Animals produce various organic compounds biology essay

[Science](), [Biology]()

It has been found that plants and animals produce various organic compounds known as secondary metabolites. These compounds have found applications as insecticides, biochemical tools or fragrances. Even though secondary metabolites from marine organisms are sectors which are expanding very rapidly (Dr Marie), terrestrial organisms represent the richest source of natural drugs, such as plants (e. g. paclitaxel (Taxol®) from Taxus brevifolia which was later found to be produced by the endophytic fungus Taxomyces andreanae (Stierle et al. 1993)), or microorganisms (e. g. penicillins from Penicillium notatum) (ref) . In 2004, Samuelsson defined secondary metabolites as substances that are formed in organisms but that do not participate in those metabolic processes which are necessary for the life and development of the organism. New eco-friendly collection methods should be used so as to provide sufficient biomass to researchers as marine resources should be used sustainably (Brümer and Nickel 2003)(Erik Hedner). With respect to this, genetic engineering has made prospecting for new drugs much more environmentally friendly, it being routine to collect as little as 1kg of living material. DNA is being extracted from this and cloned into host bacterial cells which produce quantities of the chemical in the laboratory (Blunden, 2001)(DR Marie). According to research, marine organisms such as sponges, soft corals, algae, ascidians, bryozoans, and mollusks produce secondary metabolites that are not similar than those found in terrestrial organisms(Davidson 1995; Newman and Cragg, 2004)(DR Marie). Marine sponges are a rich source of structurally novel and biologically bioactive metabolites (Purushottama 2009, p. 445). Therefore, marine sponges have been a goldmine to chemist and also found their way in to biotechnological applications as they produce various novel chemical molecules (Kumar Jha and Zi-rong). A research by Hay (1996 cited Hedner, p. 13) showed that the various secondary metabolites produce by chemically defended organisms have a synergic or additive effects among the different metabolites. According to Dr Marie, any newly produced secondary metabolites that offered an evolutionary advantage to the producing organisms would contribute in the survival of the new strain.

Biosynthesis of secondary metabolites

Primary metabolites are the precursor of secondary metabolites such as alkaloids, glycosides, flavonoids, volatile oils etc (Khanan 2007, p. 2). Due to the high investment in energy and carbon, it follows that these compounds probably have important ecological roles, either as protection against biotic factors such as herbivory, predation and competition or abiotic factors such as UV light. Whatever their specific functions they probably play some role that benefits the producing organism (Ronagni yr unk, screen2). The border between primary and secondary metabolism has not been well defined (Ronagni yr unk, p. 2 screen). Metabolites are the intermediates and products of metabolism. The term metabolite is normally reserved to small molecules. Compare to primary metabolites, secondary metabolites are not directly involved in the normal growth, development, and reproduction but they usually have important ecological function. Secondary metabolism is associated to both environmental conditions and development stages (Khanan 2007, p. 3). Secondary metabolites are often synthesized using repeated monomers, as in the case of terpenoids, or by using a mixture of different, but structurally simple, building blocks. This expands structural diversity and allows for different types of substitution. The primary pathways involved in the production of secondary metabolites are the acetyl-polymalonyl (polyketide), shikimate and mevalonate pathways (Ronagni yr unk, screen3). Figure Interrelationship of biosynthetic pathways leading to secondary constituents

Marine secondary metabolism

The uppermost biodiversity is found in ecosystems, such as rocky coasts, kelp beds, and coral reefs, where species diversity and population density are particularly high (Haefner 2003)(Hedner 2007 p. 11). Therefore, the marine environment is composed of an exceptional and various source of natural products, principally from invertebrates such as sponges, soft corals, tunicates, bryozoans and mollusks and from bacteria and cyanobacteria (Donia and Hammer, 2003)(LI Kam Wah 2006 et al, p. 115). According to (Purushottama 2009, P. 445), one of the few de novo sources of drug discovery which is a marine natural is of global interest. (Paul and Puglisi 2004, p. 189) stated that a lot of attention was laid in marine chemical ecology focusing on chemical defense mechanism of microalgae and invertebrates. This defense mechanism controls competition between predator and prey. There are 3 parallel tracks in marine natural products chemistry, marine toxins, marine biomedicinals and marine chemical ecology. Combination of the three fields of study gives marine natural products chemistry its unique character and strength (Dr Marie, p. 6). In 2007, Hedner mentioned that secondary metabolites are produced by marine organisms as a response to physical conditions, such as lack of light, low temperature, high salinity or extreme pressure. These adaptations have given rise to a vast diversity both at biological and genetic levels. They have found a way in the sphere of biotechnology and are associated to drug discovery, environmental remediation, increasing seafood supply and safety, and developing new resources and industrial processes (Mayekar et al). In order for marine organisms to reproduce, communicate, protect them against predators and competitors, they have evolved biochemical and physiological mechanisms for these purposes (Halvorson 1998)(Dr Marie, p. 12). In the marine environment, most of the bioactive metabolites that are used in clinical and preclinical trials are of invertebrates origin such as sponges, tunicates, bryozoans or mollusks which in contrast to the terrestrial environment where plants are the main producers of natural products (Proksch et al. 2002)(ref). The composition and type of compounds involved in the chemical defense can vary dramatically among geographic regions, habitats and between individuals in the local habitat, and even within a single individual (Harvel et al. 193; Hay 1996)(Hedner 2007, p. 13). We have already passed the discovery phase in the field of marine natural products and we are now moving to the second phase where research to synthesize new drugs from marine sources is being driven by the understanding of relationships and processes. Marine plants, animals and microorganisms will be the foundation for the development of new products and services which will have technological importance in the future. The Indian coast has a rich biodiversity and various marine resources in the form of estuaries, creeks, deep seas and continental shelf. Therefore, the opportunities for research in the area of marine drug development are endless (Mayekar et al).

