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Dr. Sujit Kumar
Department of Zoology, P.M.J. College V.K.S.U, Ara, Bihar, India

Correspondence:
Dr. Sujit Kumar
Department of Zoology, P.M.J. College V.K.S.U, Ara, Bihar, India

Study the genetics organism and life cycle of metamorphosis drosophila

Dr. Sujit Kumar

Abstract
Drosophila is a genus of small flies, belonging to the family Drosophilidae, whose members are often called "fruit flies". One species of Drosophila in particular D. melanogaster, has been heavily used in research in genetics and is a common model organism in developmental biology. The entire genus, however, contains about 1,500 species and is very diverse in appearance, behavior, and breeding habitat. Scientists who study Drosophila attribute the species' diversity to its ability to be competitive in almost every habitat, including deserts. The modern era of Drosophila research really took off when the embryo was analyzed in depth for genes involved in its development [6]. This work launched many fields of developmental biology and led to another Drosophila Nobel Prize [7]. The basic discovery was that discrete genes regulated different aspects of development. Many of these genes turned out to be homologous to those involved in human development and disease. These genes had been conserved over millions of years of evolution and could be studied easily and rapidly in flies. This led to a boom in the field as more and more researchers saw the potential of flies for asking basic and applied questions, and to the development of ever cleverer molecular tools to address these questions. For example, chemical mutagenesis was used for many years to generate new mutations that were screened for interesting phenotypes, followed by careful genetic mapping, a chromosome walk, and finally gene cloning [8]. Currently, the MiMIC transposon system is being applied to target all genes in the *Drosophila* genome, providing null mutations and a platform to land protein tagging, gene expression tracking.

Keywords: *Drosophila,* genetics, common model organism, *melanogaster* life cycle

Introduction

Drosophila derived from the Greek word drósos means dew loving. They belong to the Droso–philidae family; and are most frequently known as fruit flies or often called vinegar, wine or pomace flies. Their main distinguishing character is to stay on fruits, which are ripped or rotten. There is another related family Tephritidae, their members are also called as true fruit flies or fruit flies. *Drosophilae* are different from them. They feed primarily on unripe or ripe fruits. Many species of *Drosophila* are agricultural pests, especially the Mediterranean fruit flies. They oviposit through ovipositor and capable of colonizing in live fruits that are still in the process of ripening, causing massive agricultural damage Drosophila melanogaster, known colloquially as the fruit fly, remains one of the most commonly used model organisms for biomedical science. For more than one hundred years, the low cost, rapid generation time, and excellent genetic tools have made the fly indispensable for basic research. The addition of numerous molecular tools has allowed the model system to keep up with the latest advances. In this issue, various authors provide examples of how *Drosophila* is currently being used, and what directions they think the system is moving in. From human disease modeling to the Ndissection of cellular morphogenesis and to behavior and aging, this issue examines the current uses of flies, and the influence of fly research on other models.

Life cycle of Drosophila Stages and duration

Embryonic development, which follows fertilization and the formation of the zygote, occurs within the egg membrane. The egg produces larva, which eats and grows and at length becomes pupa. The pupa, in turn develops into an imago or adult. (Fig. 1) The duration of these stages varies with the temperature. At 20oC, the average length of the egg-larval period is 8 days; at 25oC it is reduced to 5 days. The pupal life at 20oC is about 6.3 days, whereas at 25o C is about 4.2 days. Thus at 25o c the life cycle may be completed in about 10 days, but at

20oC about 15 days are required. Drosophila cultures ought to be kept in room temperature where the temperature does not range below 20oC or above 25oC. Continuedexposur to temperatures above30°C may

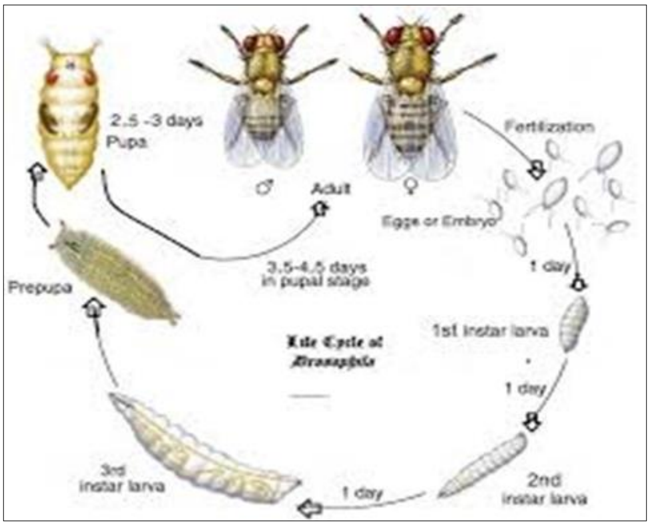

Fig 1: Life cycle of Drosophila Stages and duration

Result in sterilization or death and at low temperatures the viability of flies is impaired and life cycle prolonged [2].

