47.4-81.9
F	--	4	43.0	11.4	31.8-61.0	--	?	55.1	10.7	47.4-72.8
M + F	44	23	40.4	11.9	31.8-61.0	36	25	56.4	10.9	47.4-81.9
					Damaged prunes (50-percent RH)					
M	--	8	57.5	14.2	40.9-88.0	--	1	67.2	--	66.5-67.9
F	--	5	48.4	19.0	35.9-88.0	--	0	--	--	--
M + F	31	42	54.0	16.1	35.9-88.0	2	50	67.2	--	66.5-67.9
					Oats (80-percent RH)					
M	--	22	21.3	1.1	18.5-23.9	--	26	22.2	0.8	20.5-24.8
F	--	24	21.5	1.2	18.5-27.0	--	21	22.6	1.4	20.5-26.9
?[2]	--	1	26.2	--	25.4-27.0	--	0	--	--	---
M + F	94	50	21.5	1.3	18.5-27.0	94	50	22.4	1.1	20.5-26.9
					Sound almonds (80-percent RH)					
M	--	10	25.1	2.6	20.5-29.1	--	6	26.6	4.3	22.3-33.7
F	--	7	27.3	4.8	22.8-37.9	--	4	23.6	0.7	22.3-24.9
M + F	68	25	26.0	3.7	20.5-37.9	40	25	25.4	3.6	22.3-33.7

See footnotes at end of table.

TABLE 4. — *Duration of life cycle (egg deposition to adult emergence) and survival of* Oryzaephilus *spp. at 30° C* [1] — Continued

Sex (M, male; F, female)	*O. surinamensis*					*O. mercator*				
	Percentage of survival	Number tested	Duration (days)			Percentage of survival	Number tested	Duration (days)		
			Mean	± SD	Range			Mean	± SD	Range
					Damaged almonds (80-percent RH)					
M	--	10	26.9	3.0	19.9-30.2	--	5	25.5	0.9	23.3-27.0
F	--	7	25.5	1.1	23.9-28.3	--	17	25.2	1.2	22.3-28.5
M + F	68	25	26.3	2.4	19.9-30.2	88	25	25.3	1.1	22.3-28.5
					Sound raisins (80-percent RH)					
M	--	2	34.7	2.7	31.9-37.6	--	5	50.6	4.4	42.7-55.3
F	--	2	36.6	--	35.6-37.6	--	6	41.7	5.4	33.1-47.8
M + F	16	25	35.7	1.9	31.9-37.6	44	25	45.7	6.6	33.1-55.3
					Damaged raisins (80-percent RH)					
M	--	9	37.6	6.3	30.9-51.4	--	5	45.1	7.9	34.4-57.7
F	--	13	46.3	9.7	35.2-67.4	--	2	39.5	4.9	35.2-43.7
M + F	88	25	42.7	9.4	30.9-67.4	28	25	43.5	7.3	34.4-57.7
					Damaged prunes (80-percent RH)					
M	--	12	43.4	10.7	26.2-60.4	--	12	47.5	17.5	32.0-81.9
F	--	17	39.8	12.6	26.8-68.4	--	12	40.1	9.3	28.6-61.9
? [2]	--	2	33.8	--	30.9-36.6	--	0	--	--	--
M + F	62	50	40.8	11.5	26.2-68.4	48	50	43.8	14.2	28.6-81.9

1 Individual rearings — limited examinations.

2 Sex of individuals in this row not recorded.

3 All *O. surinamensis* died before completing life cycle on sound almonds. Neither species completed development on sound raisins or damaged prunes.