Current status

Figure Marine natural product distributionSource: Parvatkar 2011

Sponges

According to Bergquist (2009, p. 445), sponge is a sessile, filter-feeding metazoan which utilizes a single layer of flagellated cells (choanocytes) to pump water in only one direction through its body. They can be found everywhere, in tropical and subtropical benthic marine habitats but are also found at higher latitudes and even in freshwater lakes and streams (Purushottama 2009, p. 445). Sponges have evolved antagonistic effect against other invading organisms, which evolve the production of secondary metabolites (Wah, L. K et al 2006)(Gehan M. Abou-Elela et al 2009 p. 872).

Marine sponge structure

The sponge body is organized around a system of pores, ostia, canals, and chambers, which conduct water current from the inhalant sponge surface to the exhalant apertures, the osculum (Dr Marie, p. 13). In 2011, Stone et al (p. 6) mentioned that some cells are also very pluripotent (i. e., capable of differentiating into other cell types) and sponges are capable of easily remodeling cell-cell junctions. These features probably allow sponges to adapt to diverse and extreme habitats and are largely responsible for the extreme phenotypic displayed by some sponges. Nowadays, four classes of Porifera have been recognized namely: Calcarea, Hexactinellida, Demonspongiae and Sclerospongieae respectively. The Calcarea are exclusively marine sponges with a skeleton of calcium carbonate, organizes either as discrete spicules, or as a fused mass. The Hexactinellida are again marine sponges which are more common in deep water, their skeleton is siliceous, made up of megascleres and microscleres, both of which can have a hexactine structures (Bergquist 1978, p. 9). Dermospongiae is the most diverse class of sponges. There skeletons are composed of siliceous spicules, spongin fibers, or both. The skeleton of Sclerospongiae consists of siliceous spicules and spongin on a thick basal layer of calcium carbonate (Bergquist 1978, p. 10). C: UsersIvanDesktopNew folderI10-82-sponge2. jpgFigure Organisation of sponge bodySource: http://www. google. mu/imgres? q= marine+sponges+structure&hl= en&tbo= d&biw= 1440&bih= 775&sout= 0&tbm= isch&tbnid= 65pPjtSBMupDfM:&imgrefurl= http://universe-review. ca/R10-33-anatomy. htm&docid= 5Z6HQJVvjv14TM&itg= 1&imgurl= http://universe-review. ca/I10-82-sponge2. jpg&w= 564&h= 422&ei= z5ftUMubF4WElQWSh4HQAg&zoom= 1&iact= hc&vpx= 371&vpy= 125&dur= 480&hovh= 194&hovw= 260&tx= 99&ty= 98&sig= 110388565996212893616&page= 1&tbnh= 136&tbnw= 185&start= 0&ndsp= 30&ved= 1t: 429, r: 2, s: 0, i: 93

Secondary metabolites from marine sponges

A research by Wallace (1997 cited Drmarie p. 12) demonstrated that thousands of species of sponges have now be identified and each species produces a different set of secondary metabolites to help them occupy their particular niche. Marine sponges are a rich source of structurally novel and biologically active metabolites (Purushottama 2009, p. 445). Since marine invertebrates, especially sponges, often house a large number of microorganisms in their tissues, it appears tempting to assume that in many cases, associated microorganisms are the true producers of bioactive natural compounds (Murakami et al)(ref). The symbiotic microbial community is highly novel and diverse, and species composition shows temporal and geographic variation (Webster, N. S and R. t Hill 2001)(Yoo Kyung Lee et al p. 234).

