BIOME

The BIOlogy Education MEssenger

(An ATBS eNewsletter)

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From The Editorial Team.....

Greetings from the editorial team of Biome – the ATBS eNewsletter!!

Yet another year has gone by with classrooms transiently shifting to offline mode for short periods and then moving back to the online mode. Although over time teachers as well as students have been adapting well to this transition in the way classes are functioning, there are mixed feelings about which mode is better. For subjects such as biology which have hands-on work done in wet labs or in fields as the key component leading to enhanced learning, the offline mode of entering classrooms and laboratories physically undoubtedly is the preferred choice. So, we at ATBS, would like to end this year with a hope of returning to witness classrooms and our labs physically functioning at full strength.

With this hope, we bring to you this Issue 9 of Biome which includes a few articles and a lab. We are glad to have an interesting article titled 'Amazing Xerocoles' penned by our in-house member of the editorial board Prof. B. B. Nath. This issue includes Part 1 of this article and we intend to continue with the same in our next issue as well. Also Part 2 of the two-part series article on 'Animal Communication' by Prof. P. G. Kale is included in this issue. As has been the practice, Dr. Rekha Vartak, Dr. Anupama Ronad and Mr. Vikrant Ghanekar from the Biology Cell at HCBSE have contributed a lab activity which the teachers could try out with their students.

We urge you to go through the issue and make the most of it while also reverting back to us with constructive feedback and comments.

Hope you like the issue and wish you a fruitful 2022!!

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AMAZING XEROCOLES

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When we recall the lessons learned about a desert, we imagine vast stretches of shifting sand dunes, cloudless skies, burning sun and scorching winds. Deserts are unique ecoregions, covering more than 20% of the world's land mass that receive very little rain in a year. The overall moisture deficit characterizes deserts and the rate of evaporation exceeds the rate of precipitation. Arabian deserts are known for its hot daytime temperatures and the highest temperature documented so far in the Sahara Desert is 58^0C. One of the hottest places is the 'Death Valley' which is a part of Mojave Desert in California. On July 15, 1972 the day temperature of 'Death Valley' shot up to 93.9^0C. Just imagine the lifestyle of the creatures thriving amidst broiling temperatures in most of the hot deserts. Nevertheless, deserts can be both hot and cold, and the conditions are equally extreme in cold deserts like the Gobi in East Asia. In hot deserts, although the daytime temperature is extremely high, the air cools down quickly in the evening and this is due to low humidity.

Next to oxygen, the second most essential component is water in a living system in order to maintain as well as sustain life processes. Every part of the body needs water whether it is an organ or a cell. In the course of evolution of higher multicellular plants and animals in particular, one can notice amazing survival strategies of plants and animals thriving under scarcity of water. Organisms inhabiting deserts require adaptive measures to deal mostly with scarcity of water and extremes of temperature. Plants that grow and propagate in extreme arid conditions are referred to as 'xerophytes', while their counterparts, the animals thriving in extremely dry ecoregions like deserts are called 'xerocoles'. Camel is the most talked about xerocole and even a primary school goer is aware of this 'ship of the desert'. Nevertheless, there are many fascinating creatures inhabiting deserts across the world that deserve to be discussed in detail. In this article, I have focused on two amazing xerocoles, namely, kangaroo rats and horned lizards.

Kangaroo rats

Kangaroo rats (Genus: *Diplodomys*) are an interesting group of mammalian xerocoles mostly found in the arid zones (Mojave and Sonoran deserts of California and Arizona) of Western and South-Western North America. The bipedal nature of active movement of kangaroo rat resembles a Kangaroo due to its hopping style. Massive hind legs facilitate kangaroo-like leaping while a long hairy tail maintains balance of the body during hopping locomotion. These rats can often leap to cover even a distance of 7 feet and can jump up to a height of 9 feet. They can also maneuver the directions of movement while leaping and jumping and can keep their predators like Coyotes and snakes in utter confusion. Additionally, their hearing ability is extremely sensitive and during the night they can detect the slightest movement of an approaching predatory owl from a distance.