TABLE 5 — *Duration of life cycle (egg deposition to adult emergence) and survival of* Oryzaephilus *spp. at 30° C* [1]

[M, male; F, female]

Sex	*O. surinamensis*					*O. mercator*				
	Percentage of survival	Number tested	Duration (days) Mean	±SD	Range	Percentage of survival	Number tested	Duration (days) Mean	±SD	Range
					Oats (20-percent RH)					
M	--	51	24.1	1.5	19.4-29.3	--	33	28.1	2.3	24.4-34.9
F	--	47	24.3	.9	19.4-28.3	--	37	28.0	2.1	24.4-35.8
M + F	98	100	24.1	1.3	19.4-29.3	70	100	28.0	2.2	24.4-35.8
					Sound almonds (20-percent RH)					
M	--	2	41.2	2.5	38.6-43.7	--	15	43.8	6.7	37.0-57.5
F	--	2	46.1	---	45.4-46.8	--	8	39.4	2.0	34.9-43.5
M + F	8	50	43.6	3.2	38.6-46.8	46	50	42.3	5.9	34.9-57.5

See footnotes at end of table.

TABLE 5 — *Duration of life cycle (egg deposition to adult emergence) and survival of* Oryzaephilus *30° C*[1] — Continued

[M, male; F, female]

Sex	*O. surinamensis*					*O. mercator*				
	Percentage of survival	Number tested	Duration (days)			Percentage of survival	Number tested	Duration (days)		
			Mean	± SD	Range			Mean	± SD	Range
					Damaged almonds (20-percent RH)					
M	--	1	46.1	--	45.4-46.8	--	15	35.8	2.3	32.4-[illegible]
F	--	6	45.4	5.3	38.6-54.9	--	15	37.8	3.2	30.4-4[illegible]
M + F	14	50	45.5	4.8	38.6-54.9	60	50	36.8	2.9	30.4-44[illegible]
					Damaged raisins (20-percent RH)					
M	-	1	50.1	--	49.1-51.1	--	4	63.3	16.3	46.9-86.[illegible]
F	-	1	69.4	--	68.4-70.4	--	1	75.8	--	74.9-76.[illegible]
M + F	4	50	59.8	13.6	49.1-70.4	10	50	65.8	15.2	46.9-86.[illegible]
					Oats (50-percent RH)					
M	--	44	22.2	1.6	19.0-31.3	--	46	23.1	0.6	21.2-24.7
F	--	47	22.0	.7	20.0-23.3	--	47	22.9	.7	21.2-25.6
M + F	91	100	22.1	1.2	19.0-31.3	93	100	23.0	.6	21.2-25.6
					Damaged almonds (50-percent RH)					
M	--	18	29.6	3.3	26.1-41.5	--	36	27.3	1.7	23.2-32.4
F	--	37	28.6	1.8	25.2-32.5	--	47	27.3	2.2	24.2-39.4
M + F	55	100	29.0	2.4	25.2-41.5	83	100	27.3	2.0	23.2-39.4

					Damaged raisins (50-percent RH)					
M	--	16	47.4	4.7	40.1-58.5	--	11	51.2	6.0	41.5-62.3
F	--	8	46.2	4.7	40.1-52.5	--	21	49.8	7.0	37.5-65.9
M + F	24	100	47.0	4.6	40.1-58.5	32	100	50.3	6.6	37.5-65.9
					Sound prunes (50-percent RH)					
M	--	4	65.7	12.5	51.0-79.4	--	3	82.0	16.2	65.5-100.9
F	--	6	72.0	13.0	48.1-81.5	--	1	90.1	---	89.5-90.8
M + F	10	100	69.5	12.5	48.1-81.5	4	100	84.0	13.9	65.5-100.9
					Damaged prunes (50-percent RH)					
M	--	6	69.4	15.7	55.1-100.4	--	1	71.1	--	69.5-72.8
F	--	5	68.0	3.4	63.1-72.4	--	1	50.1	--	48.5-51.8
M + F	11	100	68.7	11.3	55.1-100.4	2	100	60.6	14.9	48.5-72.8
					Oats (80-percent RH)					
M	--	39	21.6	1.2	17.7-26.3	--	39	22.5	0.8	21.0-24.7
F	--	55	22.0	1.0	18.7-24.6	--	51	22.6	.9	20.1-26.4
M + F	94	100	21.8	1.1	17.7-26.3	90	100	22.5	.9	20.1-26.4
					Sound almonds (80-percent RH)					
M	--	11	29.4	2.6	24.1-35.4	--	18	27.7	2.0	24.2-32.5
F	--	16	32.3	4.1	22.0-39.3	--	16	27.2	2.3	22.3-31.6
M + F	54	50	31.1	3.8	22.0-39.3	68	50	27.5	2.1	22.3-32.5
					Damaged almonds (80-percent RH)					
M	--	17	26.5	1.7	22.0-31.4	--	18	25.6	1.8	22.3-31.6
F	--	21	26.9	1.4	24.1-31.4	--	22	26.5	2.0	22.3-31.6
M + F	76	50	26.7	1.6	22.0-31.4	80	50	26.1	1.9	22.3-31.6

