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

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Agricultural Research Service UNITED STATES DEPARTMENT OF AGRICULTURE



COMPARATIVE BIOLOGIES OF OR YZAEPHILUS 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.

Note that the 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 20percent 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. mercutor 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. mercutor 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. mercutor*.

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.

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

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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-hourlight—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 15dram 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 $\pm 0.5^{\circ}$ 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 20percent 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 1⁴ 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

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 80percent 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 20percent 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 20percent RH, whereas the reverse was generally so at 50- and 80percent 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 80percent 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.

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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 20percent 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 cats. 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.

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The observation that mold growth on the various foods at 80percent 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 20percent 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 50percent 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 20percent 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. surmamensos (figs. 8-10) and O. mercatof (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 80percent 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. mercutor 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. mercutor*) 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, Oryzaephilussurinamensis (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. mercutor 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

			Percenta	e	
Percent RH	Week [Oats	Almonds	Raisins	Prunes
20	1	·i 15	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

Durane, DM	Sumber of	Duratio	Confi- dence	
PETCER AN	hatobing -	harching Mean		interval (±days)
	Oryzacphi	lus surina	mensis	
20	869	4.1	0.01	0.5
50	285	3.8	.02	.5
80	150	3.9	.02	.5
	סעקירנס,	bhilus mer	cator	
20	616	4 5	.02	.5
50	204	4.2	.02	.6
80	593	4.1	.01	.5

	O sur	anamensi	; ;			0 mere	ator	
Stage	Number tested		Duratio	n (days)	Number tested	i	Duration	(days)
	number In stage	Mean	± SD	Range	in stage number	Mean	±SD	Range
			Oats	: (20-percei	nt RH)			
E	10/10		-		10/10			
Ll	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
Р	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
		Sou	w alm	onas 4 (20-	percent R	H)		
Е	5/5				10,10			
Ll	1/1	10.1		9.1-10.9	8/8	77	17	5 8-12 1
L2	0/0				7/7	5.3	2.6	2 2 11 0
L3	0/0	-			676	5.0	1.0	2.2-11.0
L4	0/0			-	574	5.4	1.0	2000
L5	0/0		-		5/2	5.5	1.0	4170
P	0/0				575	5.0	.0	30.03
ED-PE	0/0			.	5/6	35.3	3.1	30 9-39,8
		Dam	aged a	raisıns 4 (2	0-percent	RH)		
E	15/15				575			
Ll	4/4	82	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			
р	0/0				0.0			
ED-PE	0/0	-			0/0			
		Dar	aged j	brunes (20-	percent R.	H)		
Ξ	20/20				10/10			
Ll	2/2	74	2.1	5.1-9.7	0/0			
L2	0/0			-	0,/0			
L3	070				0, 0			
			Oats	s (50-perce	nt RH)			
E	15/15				15/15			
LI	15/15	3.0	03	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	24	.4	18-3G
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	51	.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

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

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See footnotes at end of table.