Figure 1. Kangaroo rat

Kangaroo rats remain mostly in burrows to avoid high temperatures and other extreme weather conditions prevalent in deserts. The housing pattern of kangaroo rat is also amazing. They seal the entrance of the burrow with a sand-plug during the day to keep their resting chamber cool. Another amazing behavioral adaptation of kangaroo rats is their unique sleeping pattern inside the burrow. They tuck their nose inside the furry part of their body to create a moist pocket which in turn maintains the humidity of the burrow.

Unlike other rodents, kangaroo rats possess a ‘cheek pouch’ for storing food which they carry back to burrows. As seen in other xerocoles in deserts, kangaroo rats conserve energy and water by lowering metabolic rate and by preventing water loss through skin and respiratory passages. These rats can remain alive without drinking a single drop of water and compensate their needs through metabolic oxidation of consumed seed-diet.

Horned Lizards

Horned lizards (Genus: Phrynosoma) are mostly found in the Sonoran deserts of Mexico and other arid zones of South-Western Arizona and California. Often referred to as 'horny toads', these reptiles can be easily recognized by their toad-like body contour and thorny projections on their heads. The genetic name "Phrynosoma" was coined due to its toad-like body with spines all over the body. The most favorite diet of these lizards is the ants inhabiting the deserts in semi-desert rocky ecosystems. They are known for their remarkable ability to camouflage and it is often difficult to distinguish from their surrounding sand and rocks.