See footnotes at end of table.

TABLE 5 — *Duration of life cycle (egg deposition to adult emergence) and survival of* Oryzaephilus *spp. at 30° C*[1] — Continued

[M, male; F, female]

Sex	*O. surinamensis*					*O. mercator*				
	Percentage of survival	Number tested	Duration (days)			Percentage of survival	Number tested	Duration (days)		
			Mean	±SD	Range			Mean	±SD	Range
					Sound raisins (80-percent RH)					
M	--	10	44.2	3.8	35.0-52.3	--	7	46.6	3.7	38.8-51.1
F	--	7	44.2	6.1	35.0-52.3	--	7	44.4	4.7	38.8-53.1
M + F	34	50	44.2	4.7	35.0-52.3	28	50	45.5	4.2	38.8-53.1
					Damaged raisins (80-percent RH)					
M	--	7	36.9	1.7	33.7-41.3	--	11	37.1	5.5	28.7-44.8
F	--	5	34.2	1.9	30.8-38.4	--	5	36.9	7.7	28.7-46.3
M + F	24	50	35.8	2.2	30.8-41.3	32	50	37.1	6.0	28.7-46.3
					Sound prunes (80-percent RH)					
M	--	25	48.7	5.8	33.7-60.6	--	1	47.0	--	46.1-47.9
F	--	10	51.7	9.0	41.7-77.5	--	6	55.4	8.5	44.1-71.5
M + F	35	100	49.5	6.9	33.7-77.5	7	100	54.2	8.4	44.1-71.5

[1] Multiple rearings with 10 individuals per cage.

[2] Neither species completed development on sound raisins, sound prunes, or damaged prunes.

TABLE 6. — *Weight of* Oryzaephilus *spp. males and females as influenced by food and relative humidity at 30° C*

[M, male; F, female]

Food	Sex	*O. surinamensis* Number tested	*O. surinamensis* Weight (mg) Mean	±SD	Range	*O. mercator* Number tested	*O. mercator* Weight (mg) Mean	±SD	Range
				20-percent RH					
Oats	M	17	0.39	0.05	0.29-0.47	21	0.48	0.07	0.37-0.62
	F	26	.45	.08	.29-0.57	22	.58	.07	.45-0.70
Almonds	M	1	.20	----	----	11	.46	.09	.30-0.65
	F	1	.26	----	----	14	.48	.08	.34-0.62
				50-percent RH					
Oats	M	26	.47	.05	.39-0.57	29	.64	.09	.41-0.77
	F	21	.55	.06	.39-0.66	18	.72	.10	.49-0.84
Almonds	M	19	.35	.06	.21-0.48	20	.50	.07	.27-0.61
	F	19	.45	.05	.32-0.53	20	.61	.07	.49-0.75
Raisins	M	5	.26	.07	.22-0.39	8	.38	.12	.23-0.56
	F	4	.27	.06	.18-0.31	5	.41	.07	.34-0.51
Prunes	M	6	.24	.05	.18-0.32	1	.30	----	----
	F	5	.32	.07	.26-0.41	0	---	----	----
				80-percent RH					
Oats	M	22	0.47	0.07	0.34-0.63	26	0.64	0.09	0.43-0.88
	F	24	.57	.06	.45-0.67	20	.70	.08	.52-0.84
Almonds	M	20	.39	.05	.29-0.47	11	.57	.09	.46-0.70
	F	13	.47	.09	.23-0.55	21	.68	.07	.55-0.82
Raisins	M	13	.31	.06	.23-0.45	10	.52	.15	.31-0.80
	F	13	.34	.04	.26-0.42	8	.58	.11	.45-0.81
Prunes	M	11	.38	.07	.25-0.47	12	.58	.06	.45-0.67
	F	17	.43	.06	.32-0.55	11	.67	.09	.46-0.81