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	O stor	namensis				0 merc	ator	
Stage	Number tested		Duration	-days-	Number tested	D	uration	(days)
	number in stage	Mean	:50	Range	number in stage	Меал	±SD	Range
		Dama	ged al	monds (50-f	percent R	H)		
£	15/15				15/15			
LI	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
Р	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
		So	und re	risins (50-þe	ercent Rh	D		
E	55				5/5			
- 1.1	5 5	6.1	1.1	4.0-8.2	5/5	7.3	1.8	3.0-12.0
1.2	55	6.9	1.4	4.0-10.0	5/5	6.5	1.1	4.0-9.0
13	4.4	6.5	1.6	4.1-9.2	5/5	8.1	3.2	5.0-15.0
L.J.	4.4	11.0	29	5.0-15.0	5/5	9.3	1.2	7.0-12.0
15	40	0			5/2	9.0	2.8	5.0-12.2
16	4.0	0			5/1	8.7		7.3-10.1
	4,0	v. c.o	 #	5.0-9.0	5/5	54	0.6	4 0-7 0
F ED-PE	44	39.9	4.6	31,9-33.2	5/5	46.5	9.2	35.1-60.6
		Dan	aged	raisins (50-,	þercent R	:H)		
E	10-10				10/10			
ม้า	8.8	73	0.9	6.2-9.7	8/8	8.7	1.4	7.1-12.0
1.3	66	6.7	1.8	23-87	8/8	73	.9	5.5-9.7
1.2	5 '5	7.4	1.0	18-10.7	6/6	7.2	2.0	5.0-10.7
1	0.0	10.9	1.5	5 4-15 5	6/6	97	3.1	6.0-16.2
15	చ. ఎ	10.0	4.0	0.4-10.0	6/4	0.1	37	5.0-17.0
	31				6/1	10.0		9.0-10.9
Lb	2.0	.U. च च		1960	6/6	5.0	1	3.0-6.1
P DC	22	0.0	. 2	4,0-0.0	6,0 6,6	50.6	78	38 5-64 6
ED-PE	2 2	41.0	(.4	30.1-41.1	0.0	30.0	1.0	50.0-01.0
		Dan	naged	þnæs (50-)	percent R	н)		
Ę	17 17				15/15			
L1	$15 \ 15$	8.3	4.4	2.5 - 18.5	77	12.6	3.1	8.0-16.2
1,2	13 13	12.7	9.9	4.2-39.2	나 나	8.3	3.0	4.0-11.2
1.3	10,10	198	10.0	8.9-36 8	22	96	.0	9.0-10.3
1.4	10.9	18.9	$5 \ 1$	11 8-27 0	$2 \cdot 2$	20.7	12.4	11 0-31.0
1,5	9 1	23.0		22 0-24.0	2 1	16.5		15.0-18.0
Р	88	6.8	8	49-110	22	4.9	.7	2.8-6.9
ED-PE	88	71.1	18 1	44.9-94 1	22	68 3	7	66.1-70.7

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

See footnotes at end of table.

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	0. su	nnamensi	5			0 me	rcator	•
Stage	Number tested,		Duratu	on (days)	Number tested/	<u> </u>	Duration	t (days)
	in stage	Mean	±SD) Range	number in stage	Mear	Mean ±SD Rai	
			Oai	ts (80-percei	nt RH)			- · · · · · · · · · · · · · · · · · · ·
E	10/10				979			
L1	10/10	2.7	0.3	2.0 - 3.4	9/9	29	0.3	20.24
L2	10/10	2.6	.3	1.9-3.7	9/9	2.8	0.0	14-59
L3	10/10	2.7	1.4	1.3-7.0	9/9	2.6		1 2 5 0
L4	10/9	5.3	1.5	1.2-7.7	9/8	4.9	 2	3960
L5	10/1	7.0		6.2-7.8	9/0	1.0		3.3-0.0
P	10/10	5.8	.3	4.9-7.0	9/9	5.3	 Q	 1 1 6 7
ED-PE	10/10	23.2	1.4	20.8-26.4	9/9	22.0	.3	20.7-24.1
		Sou	nd aln	nonds (80-þe	rcent RH	9		
E	5/5				5/5			
L1	5/5	4.8	0.9	3.2-6.3	5/5	4 1	05	3050
L2	4/4	4.4	2.9	2.3-9.4	5/5	3.0	0.5	3.0-3.0 . 2253
L3	4/4	3.6	.7	2.5-5.5	5/5	3 0	11	2.2-J.3 22.2-J.3
L4	3/3	5.8	.2	5.2-6.6	5/5	5.7	7	4376
Р	3/3	5.7	.5	4.2-6.7	5/5	5.4	. (4.3-7.0
ED-PE	3/3	25.8	1.0	23.8-27.0	5/5	27.1	2.5	23.6-31.2
		Dama	ged a	tmonds (80-)	bercent R	?H)		
E	5/5				5/5	·	_	
L1	5/5	4.1	0.5	3 2-5 0	5/5	37	 0.9	2042
L2	5/5	3.8	.8	2 2-5 7	5/5	24	0.2	3.0~4.2
L3	5/5	3.2	.8	1.8-5.2	5/5	3.0	. J 6	4.2-4.7
L4	5/5	6.0	.9	4.3-8 1	5/5	A 7	1.5	1.2-4.2
L5	5/0	.0			5/1	6.0	1.0	54-66
Р	5/5	5.6	. 6	3.6-7.0	5/5	5.4	5	4071
ED-PE	5/5	26.6	2.3	23.8-31.1	5/5	25.4	1.0	23.8-27.0
		Sour	d rai	suis (80-perc	rent RH)			
Е	5/5				5/5	.		
L1	5/5	6.0	2.4	4 2-10 4	5/5	 8 2	 93	2 8 10 0
L2	5/5	6.7	2.7	2 8-11 0	5/5	0 G 4 5	4.0 ງມ	3.8-10.0
L3	5/5	11.4	6.4	4 0-20 0	5/5	21.2	0.0 05	Z.J-12.0
L4	4/3	12.1	6.0	5 9-19 7	573	21.0 0.E	0.J 2 0	6.3-32.8
L5	4/0	.0			51	ມີມ ຕໍ່ຄ	2.9	0.0-13.7
P	4/4	4.9	7	4 6-6 4	374	3 Y 5	-	0.0.11.0
ED-PE	4/4	38.4	8 I	26.7.48.0	171 171	- <u>-</u>	.0	9.0-7.0
		50.7	0.1	20 (F90.V	4.14	50.8	10.7	40.7-68.1