The egg

The egg of *Drosophila melanogaster* is about 0.5 of a millimeter long. An outer investing membrane, the chorion, is opaque and shows a pattern of hexagonal markings. A pair of filaments, extending from the anterodorsal surface, keeps the egg from sinking into soft food on which it may be laid. Penetration of spermatozoa into egg occurs through a small opening or micropyle, in the conical protrusion at the anterior end, as the egg passes through the uterus. Many sperms may enter an egg, through normally only one functions in fertilization. The spermatozoa have been stored by the female since the time of mating. Immediately after the entrance of the sperm, the reduction (meiotic) divisions are completed and the egg nucleus (female pronucleus) is formed. The sperm nucleus and the egg nucleus then come into position side by side to produce the zygote nucleus, which divides to form the first two cleavage nuclei, the initial stage of development of the embryo. Eggs may be laid by the mother shortly after they are penetrated by the sperm, or they may be retained in the uterus during the early stages of embryonic development [2].

The Larval Stages

The larva, after hatching from the egg, undergoes two molts, so that the larval period consist of three stages (instars).The final stage, or third instar may attain a length of about 4.5millimeters. The larvae are such intensely active and voracious feeders that the culture medium in which they are crawling becomes heavily channeled and furrowed [2].

The larva has 12 segments: the 3 head segments, 3 thoracic segments, and 8 abdominal segments. The body wall is soft and flexible and consists of the outer noncellular cuticula and the inner cellular epidermis. A great number of sense organs are spread regularly over the whole body. (Fig. 2) [2, 3].

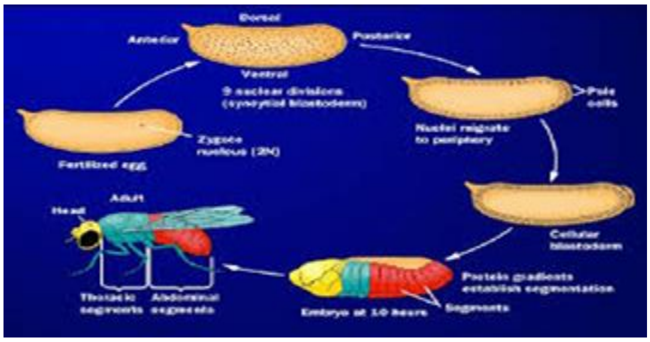

Fig 2: The Larval Stage of Drosophila

The larvae are quite transparent. Their fat bodies, in the form of long whitish sheets, the coiled intestine, and the yellowish malpighian tubules, as well as the gonads embedded in the fat body can easily be distinguished in the living larva when observed in transmitted light. The dorsal blood vessel is the circulatory organ of the larva. The larval muscles, segmentally arranged, are transparent but can be made visible when the larva is fixed in hot water. The larva contains a number of primitive cell complexes called imaginal discs, which are the primordia for later imaginal structures [2, 3].

The primary mechanism by which the larva grows is molting. At each molt the entire cuticle of the insect, including many specialized cuticular structures, as well as the mouth armature and the spiracles, is shed and has to be rebuilt again. During each molt, therefore many reconstruction processes occur, leading to the formation of structures characteristic of the ensuing instar. The growth of the internal organs proceeds gradually and seems to be rather independent of the molting process, which mainly affects the body wall. Organs such as Malpighian tubes, muscles, fat body, and intestine grow by an increase in cell size; the number of cells in the organ remains constant. The organ discs, on the other hand, grow chiefly by cell multiplication; the size of the individual cells remains about the same. In general, one might say that purely larval organs grow by an increase in cell size, whereas the presumptive imaginal organs grow by cell multiplication [2, 3].

The pupa

A series of developmental steps by means of which the insect passes from the larval into the adult organism is called “metamorphosis”. The most drastic changes in this transformation process take place during the pupal stage.

Shortly before pupation the larva leaves the food and usually crawls onto the sides of the culture bottles, seeking a suitable place for pupation, and finally comes to rest. The larva is now very sluggish, everts its anterior spiracles, and becomes motionless. Soon the larva shortens and appears to be somewhat broader, thus gradually acquiring its pupal shape. The shortening of the larval cuticle, which forms the case of the puparium, is caused by muscular action. The puparium, which is the outer pupil case, is thus identical with the cuticle of the last larval instar. When the shaping of the puparium is completed, the larval segmentation is obliterated, but the cuticle is still white. This stage lasts only a few minutes and is thus an accurate time mark from which to date the age of the pupa. Immediately after the cuticle reaches the white prepupal stage, the hardening and the darkening of the cuticle begin and proceed very quickly.