TABLE 7. — *Duration of preoviposition period and percentage of* Oryzaephilus *spp. females laying eggs in various diet and humidity conditions at 30° C*

Food	*O. surinamensis*					*O. mercator*				
	Percent laying eggs	Number tested	Duration (days)			Percent laying eggs	Number tested	Duration (days)		
			Mean	± SD	Range			Mean	± SD	Range
					20-percent RH					
Oats	100	10	11.3	4.9	5.6-24.9	100	10	5.2	1.8	3.5-9.9
Almonds:[1]										
Damaged	71	7	17.7	7.2	9.4-29.1	100	9	4.9	.7	3.5-6.9
Raisins:[1]										
Damaged	40	5	42.8	30.4	20.5-65.9	100	10	22.0	7.3	12.5-35.6
Prunes:										
Damaged	0	10	---	---	---	0	10	---	---	---
					50-percent RH					
Oats	100	10	<4.7	0.5	<4.5-6.4	100	10	<4.7	0.0	---
Almonds:										
Sound	100	5	6.6	2.4	4.3-12.0	20	5	5.0	---	<4.7-5.6
Damaged	100	5	5.2	0.7	<4.5-6.4	100	10	4.5	.5	2.7-5.9
Raisins:										
Sound	100	5	44.4	9.3	32.0-60.4	87	15	11.2	4.9	6.0-22.0
Damaged	100	5	45.0	27.3	18.0-91.8	80	5	25.7	13.3	14.9-47.2
Prunes:										
Damaged	13	15	51.4	---	49.0-53.8	27	15	17.0	10.6	7.0-34.1

					80-percent RH					
Oats	100	10	6.6	3.5	3.2-17.1	100	10	3.8	0.7	2.8-6.1
Almonds: [2]										
Damaged	80	10	5.0	1.1	3.2-7.0	100	9	5.4	1.9	3.9-10.0
Raisins:										
Sound	80	5	43.8	14.0	26.8-61.9	100	5	20.2	16.0	8.8-50.2
Damaged	100	5	20.9	6.7	10.7-31.0	100	5	14.6	4.5	9.9-22.1
Prunes:										
Damaged	100	10	22.7	4.5	13.9-31.0	100	10	16.4	2.6	11.6-22.1

[1] All O. *surinamensis* and O. *mercator* females died within 8 to 12 days without laying eggs on sound almonds or sound raisins.

[2] No tests made with sound almonds.

TABLE 8. — *Duration of oviposition period of* Oryzaephilus *spp. in various diet and humidity conditions at 30°C*

Duration (days)	*O. surinamensis* (percent/class)						*O. mercator* (percent/class)					
	Oats	Almonds		Raisins		Prunes	Oats	Almonds		Raisins		Prunes
	(10) [1]	S [2] (3)	D [3] (7)	S(5)	D(5)	D (10)	(10)	S(2)	D(8)	S(5)	D(10)	D (10)
20-percent RH												
0 [4]	0	100	30	100	60	100	0	100	0	100	0	100
1-10	0	0	0	0	20	0	0	0	0	0	10	0
11-30	30	0	0	0	0	0	10	0	0	0	20	0
31-50	40	0	70	0	20	0	30	0	0	0	20	0
51-70	10	0	0	0	0	0	20	0	25	0	20	0
> 70 [5]	20	0	0	0	0	0	40	0	75	0	30 [6]	0
Duration (days)	Oats	Almonds		Raisins		Prunes	Oats	Almonds		Raisins		Prunes
	(15)	S(5)	D(10)	S(10)	D(4)	D(15)	(15)	S(5)	D(15)	S(15)	D(5)	D(15)
50-percent RH												
0 [4]	0	0	0	10	0	86	0	60	0	7	20	74
1-10	0	0	10	0	25	0	0	20	0	7	0	13
11-30	7	20	10	0	0	0	13	0	0	0	0	13
31-50	27	20	30	10	25	0	0	0	0	0	0	0
51-70	27	0	10	10	25	7	20	20	0	13	40	0
71-80	0	0	20	10	0	7	13	0	0	0	0	0
> 80 [5]	39	60	20	60	25	0	54	0	100	73	40	0