Biopesticide

The use of chemical pesticides have become so alarming that nowadays conventional agriculture means using chemicals (Moazami NA, s. 1). In 2008 Miller stated that the application of synthetic pesticide has increase significantly since 1950 more than 50-fold, and at the present time pesticides are 10-100 times more poisonous than those used in 1950s. Carson (2007) point out the consequence of the hazardous and careless use of synthetic pesticides in agriculture i. e, environmental pollution, ecological imbalances, pesticides residues in food, fruits and vegetables, fodder, soil and water, pest resurgence, human and animal health hazards, destruction of biocontrol agents, development of resistance in pests etc. This is why, it is essential to develop a new approach to tackle pests in a more eco-friendly, economically viable and socially acceptable for the farmers (Vasantharaj 2008, P. 1). It makes no doubt that we must turn ourselves in the selection of broad spectrum biopesticides and improvements in the production, formulation and application technologies (Moazami NA, s. 4). Biopesticides contribute largely when used in line with Integrated Pest Management (IPM) programs (Gupta and Dikshit 2010, p. 186). A research by Kogan (1998 cited Bailey et al, 2011) show that pest management should be done efficiently in such a way that the impact on other components of the agroecosystem are minimized simultaneously. Hence, the need of producers, wider society and the environment must be taken into consideration. Biopesticides fall into three categories which are biochemicals pesticides, microbial pesticides and plant incorporated protectants (Muraleedharan and Elayidom 2008 p. 6). Although many pesticides are designed to kill pests, some may only inhibit their growth, or simply attract or repel them (Joshi 2006, p. 5). Biopesticides are often complex in their activities and modes of action, offering new tools in the quest to develop programs that can manage resistance (Denise Manker 2012, p. 137).

Benefits of biopesticides (Joshi, 2006, p. 5)

Biopesticides are naturally less harmful than synthetic pesticides. Biopesticides are designed to kill specific targeted pests or organisms while conventional pesticides which may affect many different organisms which do not need to be controlled. Biopesticides are often effective even when they are used in small quantities and also the decomposition rate is often high, therefore resulting in lower exposures and avoiding the pollution problems caused by chemical pesticides. As part of Integrated Pest Management (IPM) programs, biopesticides contribute to decrease the use of synthetic pesticides without decreasing crop yield. Biopesticides have the potential to reduce the risks associated with pesticides.

Plutella xylostella

The diamondback moth, Plutella xylostella(Linnaeus), belongs to the order Lepidoptera and family Plutellidae (Knodel and Ganehiarachchi 2008, p. 1). It is a real threat to the Brassicaceae family throughout the globe, and can have a drastic effect on the economy if not checked (Facknath 1997, p. 103 s. 1). The time for the egg to develop into pupa depend on the weather, with a range of about 17 to 51 days. The average time is 25 to 30 days (Capinara 2000, p. 1). These moths got their name due to the diamond pattern form by the stripe on their wings when they are at rest. The eggs are around 0. 5mm in length, oval and pale yellow. The larvae (caterpillars) are pale green, slightly tapered at each end can reach 12mm throughout their four stages. They have a dark head in the first two stages. They wriggle when disturbed, often dropping from the plant on a silken thread. At maturity the larvae spin a gauze-like cocoon, usually on the underside of leaves in which to pupate. The pupa is green at first, but turns brown larvae before the adult moth emerges (Henry and Baker 2008, p. 1). Larvae go through 4 instars: the range of days per instar is 3-7, 2-7, 2-8, and 2-10 for the 1st-4th instars (Meischer 2003). Damage is caused by larval feeding. The young larvae feed on the internal tissue forming shallow mine which look like white marks. When they grow, they come out to feed on the underside of leaves leaving holes (Anon, NA).

Plutella xylostella in Mauritius

The diamondback moth (DBM), Plutella xylostella, is one of the most important pests of cruciferous in Mauritius (Dunhawoor and Abeeluck 1997). The insecticides that are recommended depend on the severity of the pest attack (MANR 1995) (Facknath 1997): Suntap (cartap hydrochloride), Vertimec (avermectin), Cascade (flufenoxuron) andSelecron (profenofos)Figure Progression of pesticides in Mauritius due to the resistance of the Diamondback moth Source: Facknath 1997The DBM project was initiated in 1994 with the support of International Atomic Energy Agency (IAEA) to develop control measures that do not affect the environment and that could be integrated and recommended as an integrated pest management (IPM) programme package to farmers in order to reduce the pesticide load on these crops (Dunhawoor and Abeeluck, 1997). Considerable research is being done to develop an IPM strategy for DBM control. The University of Mauritius and the Ministry of Agriculture have looked for new approaches (Facknath, 1997). Table Research strategies presently being explored for the control of Plutella xylostella in MauritiusControl ApproachResearch StrategyAt The University of MauritiusAlleochemicalBotanical PesticidesMicrobial controlPathogens (Bacillus thuringiensis)Cultural controlIntercropping and use of trap cropsCombinations of aboveBotanical and cultural controlAt the Ministry of AgricultureChemical controlSynthetic pesticides and growth regulatorsBiological controlParasitoidsMicrobial controlBacillus thuringiensisPhysical controlTrapsGenetic controlF 1 sterilitySource: Facknath 1997

