Serotonin triggers desert locust swarms

Part of: GS-III- Natural Hazard (PT-MAINS-PERSONALITY TEST)

Background

During the last 10 days, there has been a host of analytical articles in the press about the latest locust swarming from the Rajasthan/Gujarat desert region, all the way into Madhya Pradesh and Chhattisgarh, causing extensive damage to the crops. These articles have also pointed out how India (and indeed Pakistan as well) has been handling this plague since centuries, indeed even since the Mahabharata times (recall how Karna challenged the Pandava’s army: “we will pounce on you, as — shalabasana — a swarm of locusts”).

History

- The British colonial government had set up Locust Warning Organizations (LWOs) since the early 1900s at Jodhpur and Karachi in the Indian subcontinent.
- After Independence, the Union Ministry of Agriculture has continued and improved upon the LWOs, one with administrative affairs at Faridabad, near New Delhi, and another LWO at Jodhpur, Rajasthan, where the technical aspects are handled along with local branches in the region.
- They use the technique of aerial spray of insecticides (using drones these days), as well as spraying by land-based workers in the field. And they are doing a good job of it.

Locust control

- The Agriculture Ministry uses a site called <vikaspedia.in>, which gives considerable details of the problem of locust control and plant protection, and the current methods of handling them.
- The Directorate of Plant Protection, Quarantine and Storage, at the Ministry has a site, <ppqs.gov.in>, which details the contingency plan for desert locust invasions, outbreaks and upsurges.
- The locust problem is not confined to India alone, but most of Africa, West Asia, Iran and even parts of Australia.
- The Food and Agricultural Organization (FAO, this is a part of the United Nations, and based in Rome, Italy) co-ordinates and helps these nations with advice and funds in combating this plague.
- The informative document from FAO, called the Locust Environmental Booklet, gives an update on the situation and methods of handling locust swarms.
- And an excellent update (available online) on ‘locust swarm and its management’ has been published on May 29 by the ICRISAT Development Centre (IDC) of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), based in Hyderabad.
- By and large, “detect the swarm and kill it as it moves” has been the method, and countries across the world are using it.

How locusts form swarms

- This however raises the important scientific question of how and why locusts collect...
together by the thousands in order to make a swarm.

- Insect biologists have long since known that the locust is by nature a recluse and a singleton, not mixing with others in the same group. Yet, when the harvest season arrives, these singletons team up with others as an army of swarms to attack plants for food.
- **What is the mystery? What is the biological mechanism by which this sociological transformation comes about?** If we know this mechanism, there can be novel ways of stopping this group rampage.

Stephen Rogers of Cambridge University, U.K. (and University of Sydney, Australia) is an acknowledged world expert in the study of how and why such swarms come about.

- In one of his papers, way back in 2003, he showed that when solitary locusts happen to come near each other (*looking for food*) and happen to touch each other, this tactile stimulation, even just in a little area of the back limbs, causes their behaviour to change.

  - This mechanical stimulation affects a couple of nerves in the animal’s body, their behaviour changes, leading to their coming together.
  - And if more locusts come nearby, the crowding starts, and what was once a simple looking insect becomes larger in size and shape, and its colour and morphology changes.
  - In the next paper, his group showed substantial changes in some molecules that modulate the central nervous system of the locust, the most important among them being serotonin, which regulates mood and social behaviour.

  - And putting all these together, they came out with a publication in *Science* in 2009 (<https://science.sciencemag.org/content/323/5914/627>), that serotonin is indeed responsible for swarm formation.

  - In this paper, they did a lab experiment wherein they placed locusts in a container one by one, and as the numbers increased, the coming together triggered mechanical (touch) and neurochemical (serotonin) stimulations to make crowding (*gregarisation*) occur within a few hours! Interestingly, when they started adding substances that inhibit the production of serotonin (for instance, molecules such as 5HT or AMTP), the crowding was significantly less.

  - (For a comprehensive summary of this work, I recommend his 2014 article in the book: “New Frontiers in Social Neuroscience”, downloadable free at <Researchgate.net>.

**Stopping swarms**

Now, here is a potential way of stopping swarms from forming! Can we work with the LWOs in Jodhpur and other places, spray serotonin inhibitor molecules as the swarm begins to form Rogers had indeed hinted this in his *Science* paper. Is this possible or a quixotic idea. Let the experts tell us. It is well worth a try.

**Finally, the insecticides (mainly malathion (PT))** sprayed on the swarms need to be looked at for side-effects. Though many studies have cleared it as not very harmful, we need to work on biopesticides which would be environmentally and animal/human health-friendly, using natural and animal products of India.