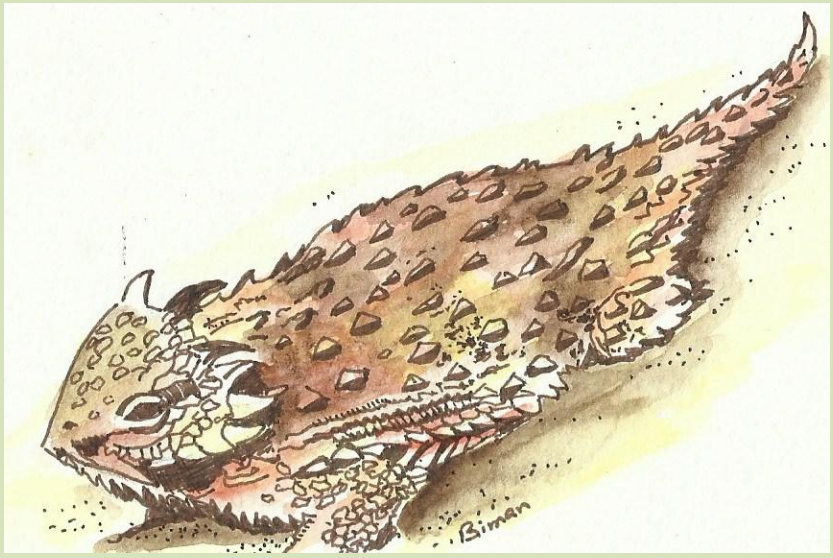

Figure 2 Horned lizard

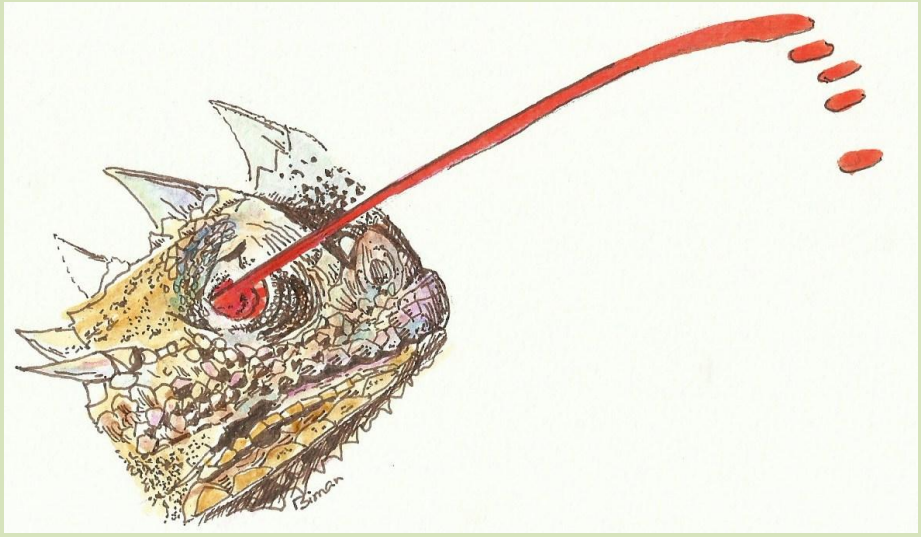

Figure 3. Blood squirting from the eyes of the horned lizard

Another group of lizards, the Chameleons, lash out their long mucous-coated tongue to catch a prey. The strategy used by the horny lizards for trapping ants and other small insects is similar to that used by Chameleons for trapping ants and other small insects and they use their sticky tongues, which is smaller in length as compared to Chameleons and is non-protrusible.

There is no doubt that the horned lizard possesses a scary look and its first line of defiance is to display its sharp spikes and horns. However, the lizards camouflage and mostly remain blended with the sandy or rocky background where they move around. If caught off-guard, the lizard attempts to evade predators by 'playing dead'. If they encounter a predator too closely, they inflate their body to puff out the spines as well as exhibit a bulged body which would be difficult to swallow by the predator. If all the defense tactics fail to repel the predator, the horned lizard displays an unique defiance strategy by squirting blood form its eyes. The shoot-out of blood stream can cover a distance of around two feet. This amazing ability to rupture small capillaries around their eyes conferred the horned lizards an evolutionary advantage enhancing their survival in a fiercely competitive desert ecosystem.

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Orientation for Competetive Examinations in Life Sciences (OCELS)

A web based workshop titled 'Orientation for Competitive Examinations in Life Sciences (OCELS)' was organized jointly by the Association of teachers in Biological Sciences (ATBS) and Indian National Young Academy of Sciences (INYAS)

Target Audience: PG (Life Sciences) students

Duration: 6th – 13th June, 2021

Mode: Online
Daily two lectures followed by MCQ based examinations.

Biological Communication
(Part 2 of 2)

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ANIMAL COMMUNICATION- II

All living beings succeed in the struggle for existence through appropriate communication with the abiotic as well as biotic components of the environment. Animal communication has been investigated quite in depth by the scientists world over.

Among various components of communication, the most fascinating are the cues or signals employed by the animals for effective communication. Though the range is quite extensive, the three types of signals used most often by the animals are the chemical, visual, and audio signals.

Chemical signals

They are probably the most primitive of all signals and are used not only by the individuals but by the cells and tissues as well. The slime molds, with an extremely simple organization of the body, emit chemical cues for gathering the uninucleate beings together into a 'plasmodium' for the purpose of breeding. The most outstanding example of chemical signals, however, is that of pheromones. The chemicals that carry and spread the information are called semio-chemicals (semeion ≡ mark or signal) and can be intra-specific or inter-specific. When used for intraspecific communication, they are called pheromones while employed in inter-specific communication, they are called allomones. When such signals are helpful to the receivers, these signals are called 'kairmones'.

The term pheromones, originally applied to the sex attractants of insects but are now used for all kinds of chemicals released into the environment and functioning in all major groups. They may be ingested, absorbed by body surface or perceived by olfaction. They evoke specific behavioral, developmental or reproductive responses, which are very significant for ecology and survival of the species. α -ketodecanoic acid secreted by the mandibular gland of queen honeybee is ingested by the workers and inhibits the development of their ovaries. Male desert locusts secrete chemicals that are absorbed by the general body surface of nymphs and accelerate their growth and metamorphosis.

Pheromones exert influence on the central nervous system to produce rapid and reversible changes in behavior. The aggression pheromones, alarm substances and sex attractants belong to this category. The secretions of queen bee, locusts and sex attractants also fall in this category. The sex attractants of other invertebrates influence endocrine glands (mostly pituitary) to initiate a cascade of physiological changes eventually modifying the behavioral pattern of the target organism. Ants deposit trail pheromones to track the shortest route to the food from their nests. Canids and many other carnivore mammals use putrefied urine from peri-anal or inguinal pockets to mark territories. Rabbits smear their fecal pellets with the secretion of peri-anal scent glands to mark territories. Secretion of peri-orbital glands is used by certain species of deer to mark their home range. The chin-glands in male crocodile are used to secrete sex attractants. Preputial glands of rodents have the same function.