About three and a half hours later the puparium is fully coloured. Pigmentation apparently starts in the external surface of the cuticle and proceeds inward [2, 3].

Four hours after the formation of the puparium, the animal within it has separated its epidermis from thepuparium and has become a headless individual having no external wings or legs and known as the "prepupa". A very fine prepupal cuticle has been secreted and surrounds the prepupa [2, 3].

Pupation takes place about 12 hours after puparium formation. By muscular contraction the prepupa draws back from the anterior end of the puparim and everts its head structures. This movement also ejects the larval mouth armature, which until now was attached to the anterior end of the prepupa. The wings, halteres and legs are also everted. A typical pupa with head, thorax, and abdomen is thus shaped. In section it is seen that the pupa now lies within three membranes: an outer membrane, the puparium: an intermediate membrane, the prepupal cuticle; and an inner membrane, the newly secreted pupal cuticle [2, 3].

Now metamorphosis involves the destruction of certain larval tissues and organs (histolysis) and the organization of adult structures from primitive cell complexes, the imaginal discs. It must, however, be realized that some larval organs are transformed into their imaginal state without any very drastic change in their structure. The duration and extent of these transformation processes vary greatly for the different organs involved. Larval organs which are completely histolyzed during metamorphosis are the salivary glands, the fat bodies, the intestine and apparently the muscles. All these organs are formed anew, either from imaginal disc cells already present in the larva or from cells which come visibly into being in the course of pupal reorganization. The Malpighian tubules are relatively little altered during metamorphosis but nevertheless undergo some change in their structural composition. The same situation seems to prevail in the brain, which is not completely histolyzed. The extremities, eyes, mouthparts, antennae, and genital apparatus differentiate from their appropriate imaginal discs, which were already present in the larval stage and which undergo histogenesis during pupal development. The body wall of the imaginal head, thorax, and abdomen is also formed from imaginal disc cells. The body wall of head and thorax is formed by the combined effort of all the imaginal discs in this region, each of which contributes its part. The hypoderm of the abdomen is formed by segmentally arranged imaginal cells which first become visible in young prepupae [2, 3].

Adult stage

When metamorphosis is complete, the adult flies emerge from the pupa case. They are fragile and light in color and their wings are not fully expanded. These flies darken in a few hours and take on the normal appearance of the adult fly [4]. Upon emergence, flies are relatively light in color but they darken during the first few hours. It is possible by this criterion to distinguish recently emerged flies from older ones present in the same c bottle [2]. They live a month or more and then die. A female does not mate for about 10 to 12 hours after emerging from the pupa. Once she has mated, she stores a considerable quantity of sperm in receptacles and fertilizes her eggs as she lays them. Hence, to ensure a controlled mating, it is necessary to use females that have not mated before. These flies are referred to as virgin females [3, 4].

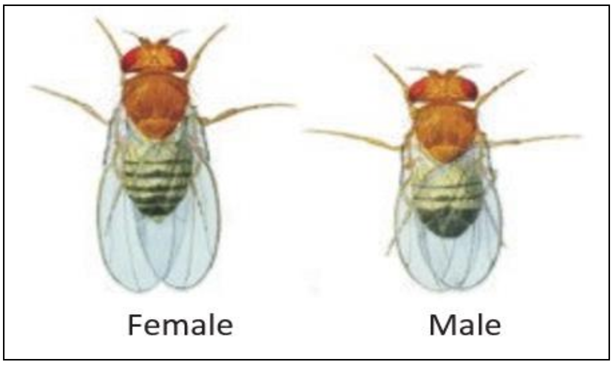

Fig 3:

Features to determine the sex of adult fly

1. Size of adult

The female is generally larger than the male.

2. Shape of abdomen

The tip of the abdomen is elongated in the female, and somewhat more rounded in the male [2].

3. Markings on the abdomen

Alternating dark and light bands can be seen on the entire rear portion of the female; the last few segments of the male are fused [5]. The abdomen of the female has seven segments that are readily visible with low power magnifiers, whereas that of the male has five [2].

4. Appearance of sex comb

The males have so called sex combs, a fringe of about ten stout black bristles on the distal surface of the basal (uppermost) tarsal segment of the fore leg (fig. 4). Such bristles are lacking in the female [2]. Sex identification via the sex comb can also be done successfully in the pupal stage.

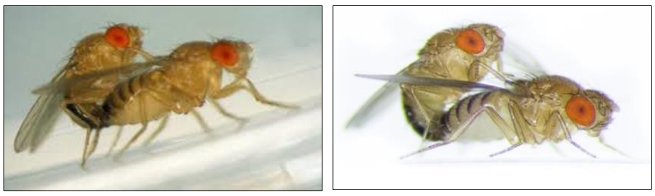

Fig 4: Sex combs in a male fly

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