TABLE 3. — Duration of stages of Oryzaephilus spp. at 30° C⁻¹ — Continued

See footnotes at end of table

	O. suri	namensis				0. merc	ator		
Stage	Number tested/		Duration	(days)	Number tested/	Duration (days)			
	number in stage	Mean	≐SD	Range	number in stage	Mean	±SD	Range	
		Dam	aged v	aisins (80-þ	ercent Ri	H)			
F	5/5				5/5				
1	5/5	5.7	1.1	3.8-7.0	5/5	5.8	1.4	3.8-8.2	
10	5/5	6.1	1.3	4.5-9.0	5/5	5.8	3.8	1.2-12.1	
13	5/5	6.0	1.3	4.7-8.8	4/4	5.2	1.4	3.1-7.3	
1.4	5/5	116	3.9	8.8-20.0	4/4	8.7	1.7	6.6-11.3	
15	5/0	0			3/1	5.6		5.0-6.2	
DJ	4/4	5.6	17	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	
		Dam	aged ;	brunes (80-‡	ercent R.	H)			
E	10/10				10/10				
1.1	10/10	6.8	2.5	3.2-11.0	10/10	8.5	3.5	2.0-13.8	
1.2	9/9	12.7	8.8	3.3-36.5	8/8	5.6	1.2	3.6-8.3	
1.3	8/8	13.2	6.5	4.3-25.1	7/7	5.8	2.6	2.4-9.9	
1.4	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	

TABLE 3. — Duration of stages of Oryzaephilus spp. at 30° C⁻¹ — Continued

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.

		O sur	mamensis				0.	mercator	· · ·	
Sex	Per- cent-	Numbur		Duration (da	ys)	Per- cent-	Number		Duration (days)
(M. male, F, female)	age nf sur- vival	tested	Mean	± SD	Range	- age of sur- vival	Number — tested	Mean	± SD	Range
				(Dats (20-percent	RH)				
М		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
				Aln	ionds (20-percer	nt 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
				Ç	Dats (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-per	cent RH)			· · ·	
Μ	·	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			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

TABLE 4. — Duration of life cycle (egg deposition to adult emergence) and survival of Oryzaephilus spp. at \Im^{00} C⁻¹