Audio Signals

Compared to chemical signals, sound can transmit information much faster, though not as fast as that transmitted by visual cues. Sound can be produced by a single organ and can travel around objects, through dense vegetation, and can be used in the dark. It, however, fails to reveal the location of the sender. Information can be conveyed by both frequency and amplitude modulation. In the sound spectrographs, a unit of bird song contains sounds of various frequencies and amplitudes. Low frequency sound travels great distances and is used by animals with large home ranges. Howler monkeys (*Alouatta*), for example, signal other groups using low frequency calls. Animals with smaller home ranges like those of squirrel monkeys (*Saimiri sciureus*) use high frequency sounds, which dissipate rapidly to maintain contact among members of the group.

Several workers including Thrope (1958), Marker and Tamura (1962) have analysed bird songs, probably the most complex of the acoustic communications. Birds raised in isolation never develop the normal song. Though the primary song imprinted right at the time of hatching is rehearsed and the sub songs gradually perfected to the effective primary song at maturity, at least an exposure to the primary song prior to the first breeding season seems necessary to have development of primary song in most songbirds. The isolated notes develop without any experience and the bird attempts random sequences of such calls to construct a sub song but the species-specific song must be learned from others, most likely the father. This learning is highly selective. Laboratory reared swamp-sparrows of the genus *Melaspiza* failed to learn the species-specific song though they readily learned the song of the other species when exposed to it. Birds have been shown to modify their song to match the local 'dialect'if they move into a new area at the beginning of a breeding season. Females may not mate as readily with strange singing males.

High frequency sounds are used by a variety of animals, particularly mammals. The distress calls of young rodents and certain vocalizations of wolves and dogs are well above the range of human hearing. Echolocation in bats is yet another example of the use of high frequency sounds. Noctuid moths do not produce sounds themselves but possess tympanic membranes on each side of the body to receive sonar pulses from bats. This interception of signals helps them in escaping their predators. Based on the direction and intensity of these signals the moth chooses to fly away in the opposite direction, dive, or desynchronize its wing beats to produce erratic flight.

Underwater sound has properties somewhat different from sound in air. Fish and invertebrates

produce a variety of sounds, some of which have only recently been investigated. Marine animals produce clicks, squeals, and longer more complex sounds incorporating many frequencies. Most of these are short duration sounds which are thought to function in echolocation. Baleen whales (of Mysticeti family) produce lower and longer sounds than do the toothed whales, such as dolphins. Payne and McVay (1971) analyzed the sounds of the humpback whale (*Megaptera navaneangliae*), which are varied and occur in sequences of seven to thirty minutes duration and are then repeated. The songs have a great deal of individuality, and each whale adheres to its own song for many months before developing a new one.
No clear function of these songs has yet been ascertained though they seem to maintain group cohesion across thousands of miles because of the less attenuation of low frequency sound in water.

Visual and Light signals
Visual cues have limited applications, since they need ambient light and that the sender and receiver have to be in direct line of sight. However, when these conditions are fulfilled, visual displays help the receiver to locate the signaler precisely in space and time. Monkeys and apes, with a few exceptions, are social, diurnal primates that rely extensively on visual displays. As primates, human beings also depend largely on visual cues for communication.

Certain beetles have specialized photogenic tissue in the abdominal region used for emitting flashes of light. These light signals are related to mate attraction. Each species has its own flash code and flashes of the males vary in intensity, duration and interval in a species-specific way to attract the females of the same species. Within a species, the flash interval varies depending on whether the male is searching for a female or courting the one it has found. In one particular species (*Photuris versicolor*), the female, once mated, may mimic the flash response of females of closely related species, thereby luring males of that species and then devouring them. Such females are aptly termed *females fatales* by Lloyd (1965). To make matters more complicated, males of some species of the genus *Photuris* mimic males of other speciesto attract the females of their own species and then engage them in second mating (Lloyd, 1980). Bioluminescence helps deep sea fishes in luring the prey, attracting the mates and identifying species mates.

