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Bioluminescence

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Mechanism of Phenomenon of Light Production in Insects

The phenomenon of Bioluminescence or the generation of light is seenin many organisms , and is mostly and predominantly contributed to their association with luminous bacteria, but these insects have also evolved certain reluctant photogenic organs that can produce light. These organs may either occur in both sexes, or may be only restricted to females and immature forms, particularly in the members belonging to the fireflies. The light organs in insects are situated very close to the body surface behind a passage of thee translucent cuticle. They may also be found dispersed anywhere from the head to the tip of abdomen, including the thorax. These organ generally created from the fat bodies of the insect, except *in Arachnocampa* species of (Diptera) where these organs originate from the enlarged distal ends of the malpighian tubules. Photogenic organs consist of a number of specialized cells called photocytes, which are arranged perpendicularily at right angles to the cuticle, which allows and permits light to pass through it uninterruptedly . Behind the photocytes there is a reflecting surface which prominently containing of urate granules. These organs get oxygen through air tubes or tracheoles for their energy and respiration . They contain a heavy bulk of mitochondria that supplies (ATP) required for the chemical reaction and functioning .

Thomas Bartholin, a Danish physicist, first published a book on 'Animal Lights'as early in the year 1647. However, it was only in the year 1885 that Raphael Dubois, a French physiologist, demonstrated that three substances are involved in bioluminescence phenomenon which are luciferin, luciferase and molecular oxygen. Bioluminescence phenomenon is mostly due to the substrate-enzyme complex of luciferin - luciferase occuring within the cellular cyto-plasm. Luciferin mostly refers to any light-emitting compound (lucifer means 'light-bringing' in latin). These luciferin-luciferase complexes differ greatly in structure among the various species. Luciferin and luciferases of the Africanfirefly, *Photinus,* was isolated in pure crystal form by the scientists Institute in the

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early 1960s. Luciferin, which is released by definite organs called photocytes, is a light weight compound that may be an aldehyde, or a protein. Light is produced by the oxidation of lucifer in in the presence of the enzyme luciferase having the (molecular weight 62 kDa) . ATP first activates luciferin provided in the associate of (Mg2+) and luciferase to generate the first product of adenyl luciferin. During the oxidation of luciferin hugequantity of energy around 50-900 KCal per mole, become available , so that the product of the reaction is left in a remount excited state.

This product emits light when the excited state returns to the ground. state. The reaction is very efficient, some 98% of the energy intermediaries between nervous gland and the light organ, activate the light production. Light generated by*Arachnocampa*is blue-green while that of Fulgora is white,thus demonstrating the diverse variation in the colouration of the light produced. Thus, thecolour of light emitted varies with species and the variation may be due to environmental factors or differences in the structure of luciferase in their systems . Bioluminescence however has no significant role functionally and garner no functional significance.

However, in many animals, light production has known to have certain functional significance. For example, in many arthropods, the light from bioluminescence is helped to attract the opposite sex for mating, or it may be used to attract prey, or for defense.

- **Mating signal:**

Light is seen to act as a prominent mating signal for fireflies. For certain species the bioluminescence attracts individuals of the same species to conjugate, thus indirectly improving the chances of mating. In some species of Lampyridae, the

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females are wingless and sedentary; light production is therefore important for them to attract the winged mates. Flash patterns in bioluminescent insects vary between species and between sexes of the equal species. Some tropical species congregate and aggregate in large numbers and flash together in unison. Male and female fireflies of *Photurispyralis* emerge at dusk, emitting a single short flash at regular intervals. The flashes are usually from male fireflies searching for their mates. Males ratioed to the females fifty to one. This Exchange of signals is repeated 5 to 10 times until they start mating and then the mating procedure continues.

The mostadequate example of light which is acting as an attractant for prey is present in the New Zealand glowworm fly, *Arachnocampaluminosa.* Thefemale flies deposit eggs upon the ceiling of dark caves and in cryptic places. These attracted insects get entangled in the sticky threads and are preyed upon by the larvae. The caves inhabited by flies are popularly known as 'luminous caves' and are tourist attraction spots in New Zealand.

- **Defence**

In glow worms the simultaneously glow of the upper region when the larvae are movig , suggests a possible function, whereas the situation under the lateral light organs are switched on suggest an extensive defense function. Sudden flashes can repel potential predators. The glow worm larvae live at high densities, confined to small areas, and may use simultaneous emission to frighten and alarm the potential enemies, or they may also use the light to intimate the mated females about to lay eggs about over crowding and competition for food sources.

- **Applications of Bioluminescence**

The phenomenon of bioluminescence or chemo luminiscence is utilized as a valuable scientific tool in many biological experiments such as space research .

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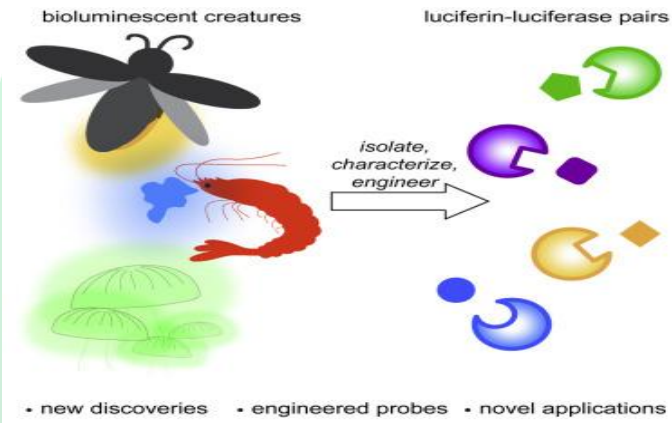
Space Research:

Luciferin are system can be used in spacecrafts and can be sent to other planets to explore the existence of lifeforms dwelling on the outer space . The motto is that a special electronic device would pick up soil from the alien surface and mix it with water, oxygen, luciferin and luciferase.

Perhapsas minor quantity as that of one quadrillionth of a gram of ATP is enough to be detected by the electronic detectors. The presence of ATP would suggest that in turn the existence of some kind of life in that alien soil that is similar to lifeforms on Earth.



Medical Research

The presence of ATP in every living organism has been successfully exploited in medical research too. Injection of luciferin and luciferase can exhibit different reactions in a normal and cancerous cell, and can help in detecting energy problems in human cells. This technique is now widely used to research on heart ailments, muscular dystrophy, urological problems, etc. Bioluminescence is used as a prominent drive for mapping organism distribution patterns also in molecular biological studies.

Recently, in 2001, scientists in USA have modified the genetic material of the pink bollworm, with green fluorescent protein which is derived from the jelly fish, *Aequoravictoria*. The GFP transgenic bollworm strain and stains strongly green when viewed in its larval stage. The objective of this research is fold; the first is to generate a GFP marked strain of pink bollworm for field performance studies and to successfully map the distribution of the pest. It may also serve as an prominent tool and research for field managers. Their future objective is to eventually add a

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temperature-sensitive lethal gene along with the GFP gene into the pink bollworm that could be used for its management.

- **Fluorescent marker gene:** A master gene is a short sequence of DNA that acts as a label and it is inserted along with a gene of interest into cells. Fluorescent marker genes make the transformed cells glow under light. Genetic markers also enable the scientists to choose only the cells that have taken up the target genes and discard others. Take up to two years to complete, with the most of the life history of the fire flies is spent in the larval stage.

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