Fruit Flies in Foodservice Facilities: Science-Based Fruit Fly Solutions

By John Barcay Ph.D., and Douglas Gardner BCE, RS

Introduction: Fruit Flies in Foodservice Facilities

The term "fruit fly" is the common name used to refer to small flies found in kitchens and foodservice facilities. The two most common fruit fly species are the Red-Eyed Fruit Fly, *Drosophila melanogaster*, and the Dark-Eyed Fruit Fly, *Drosophila repleta*[1]. Other fruit flies found in foodservice facilities include Moth flies and Phorid flies, often called "drain flies." There is some discussion in taxonomic circles about the validity of calling these flies 'fruit flies,' but for the purposes of this paper, they will be referred to as such[2].

The prevalence of fruit flies in foodservice facilities has seemingly increased over the last decade. This is likely due to a combination of factors, including reduced pesticide use and a decrease in good sanitation practices. Both the Red-Eyed Fruit Fly and the Dark-Eyed Fruit Fly can be found in foodservice facilities, but the Dark-Eyed Fruit Fly is likely more common due to the prevalence of suitable breeding areas[3]. For these reasons, the focus of this review will be on the Dark-Eyed Fruit Fly.

Though small, the Dark-Eyed Fruit Fly can have a major impact on foodservice facilities. This pest can quickly become a nuisance to customers and even affect a facility's reputation or brand. In addition, fruit flies can negatively impact health inspection scores and may even transfer bacteria to food and food preparation surfaces. A better understanding of the Dark-Eyed Fruit Fly will lead to more successful strategies to reduce this pest and thereby minimize the risks associated with its presence in foodservice facilities.

Objective: Understanding Dark-Eyed Fruit Flies to Provide Science-Based Solutions

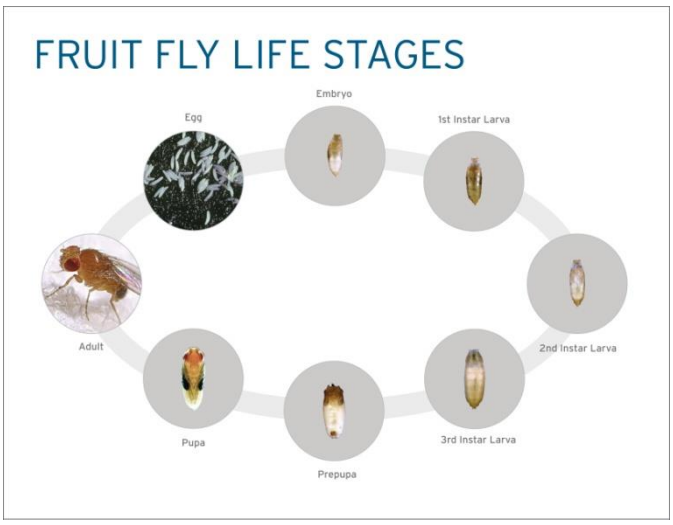
An understanding of fruit flies can lead to science-based solutions. The objective of this paper is to understand the biology and behavior of Dark-Eyed Fruit Flies in order to provide science-based recommendations and procedures to minimize activity inside foodservice facilities.

Biology and Behavior:

The Dark-Eyed Fruit Fly is uniquely adaptive, and can live, feed and breed in foodservice facilities year-round. Their tiny size, relatively short life-cycle and preferred food sources help them succeed as a persistent pest.

Fruit flies undergo complete metamorphosis with four stages of development: egg, larva, pupa and adult. The time from egg to adult for the Dark-Eyed Fruit Fly is about three weeks, much longer than its smaller cousin the Red-Eyed Fruit Fly. Adult flies can live more than a month[3] which is also relatively long-lived. The Dark-Eyed Fruit Fly can be distinguished from the Red-Eyed Fruit Fly by its slightly larger size and darker coloration.

[1] Mallis, 2011
[2] Triplehorn and Johnson 2005, Fruit Fly is the common family name for flies in the family Tephritidae such as the Mediterranean fruit fly or apple maggot fly
[3] Laboratory behavioral research - Ecolab

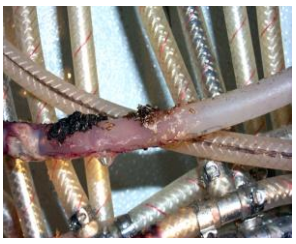


A. Breeding Sites

Once an adult female fruit fly enters a foodservice facility, it is simply a matter of time before she will find optimal locations to lay eggs[1]. The Dark-Eyed Fruit Fly is well equipped with sensory capabilities designed specifically to locate suitable breeding sites[2]. Once established inside, this pest will use meandering flights[3] to investigate every inch of the facility and find even the smallest amount of material to use as a breeding site.