7. 0 Insecticide resistance

Resistance, from the scientific perspective, is a heritable, statistically decrease in sensitivity to a chemical in a pest population relative to the response of susceptible populations that have never been exposed to pesticides. When resistance occurs, the efficiency of a pesticide is decreased significantly (Dennehy and Dunley, 1993). IRAC (NA) mentioned that the repetitive failure of an insecticide to control a pest population at a certain level reflects insecticide resistance even though the insecticide has been used by following the instruction on the product label and problems like storage, application, and unfavorable climatic or environmental conditions can be eliminated as a cause of failure. Dennehy and Dunley (1993) stated that the chemical provide less control of the pest at locations where the proportion of population that is resistant is high compare to locations where it is low and where there is no resistance at all as the relative efficacy of the insecticide has been reduced.

7. 1 Development of resistance

Pesticide resistance is a genetically based phenomenon. When a pest is exposed to a pesticide, a few individuals will survive. This is because they are genetically predisposed to be resistant to the pesticide. The increase in application rate and dose of the pesticide will not only kill a large proportion in the pest population but will also cause an increase in pesticide resistance. The parents will pass their genetic makeup to their offspring. Consequently, the ability of the pest to be resistant to pesticide will continue to increase from generation to generation (Bellinger, 1996). Both the frequency and intensity of the resistance determine the level of resistance and the relative efficiency of the pesticide. Frequency refers to the proportion of the pest population that is resistant; intensity is the strength of the resistance in each resistant pest. It makes no doubt that as the frequency of resistant individual increases in a population resistance will be a real problem. The intensity of a resistance can also affect the pesticide’s usefulness in the field. The efficacy of a pesticide on the field is not affected drastically when a pest population has a resistance of low intensity even though the frequency is high. In contrast to this, the efficiency of a chemical can be reduced if the level of resistance is high despite the fact that the frequency in the pest population is low (Dennehy and Dunley, 1993). Figure Frequency and intensity of resistance Source : (Dennehy and Dunley, 1993)It has been shown that resistance is not the only reason why the relative efficiency of a chemical is decreased. Some other reasons are (Dennehy and Dunley, 1993): The breaking down of the pesticide by soil microorganisms. The pH of the spray water is too high. Poor application procedures of the pesticide. For examples some instances of poor pesticide performance, initially attributed to pest resistance, have proved to be caused by a breakdown of the pesticide by soil microorganisms or high pH of spray water or by poor pesticide application procedures (Dennehy and Dunley, 1993).

7. 2 Mechanisms of resistance

There are several ways insects can become resistant to crop protection products, and pests often exhibit more than one of these mechanisms at the same time (IRAC, NA).

• Behavioral resistance

Resistant insects may detect or recognize a danger and avoid the toxin. This mechanism of resistance has been reported for several classes of insecticides, including organochlorines, organophosphates, carbamates and pyrethroids. Insects may simply stop feeding if they come across certain insecticides, or leave the area where spraying occurred (for instance, they may move to the underside of a sprayed leaf, move deeper in the crop canopy or fly away from the target area).

• Penetration resistance

Resistant insects may absorb the toxin more slowly than susceptible insects. Penetration resistance occurs when the insect’s outer cuticle develops barriers which can slow absorption of the chemicals into their bodies. This can protect insects from a wide range of insecticides. Penetration resistance is frequently present along with other forms of resistance, and reduced penetration intensifies the effects of those other mechanisms.

• Metabolic resistance

Resistant insects may detoxify or destroy the toxin faster than susceptible insects, or quickly rid their bodies of the toxic molecules. Metabolic resistance is the most common mechanism and often presents the greatest challenge. Insects use their internal enzyme systems to break down insecticides. Resistant strains may possess higher levels or more efficient forms of these enzymes. In addition to being more efficient, these enzyme systems also may have a broad spectrum of activity (i. e., they can degrade many different insecticides).

• Altered target-site resistance

The site where the toxin usually binds in the insect becomes modified to reduce the insecticide's effects. This is the second most common mechanism of resistance.