Duration (days)	Oats (10)	Almonds D(10)	Raisins S(5)	Raisins D(5)	Prunes D (10)	Oats (10)	Almonds D(10)	Raisins S(5)	Raisins D(5)	Prunes D(10)
80-percent RH										
0[4]	0	0	0	0	0	0	0	0	0	0
1-10	0	0	0	0	0	0	0	0	0	0
11-30	0	0	0	0	10	0	0	0	0	0
31-50	0	10	40	20	10	0	0	0	0	30
51-70	0	20	40	40	50	10	10	0	40	10
71-80	10	0	0	0	0	0	0	0	0	10
> 80[5]	90	70	20	40	30	90	90	100	60	50

1 Number of individual adult pairs in test is given in parentheses after name of food or quality of food (S or D).

2 Sound fruit

3 Damaged fruit

4 Females failed to oviposit.

5 Females still ovipositing at end of test.

6 This figure represents 3 females that were still ovipositing at the end of 38, 41, and 59 days.

TABLE 9. — *Longevity of adult* Oryzaephilus surinamensis *as influenced by food and relative humidity at 30° C*

Duration (days)	Males (percentage per class) Oats (9)[1]	Almonds S[2] (3)	Almonds D[3] (7)	Raisins S(5)	Raisins D(5)	Prunes D (8)	Females (percentage per class) Oats (10)	Almonds S(3)	Almonds D(7)	Raisins S(5)	Raisins D(10)	Prunes D(10)
20-percent RH												
< 10	0	100	0	100	0	0	0	67	0	100	0	0
10-30	0	0	0	0	20	63	0	33	29	0	0	50
31-50	11	0	0	0	20	12	20	0	0	0	20	40
51-70	45	0	30	0	40	25	60	0	29	0	40	10
71-80	22	0	0	0	20	0	0	0	29	0	0	0
> 80	22	0	70	0	0	0	20	0	13	0	40	0

Duration (days)	Oats (10)	Almonds S(3)	Almonds D(9)	Raisins S(10)	Raisins D(5)	Prunes D(15)	Oats (15)	Almonds S(5)	Almonds D(10)	Raisins S(12)	Raisins D(5)	Prunes D(18)
50-percent RH												
< 10	0	0	0	0	0	0	0	0	0	0	0	0
10-30	0	0	0	0	0	0	0	0	0	0	0	0
31-50	0	0	0	0	0	27	20	0	30	0	0	11
51-70	0	0	11	0	0	20	13	40	20	0	0	17
71-80	0	0	0	0	0	0	27	0	10	0	0	11
> 80	100	100	89	100	100	53	40	60	40	100	100	61
> 100[4]	50	--	56	100	80	33	33	--	20	100	80	56
> 150[4]	--	--	--	20	20	13	--	---	--	58	20	11
> 200[4]	--	--	--	20	--	7	--	---	--	17	--	6

Duration (days)	Oats (10)	Almonds D(8)	Raisins S(5)	Raisins D(5)	Prunes D (10)	Oats (10)	Almonds D(10)	Raisins S(5)	Raisins D(5)	Prunes D(10)
					80-percent RH					
< 10	0	0	20	0	0	0	0	0	0	0
10-30	0	0	20	0	0	0	10	0	0	0
31-50	0	0	0	0	0	0	0	0	0	0
51-70	0	0	0	20	0	0	0	0	0	20
71-80	0	0	0	20	22	10	20	0	20	0
> 80	100	100	60	60	78	90	70	100	80	80
> 90 [4]	100	90	40	60	56	90	70	100	80	80

[1] Number of individual adult pairs in test is given in parentheses after name of food or quality of food (S or D).