				Damage	i almonds (50-pe	rcent RH)					
ъл		12	28.3	2.5	24.9-35.0	· ·	10	27.7	1.4	24,5-30.0	
E.		12	28.1	4.3	23.6-40.0	· ·	12	28.2	2.2	24.5 - 31.7	
Г Х1 ± Г	30	25	28.2	3.5	23.6-40.0	88	25	28.0	1.9	24.5 - 31.7	
IVI - I	2 0	20	20.2	Sound	raisins (50-perc	ent RH)					
		n	10.0	6.4	40 9-52 0		2	49.9	9.6	41.5-58.9	. 0
М	i de la Transiera de la composición de	2	40,9	0.4	40.5 52.0		2	67.7	2.1	65.5-69.9	N S
F		0	40.0	 c A	40.9-52.0	17	23	58.8	11.7	41.5-69.9	ZA
M + F	8	25	40.9	0.4	40.0-02.0	••					EF
				Damage	ed raisins (50-pe	rcent RH)					H
		c	28.6	74	31.8-51.0		6	57.0	12.0	47.4-81.9	EL
M			43.0	11.4	31 8-61.0		3	55.1	10.7	47.4-72.8	S
F T		- 1 	40.4	11.9	31 8-61 0	36	25	56.4	10.9	47.4-81.9	9
M + F	44	23	ч о ч								
				Damag	ea prunes (50-pe	сет кн)					R
М		8	57.5	14.2	40.9-88.0		1	67.2		66.5-67.9	IE
E.		š	48.4	19.0	35,9-88.0	i	0				
M + F	31	42	54.0	16.1	35.9-88.0	2	50	67.2		66.5-67.9	FR
141 - 1.	JI	-			Oate (RD-borcont	RH					Ξ
					onis (00-percent						ST
м	· · · · · · · · · · · · · · · · · · ·	22	21.3	1.1	18.5-23.9	<u> </u>	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	H
· 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	B
				Sound	almonds (80-ber	cent RH)		- · · · · · · · · · · · · · · · · · · ·			\mathbf{TS}
				20.0.0			c	26.6	43	22 3-33 7	-
M		10 -	25.1	2.6	20.5-29.1	: 	0	20.0	- 0.7	22 3-24 9	
F		7	27.3	4.8	22.8-37.9		4	20.0	3.6	22 3-33 7	
M + F	68	25	26.0	3.7	20.5 - 37.9	40	25	40.4	9.0	AA.0-00.1	

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		0 5027	namensis				ρ	mercator		······
Sex	Per- cem			Duration (days	X	Per cent			Duration (days)
(M, male: F, female)	age of sur vival	tested	Mean	* SD	Range	of Sur Vival	tested	Mean	+ SD	Range
				Damaged	almonds (80-)	xercent RI	1)			-
М		10	26.9	3.0	19.9-30.2	e su e	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 re	aisins (80-perc	ent RH)				
M		2	34.7	27	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-pe	reent 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
				Damagea	primes (80-pe	rcent RH))	an an se se Se		
M		12	43.4	10.7	26.2-60.4		12	47.5	17.5	32.0-81.9
F	u s é is	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

TABLE 4. — Duration of life cycle (egg deposition to adult emergence) and survival of Oryzaephilus $spp.at \approx 30^{\circ} C^{-1}$ — Continued

ORYZ.4EPHILUS ON DRIED FRUITS AND NUTS

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

••••••••••••••••••••••••••••••••••••••	·····	ંદા	rinamensis				() mescalo)		· · ·
	Per			Duration (days	Per cent	N 1 1		juration (days)	
Sex	Sex age Number — of tested Mean sur yival	Mean	+ SD Range:	age of sur vival	Sumper tested	Mean	+SD	Range	
				Oats (20-perc	ent RH)				
M F M + F	 93	51 47 100	24.1 24.3 24.1	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	70	33 37 100	28.1 28.0 28.0	2.3 2.1 2.2	24.4-34.9 24.4-35.8 24.4-35.8
				Sound almonds (20-	percent RH)				
M F M + F	 8	2 2 50	41.2 46.1 43.6	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	 46	15 8 50	43.8 39.4 42.3	6.7 2.0 5.9	37.0-57.5 34.9-43.5 34.9-57.5

[M, mate; F, female]

See footnotes at end of table.