Optimal breeding sites for the Dark-Eyed Fruit Fly are found in moist, decaying, organic material, often in the form of a biofilm. Bacteria, yeast and fungi, all contribute to the formation of biofilms[4]. Some of the most common biofilms associated with fruit fly breeding sites are "sugar snakes" in drain lines, slimy deposits on drains and loose aggregates of organic material found under and around equipment. Due to the consistent presence of moisture, other common fruit fly breeding locations include: inside and outside beverage service equipment, in cracks and crevices throughout bar areas, under and between worn floor tiles, in beverage drain lines, in and around floor drains, and on decaying fruits and vegetables. In some situations, breeding conditions are formed due to structural issues that result in sustained wet areas such as under poorly sealed mop sinks. Cleaning practices, such as nightly power washing floors, may also contribute to fruit fly breeding. These practices can result in water and food debris being forced inside wall voids and behind floor tile cove-molding.

Organic material in a floor drain suitable for Dark-Eyed Fruit Fly breeding



Organic material on beverage drain lines suitable for Dark-Eyed Fruit Fly breeding

Worn floor tiles that could harbor organic material suitable for Dark-Eyed Fruit Fly breeding.

Once a suitable breeding site is found, female fruit flies will lay eggs and establish a population of larvae at the site. Depending on the amount of breeding material available, the location may become an attraction for additional flies[5] and even a hub for breeding and feeding. As long as breeding material is available, the site will continue to attract more and more adult flies. Fruit fly population growth occurs on a logarithmic scale which means if left unchecked, the number of fruit flies produced will increase rapidly. A few flies one day may become hundreds of flies the next day.

[1] Yang et.al., 2008
[2] Budick et.al., 2007; Budick and Dickinson, 2006; Chow and Frye, 2008; Duistermars et.al., 2009
[3] Frye and Dickinson, 2004
[4] Kokare et.al., 2009
[5] Sevenster and Van Alphen, 1993; Wertheim et.al., 2006

The best long-term solution to maintain a fruit fly-free environment is, and always will be, good sanitation practices. Identifying and eliminating breeding sites, as well as the organic material that could become a breeding site, will break the fruit fly life cycle and prevent fruit flies from rapidly reproducing.

B. Resting and Foraging Sites

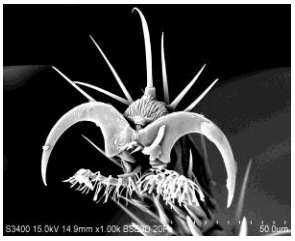
Adult Dark-Eyed Fruit Flies display distinct daily patterns of behavior with two peak periods of activity at dawn and dusk[1]. These behaviors are controlled by internal timing signals (circadian clocks) and external signals such as light-dark cycles[2]. These patterns of behavior become less distinct when flies live inside facilities due to altered light schedules and human activity. In spite of this, there are still general activity patterns that the Dark-Eyed Fruit Fly follows.

Dark-Eyed Fruit Flies sleep[3] when facilities are quiet and lighting is reduced. This resting behavior continues until light begins to increase[4]. Fruit flies become very active during morning hours where they focus on finding and visiting breeding sites, actively feeding, and exhibiting reproductive behaviors[5]. In the evening, there is another period of increased activity where many flies will move to areas away from breeding sites and find quiet locations to rest. Resting sites can be found on walls, ceilings, chords, pipes, cardboard boxes and other various surfaces. Dark surfaces seem to be preferred for resting, but fruit flies will rest on any available surface.

As daily behavior patterns cause different concentrated locations, visual fly activity inspections should be done at the same time of day to reduce the possibility of false negative results. Adult flies are not always concentrated near actual breeding sites. During foraging, flies can be found where there are attractive odors but no opportunity for larval development. These foraging sites usually include very visible areas such as bars, garbage receptacles, mop sinks and other locations. While identifying resting and foraging sites is important to reducing fruit flies within a foodservice facility, it is even more important to identify actual breeding sites and eliminate them through good sanitation practices[6].

Fruit Flies and Food Safety

Fruit flies are known to have an association with bacteria and other microorganisms in the substrates in which they live and feed. Thus, the presence of Dark-Eyed Fruit Flies in a foodservice facility creates a potential food safety risk as it is suspected in that the fly may be capable of mechanically transferring pathogens from breeding material to other surfaces where they land and groom[7]. Ecolab has demonstrated the transfer of disease causing organisms by the Dark-Eyed Fruit Fly to food surfaces is possible, thus having a potential impact on food safety. New research conducted by Ecolab entomologists and microbiologists demonstrates that the Dark-Eyed Fruit Fly is capable of transferring *E. Coli*, *Salmonella* and *Listeria* to surfaces from a contaminated source to fresh, ready-to-eat food[8]. This along with potentially rapid bacterial growth in many ready-to-eat foods, indicates that fruit a fruit fly infestation can pose a public health risk in restaurants and other food-handling facilities.