Colors and their displays help in communicating sexual maturity and willingness to mate. In schooling/ shoaling fish, colored spots/ stripes, specific to the age, help the fish of same age group come together. Dominance, aggression, territory defending and many such behavioral responses depend on displays of colors. Fish and several other invertebrates are able to change color within seconds by expanding and contracting chromatophores beneath their skin. The most spectacular in this regard is the octopus. In this animal the waves of color advance and recede according to its mood. Because of the limitations of visual displays, these displays are usually coupled with other modes of communication, such as auditory. For instance, while singing, the redwing bird spreads its tail, lowers its wings, and raises its epaulets at the same time as it renders the song.

Effectivity of communication increases when two or more types of cues and actions are combined to expand the information being transmitted.

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Biology can be fun……..

We had shared a dichotomous key for some samples of fish scales in the last issue. To complement the animal specimen we thought it would be fun to do the same for some plant specimen. So here we have included a dichotomous key for some botanical samples which can be easily found around us.

Ashoka (*Saraca indica*)

Mogra(*Jasmin sambae*)

Introduction:

Dichotomous keys are an interesting way to observe and learn about the morphology of various biological specimens in a comparative manner. They are used to identify and classify specimens based on the morphological characters. Dichotomous (meaning 'divided into two parts') keys are used by answering a series of steps wherein two contrasting observations for any given feature is to be observed and answered at each step. Thus each step in the key can have two possible outcomes. Following the sequences of steps in a dichotomous key will eventually lead one to the identification of the specimen.

Dichotomous key for leaves

The dichotomous key given in this task can be used to classify the twig samples.

Requirements

Specimen / Biological samples:

Twigs with leaves from the following plants:

1. Ashoka (*Saraca indica*)
2. Mogra (*Jasmin sambae*)
3. Tamarind (*Tamarindus indica*)
4. Ixora (*Ixora coccinea*)
5. Rose (*Rosa indica*)

Method:

Follow the dichotomous key for each specimen and assign each one to the appropriate alphabet in the key.

Tamarind (*Tamarindus indica*)

Ixora (*Ixora coccinea*)

Rose (*Rosa indica*)

Step		Character	
1.	a.	Simple leaf	go to 2
	b.	Compound leaf	go to 8
2.	a.	Leaves arranged opposite to each other	go to 3
	b.	Alternate arrangement of leaves	go to 5
3.	a.	Leaves petiolate	go to 4
	b.	Leaves sessile	**A**
4.	a.	Interpetiolar stipules present	**B**
	b.	Interpetiolar stipules absent	**C**
5.	a.	Leaves petiolate	go to 6
	b.	Leaves sessile	**D**
6.	a.	Pulvinus (swollen leaf base) present	go to 7
	b.	Pulvinus absent	**E**
7.	a.	Margin entire	**F**
	b.	Margin serrate	**G**
8.	a.	Pinnately compound	go to 9
	b.	Palmately compound	**H**
9.	a.	Unipinnately compound	go to 10
	b.	Bipinnately compound	**I**
10.	a.	Paripinnately compound	**J**
	b.	Imparipinnately compound	**K**

----------Rekha Vartak, Anupama Ronad & Vikrant Ghanekar
Biology Olympiad Cell
HBCSE (TIFR)

International Biology Olympiad (IBO) Challenge II

The physical offline International Biology (IBO) event to be held in Lisbon, Portugal in July 2021 had to be converted to an online event due to the pandemic situation across the globe. Consequently the face-to-face IBO was cancelled and replaced with an online IBO Challenge Part II. The event was held from 18th July till 23rd July, 2021. The Opening and Closing ceremonies were live streamed on YouTube. Student participants from every team appeared for the online proctored exams from their own countries. The practical exam was held on the 19th of July and the theoretical exam was held on the 21st of July. There were two computer-based exams: one theoretical-practical and one theoretical exam, each for three hours. The theoretical-practical exam celebrated the 500th anniversary of the Portuguese explorer Ferdinand Magellan who circumnavigated the earth for the first time during 1519 – 1522. The exam had 8 parts, each of which consisted questions covering areas such as plant biology, zoology, ecology and biotechnology. The students were monitored online with invigilation both from the host country as well as assigned invigilators from HBCSE. 304 students from 76 countries participated in the event. Four students from team India participated in the event and secured 3 silver and 1 bronze medal.

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