				[**	i, maie, r _i ie					
			nami nsis					o meriator"		
	Per cent-			Duration day		Per cent			Duration eday.	••••••••••••••••••••••••••••••••••••••
Sex	age of Sur- Vivát	sumper testel	Mean	* SD	Bange	ef sur- vival	tested	Меді	+ NJ1	£
	·····		271 A.M. Law (2009) ((2009) A.M. Law (2009)	Damaged	almonds (20	-percent RH	') - ·			and and a set of the s
M F M + F	 14	1 6 50	46.1 45.4 45.5	5.3 4.8	45.4-46.8 38.6-54.9 38.6-54.9	 60	15 15 50	35.8 37.8 36.8	2.3 3.2 2.9	32.4-4 30.4-44 30.4-44
				Damaged	raisins (20-	percent RH)				
M F M + F	- 4	1 1 50	50.1 69.4 59.8		49.1-51.1 68.4-70.4 49.1-70.4	 10	4 1 50	63.3 75.8 65.8	16.3 15.2	46.9-86 74.9-76.7 46.9-86
				Oats	s (50-percen	t RH)				
M F M + F	 91	44 47 100	22.2 22.0 22.1	1.6 .7 1.2	19.0-31.3 20.0-23.3 19.0-31.3	 93	46 47 100	23.1 22.9 23.0	0.6 .7 .6	21.2-24.7 21.2-25.6 21.2-25.6
				Damaged a	lmonds (50-	percent RH)				
M F M+F	 55	18 37 100	29.6 28.6 29.0	3.3 1.8 2.4	26.1-41.5 25.2-32.5 25.2-41.5	 83	36 47 100	27.3 27.3 27.3	1.7 2.2 2.0	23.2-32.4 24.2-39.4 23.2-39.4

TABLE 5 — Duration of life cycle (egg deposition to adult emergence) and survival of Oryzaephilus 30° (l = - Continued [M, male; F, female]

				Damag	red raisins (50-pe	ercent RH) 1111			
М		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	37.5-65.5
				Soun	d prunes (50-perc	ent RH)		-		
М		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
				Dan	naged prines (50-	percent 1	RH)	· · · ·		
М	· · · · · ·	6	69.4	15.7	55.1-100.4	رت حصر ال	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-percer	it RH)				
М		39	21.6	1.2	17.7-26.3		39	22.5	0.8	21.0-24.7
F	a da antes de la composición de la comp	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
				Sou	nd almonds (80-p	ercent RI	4)			
М		-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
	n an			Dam	aged almonds (80	-percent	RH)			
Μ		17	26.5	1.7	22.0-31.4		18	25.6	1.8	22.3-31.6
\mathbf{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.

μ

	1				-[m, mare, r, n	smare j		1. Sec. 1. Sec		
		et - 4	mamin-i				0	mercator		
n de la composition Notae de la composition Notae de la composition de la composition	Per			Datation daxs		Per cent	Name	-	Duration stays	
Sex	are f	tion ter f	Mean	·····	Rane	तहरू भी	tested -	Méan	+ SD	Range
						sur vival		·* •• • •		
				Sou	nd raisins (80-	peri al R	2H)			
М	d ji 🖆 tay	10 -	44.2	3 8	35.0-52.3		7	46.6	3.7	38.8-51.1
F		7	4.7.2	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
				Damag	ed raisins (80-	percent R	2 <i>H</i>)			
М	- <u>-</u>	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
			an an an a' an	Sound ‡	nunes (80-perc	ent RH)				
Min Barbara		25	48.7	58	33.7-60.6		1	47.0		46.1-47.9
Filler -		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

TABLE 5 — Duration of life cycle (egg deposition to adult emergence) and survival of Oryzaephilus spp. at %30° C¹ — Continued [M. male: F. female]

Multiple rearings with 10 individuals per cage.

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

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		0 surmaine	vists				0 mercato	r	
		Number		Weight (m	g i	Number		Weight (mg)	
Food	Sex	tested	Mean	± SD	Bange	tested	- Mean	±SD	Range
				2	0-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		the second second	11	.46	.09	.30-0.65
	F	1	26			14	.48	.08	.34-0.62
				5	0-percent RH				
Oats	М	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	1.9	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	i in a second second	
	F	5	.32	07	.26-0.41	0			
				(1,1,2,1,2,2,1,2,2,2,2,2,2,2,2,2,2,2,2,2	80-bercent RH				
Oats	M	22	0.47	0.07	0.34-0.63	26	0.64	0.09	0.43-0.88
	$\sim F$	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	М	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 6. — W'eight of Oryzaephilus spp. males and females as influenced by food and relative humidity at 30° C [M, male; F, female]