[2] Sound fruit.

[3] Damaged fruit.

[4] There could have been a greater percentage of individuals in these classes had all tests been carried for 200 days; however, more effective use of time and equipment demanded that some tests be ended after 80, 100, or 150 days.

TABLE 10.—*Longevity of adult* Oryzaephilus mercator *as influenced by food and relative humidity at 30° C*

Duration (days)	Males (percentage per class)						Females (percentage per class)					
	Oats (10) [1]	Almonds		Raisins		Prunes D(9)	Oats (10)	Almonds		Raisins		Prunes D(10)
		S[2] (2)	D[3] (8)	S (5)	D(10)			S(2)	D(8)	S(5)	D(10)	
20-percent RH												
< 10	0	0	0	100	0	0	0	0	0	100	0	0
10-30	0	100	0	0	0	0	0	100	0	0	0	10
31-50	10	0	0	0	0	89	20	0	0	0	0	70
51-70	20	0	0	0	10	11	20	0	0	0	20	20
71-80	0	0	0	0	0	0	10	0	0	0	0	0
> 80	70	0	100	0	90	0	50	0	100	0	80	0
Duration (days)	Oats (15)	Almonds		Raisins		Prunes D(13)	Oats (16)	Almonds		Raisins		Prunes D(15)
		S(3)	D(9)	S(16)	D(5)			S(5)	D(10)	S(16)	D(5)	
50-percent RH												
< 10	0	0	0	0	0	0	0	0	0	0	0	0
10-30	0	33	0	0	0	0	6	40	0	0	0	0
31-50	0	0	0	0	0	8	0	20	0	0	0	13
51-70	0	0	0	0	0	54	6	0	0	6	0	13
71-80	0	0	0	0	0	23	25	20	0	0	20	33
> 80	100	66	100	100	100	15	63	20	100	94	80	41
> 100 [4]	33	--	44	81	80	8	12	--	50	75	80	13
> 150 [4]	--	--	--	25	--	--	--	--	--	12	--	--

Duration (days)	Oats (10)	Almonds D(9)	Raisins		Prunes D(9)	Oats (10)	Almonds D(10)	Raisins		Prunes D(10)
			S(5)	D(5)				S(5)	D(5)	
80-percent RH										
< 10	0	0	0	0	0	0	0	0	0	0
10-30	0	0	0	0	10	0	0	0	0	0
31-50	0	0	20	25	0	0	10	0	0	0
51-70	0	0	20	0	0	0	10	0	0	0
71-80	0	0	0	0	0	0	10	0	20	10
> 80	100	100	60	75	90	100	70	100	80	90
> 90[4]	100	75	60	75	67	90	70	100	40	89

[1] Number of individual adult pairs in test is given in parentheses after name of food or quality of food (S or D).

[2] Sound fruit.

[3] Damaged fruit.

[4] There could have been a greater percentage of individuals in these classes had all tests been carried to these points.

TABLE 11. — *Population development of* Oryzaephilus surinamensis *and* O. mercator *in intraspecies* [1] *and interspecies* [2] *rearings at 30° C*

Percentage of RH	Food	Intraspecies rearings		Interspecies rearings	
		O. surinamensis	*O. mercator*	*O. surinamensis*	*O. mercator*
		Percentage of increase [3]			
20	Oats	2,470	1,552	2,778	2,538
	Almonds	20	40	2	122
	Raisins	0	0	0	4
	Prunes	0	0	0	0
50	Oats	9,412	7,018	6,857	10,243
	Almonds	112	76	10	135
	Raisins	28	19	4	55
	Prunes	0	0	0	0
80	Oats	10,007	10,171	10,710	9,404
	Almonds	518	522	210	740
	Raisins	113	99	24	198
	Prunes	0	0	0	16

[1] Started with 10 pairs of adults per test setup.

[2] Started with 5 pairs of adults of both species per test setup.

[3] Numbers of adults were determined 10 weeks after start of test and presented as a percentage of the initial number of adults in the test.

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