Fruit Fly Tarsus (foot): Flies' sticky feet can collect and spread bacteria. Note the particles on the tarsal claws which were picked up from the breeding material.

Flies' sponging mouthparts may be able to contaminate food and food handling surfaces.

[1] Sevenster and Van Alphen, 1993; Wertheim et.al., 2006
[2] Lewis and Taylor, 1965
[3] Grima et.al., 2004; Hardin 2005; Rieger et.al., 2007; Zhang et.al., 2011
[4] Hendricks et.al., 2000; Nitz et.al., 2002; Zimmerman et.al., 2004
[5] Fujii et.al., 2007
[6] Field observations – Ecolab
[7] Field research and observation – Ecolab
[8] Black et al., 2018

Summary and Recommendations for Actions

What You Should Do

The following recommendations will help reduce conditions that attract and maintain small flies within your foodservice facility.

Minimize exterior breeding opportunities

- Close all garbage receptacles with tight-fitting covers and eliminate garbage spillage
- Move garbage receptacles away from the facility whenever possible
- Eliminate standing water around the facility
- Remove weeds, tall grass and other excessive vegetation near the facility
- Remove clutter and items stored on the ground near the facility

Minimize fruit fly entry opportunities

- Seal all doors and inspect and repair entrances on a regular basis
- In high pressure situations, consider double-door vestibules, air doors and plastic strip doors
- Minimize the amount of time doors and windows are left open
- Inspect incoming goods and products and reject material with evidence of fruit fly activity or that show signs of spoilage

Minimize interior breeding opportunities

- Eliminate all standing water and accumulated condensation
- Establish standard cleaning practices including periodic deep cleaning under equipment and counters
- Regularly clean drains to ensure minimal accumulation of debris in and around openings
- Replace cracked floor tiles and missing grout
- Seal all cracks and crevices in wet areas to minimize water entry
- Repair plumbing and drain problems immediately
- Clean rags and mop heads before storing
- Store perishables in closed plastic tubs

What Your Pest Service Provider Should Do

- Provide a science-based, risk assessment approach to monitor and address fruit fly activity in and around your facility
- Provide regular, visual inspections of the outside and inside of structures by trained professionals
- Document sanitation and structural issues that are conducive to fruit fly activity and may lead to interior presence of flies
- When fruit flies are found, identify primary breeding locations, secondary breeding locations and foraging locations
- Meet with management and make recommendations on improving conditions to reduce fly activity inside
- Apply pesticide as needed to targeted areas, reducing the risk of exposure

For more information, contact Ecolab Pest Elimination at 1.800.325.1671.

ABOUT THE AUTHORS:

John Barcay, Ph. D.

Dr. John Barcay is an expert on pest elimination techniques for food and beverage processing, food-service, hospitality and related industries. Since joining Ecolab in 1990, Barcay has specialized in developing thorough and effective integrated pest management programs with minimal use of pesticides. As a senior scientist and program leader, Barcay helped develop Ecolab Pest Elimination's pesticide evaluation and pest program development. He has published many articles on the use of pesticides to eliminate cockroaches and is the co-holder of several industry related patents. Barcay received both his master's degree and doctorate in urban entomology from Purdue University. His dissertations examined the behavior of German cockroaches relative to attractants, repellents, and insecticidal baits. He is a member of the National Pest Management Association, Entomological Society of America, American Mosquito Control Association, Gamma Sigma Delta (the honor society of agriculture), Society for Vector Ecology and Pi Chi Omega, a professional fraternity for urban pest control, and Association of Structural Pest Control Regulatory Officials (ASPCRO),

Douglas B. Gardner, BCE, RS

Doug Gardner provides 15 years of industry experience and nine years of academic research to the Ecolab Pest Elimination team. His background as a biologist includes a B.S. degree in biochemistry from the University of Arizona and an M.S in entomology from Texas Tech University. He is a Board-Certified Entomologist, a Registered Sanitarian and a Certified Black Belt in Lean Six Sigma. In his professional career, he has served in a broad variety of positions including service specialist (technician), operations manager, technical support manager and scientist. As the manager of the technical support team at Ecolab, Gardner was responsible for field support and field training across North America. He experienced and solved pest challenges in most commercial environments. He is currently a senior scientist providing expertise and driving innovation for Ecolab's rodent, small fly and large fly programs. He is a member of the National Pest Management Association, Entomological Society of America, National Environmental Health Association, and Pi Chi Omega (a professional fraternity for urban pest control).

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