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ORYZAEPHILUS ON DRIED FRUITS AND NUTS

		O. surman	nensis				C	mercator		
Food	Percent taying	Number		Duration	(days)	Percent	Number		Duration (day	ys)
	egga	tested	Mean	± SD	Range	eggs	tested	Mean	± SD	Range
					20-percent RH	· · · · · ·			·····	
Oats Almonds 1	100	10	11.3	4.9	5.6-24.9	100	10	5.2	1.8	3.5-9.9
Damaged Raisins 1	71	7	17.7	7.2	9,4-29,1	100	9	4.9	.7	3.5-6.9
Damaged Prunes	40	5	42.8	30.4	20.5-65.9	100	10	22.0	7.3	12,5-35.6
Damaged	0	10	المتحجر أر			0	10			
					50-percent RH					
Oats Almonds	100	10	< 4.7	0.5	<4.5-6.4	-100	10	<4.7	0.0	
Sound	100	5	6.6	2.4	4.3-12.0	20	5	5.0		<a 6<="" 7-5="" td="">
Damaged Raisins:	100	5	5.2	0.7	< 4.5-6.4	100	10	4.5	.5	2.7-5.9
Sound	100	5	44.4	93	32 0+60 4	87	15	119	4.0	60.000
Damaged Prunes:	100	5	45.0	27.3	18.0-91.8	80	5	25.7	4.5	0.0-22.0 14.9-47.2
Damaged	13	15	51.4		49.0-53.8	27	15	17.0	10.6	7.0-34.1

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

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					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:	a fa su la				and the second second					
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	1.0	22.7	4.5	13.9-31.0	100	10	16.4	2.6	11.6-22.1
<u> </u>	1			신 가슴 가슴을 많다.						

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

 2 No tests made with sound almonds.

	(). surmamensi	s (percent/cla	S8)	and a shared justice is specify			0. 1	nercator (percen	t/class)		
Duration	Oats	Aln	onds	•	Raisins	Prunes	Oats	٨	lmonds	Ra	isins	Prunes
(days)	(10) 1	S ² (3)	11 3 (7)	S(5)	D(5)	D (10)	(10)	S(2)	D(8)	S(5)	D(10)	D (10)
	- /)-percent RE	1					
04	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	20	0.
31-50	40	0	70	0	20	0	30	0	0	0	20	Ö
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	Oats	AI	monds	·	Ratsins	Prumos	Oats	Α	Imonds	Rai	sins	Prunes
(days)	(15)	S(5)	D(10)	S(10)	D(4)	D(15)	(15)	S(5)	D(15)	S(15)	1)(5)	D(15)
					5(0-percent RI	1		· · · · · · · · · · · · · · · · · · ·		-	
04	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+1	13	0	0	0	Ō	···· 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

TABLE 8. — Duration of oviposition period of Oryzaephilus spp. in various diet and humidity conditions at $30^{\circ}C$

Dumtion	Data	Almonds			Raisins	_		Pranes		Jats	Alr	nonds			Raisins		Prune
(days)	(10)	D(10)	·	S(5)		D(5)		D (10)		(10)	D	(10)		S(5)		D(5)	D(10)
	 				· · · · ·		80-1	bercent	RH	-		·	n de la composition a composition de la composition a composition de la co				· · · · ·
04	0	0		0		0		0		0		0		0	· -	0	0
1-10 11-30	n genine Hig	Q Q		0		0		9 10.101.		0		0		0		0	0
31-50 51-70	0 0	10 20		40 40		20 40		10 50		0 10		10		0		40	10
71-80 > 80 5	10 90	0 70		0 20		0 40	-	0 30		0 90		0 90		0 100		60	10 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.

		Males (perco	mage per cla	55)				Female:	s (percentage	per class)		· · ·
Duration	Oats	Almo	nds	Raisi	115	Prunes	Oats	Almo	onds	Rais	ins	Prunes
(days)	1 9 1 i	S 2 (3)	D 3 (7)	S(5)	D(5)	D (8)	(10)	S(3)	D(7)	S(5)	D(10)	D(10)
					20	percent_RH						
< 10	0	100	0	100	0	0	0	67	0	100	0	- 0
10-30	0	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	Oats	Alm	onds	Rais	uis	Prunes	Oats	Alu	nonds	Rai	sins	Prunes
(days) -	. (10)	S(3)	D(9)	S(10)	D(5)	D(15)	(15)	S(5)	D(10)	S(12)	D(5)	D(18)
					50	-percent_RH				· · · ·		
< 10	- 0 -	0	0	0	0	0	0	0	0	0	, O	0
10-30	0	0	0	0	0	0	0 0	0	ů.	· · · õ	0.	n -
31-50	0	0	0		0	27	20	0	30	Ő	0	11
51-70	an O	0	11	0	0	20	13	40	20	Õ	·	17
71-80	0	0	0	0	0	0	27	0	10	0	ñ.	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		- <u></u>		20		7		- <u></u>	· . 	17		6

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

Duration Qats Almonds	Raisins	Prunes	Oats	Almonds	e fatour fatour.	Raisins	. Prunes
(days) (10) D(8)	S(5) D(5)	D (10)	(10)	D(10)	S(5)	D(5)	D(10)
		80-percent RH					
< 10 0 0 20) 0	0	0	0.	0	0	0
10-30 0 20) 0	0	0	10	0	0	• •
31-50 0 0 ú) 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.

		Males (per	centage per cla	iss)	1.			Female	s (percentage)	per class)		
Duration	Oats	Al	monds	Rat	sins	Prunes	Oats	Alı	nonds	Ra	isins	Prunes
(days)	(10) 1	S ² (2)	D ³ (8)	S (5)	D(10)	D(9)	(10)	S(2)	D(8)	S(5)	D(10)	D(10)
					20-	percent RI	4	* -		2012 2012	·	
< 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	Ö	10
31-50	10	0	0	0	0	89	20	0	0	0	Ő	70
51-70	20	0	0	0	10	11	20	Ō	0	. Õ	20	20
71-80	0	····· 0 .	0	0	0	0	10	··· 0 ···	Ō	0	0	0
> 80	70	0	100	0	90	0	50	0	100	0	รบ	· 0.
Duration	Oats	Alu	nonds	Rai	sins	Prines	Oats	Alm	onds	Ra	isins	Drunoa
(days)	(15)	S(3)	D(9)	S(16)	D(5)	D(13)	(16)	S(5)	D(10)	S(16)	D(5)	D(15)
					50-	þercent RI	H	· · · ·			· · · · ·	
< 10	0	0	0	0	- 0	0	0	0	0	0		n
10-30	0	. 33	0	0	0	n n	6	40	° Ő		0	0
31-50	0	0	0	··· · · · · ·	0	8	Õ	20	ů N	Ň	0	19
51-70	0	0	0	0	0	54	6 6	0	0	6	0	10
71-80	0	0	0	0	0	23	25	20	0	0	20	
> 80	100	66	100	100	100	15	63	20	100	94	20	33 /11
> 100 4	33	<u></u>	44	81	80	8	12		50	75	80	19
> 150 4	· 	, , ·		25						12		

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

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Duration	Oats	Almonds	R	alsins	Prunes	Oats	Almonds	R	aisins	Prune
(days)	(10)	D(9)	S(5)	D(5)	D(9)	(10)	D(10)	S(5)	D(5)	D(10
				80 - p	ercent 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.

ORYZAEPHILUS ON DRIED FRUITS AND NUTS

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,		Intraspecie	s rearings	Interspecies rea	rings
Percentage of RH	Food	O. surinamensıs	0. mercator	Q. surinamensis O	mercator
		······································	Percentage of inc	rease ³	·····
20	Oats	2,470	1,552	2,778	2,538
	Almonds	20	40	2	122
	Raisins	Ú	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
во	Oats	10,007	10,171	10,710	9,404
	Almonds	518	522	210	740
	Raisins	113	99	24	198
	Prunes	0	O	0	16

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

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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