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Rearing spiders as biological pest-control agents

1. GENERAL INFORMATION

1.I Title of practice or experience

Rearing spiders as biological pest-control agents

1.2 Category of practice/experience and brief description

Spiders are the largest group of arachnids, comprising more than 30,000 species distributed over 60 families worldwide. Its members are among the best known and most widely distributed of all the arachnids. Spiders are also unique in that they have inhabited almost all environments, including one at 23,000 ft on Mount Everest. They have also invaded the world of water despite the fact that none can breathe in water although one species from Europe, *Argyroneta aquatica,* is totally aquatic.

Spiders are an important group of predators in various ecosystems. However, their role in pest control and crop protection has not been utilised properly in India. This report describes the mass rearing technology that has been developed to rear one species of household spider (giant crab spider) which is an efficient predator of cockroaches. This technology can also be extended to other spiders with certain modifications. Besides this, a few practical tips are provided which could be combined with mass rearing and release for conservation and augmentation of these spiders. The innovation is part of a general scheme designed to utilise biological control agents for control of pests without recourse to toxic pesticides the impact of which on health is well known.

1.3 Name of person or institution responsible for the practice or experience

Centre for Indian Knowledge Systems

1.4 Name and position of key or relevant persons or officials involved

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1.5 Details of institution

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1.6 Name oj'person and/or institution conducting the research

As in 1.4 above

1.7 Details of research person/institution

As in 1.5 above

2. THE PROBLEM OR SITUATION BEING ADDRESSED BY THE PRACTICE/INNOVATIVE EXPERIENCE

Various living organisms lived in perfect harmony and balance with each other in different ecosystems before chemical agriculture and chemical pest control came into the picture. Today, we see a kind of agricultural development which is based on monoculture and extensive use of chemicals. This has led to the emergence of several pests which has in turn led to the failure of crops. The number of pests developing resistance to pesticides over the years has been increasing at a very alarming rate. The pesticides have proven to be extremely toxic and have led to a number of side effects: impact on public health, toxic residues in food and disturbance of local ecosystems. Use of such chemicals has also led to the eradication of natural predators such as spiders which normally keep pest populations in balance.

Use of chemical pesticides has killed off natural predators not only in the agroecosystems but also in households. Several toxic chemicals are often recommended to control pests in households. Often, these chemicals are mistakenly ingested by children, domestic pets or even birds.

The work with spiders detailed in this report was designed to address the problems faced by farmers and homemakers. Mass rearing technologies have been worked out for certain species which can be extended to other groups.

This can form a basis for biological control.

One of the main reasons many people kill spiders on sight is the ugly-looking web, which they construct for many purposes like catching prey, attracting the opposite sex, etc. But the fact is that not all spiders construct webs. There are certain spiders called "Wanderers" which do not construct webs to catch their prey but actively chase them instead. Spiders are beneficial to human beings in the sense that they feed on the pests of man such as cockroaches, flies, etc. Predatory arachnids such as spiders are an important group of biological control agents. They are able to survive periods of starvation when prey is difficult to find. As the use of chemical insecticides gained currency, however, the role of spiders as natural pest controllers was greatly neglected and even forgotten. Today, however, people are becoming increasingly aware that in the long run, the harmful effects of the insecticides far outweigh the advantage of temporary pest control. What people are not so aware of is that even creatures commonly found in their own homes can play an important role in controlling domestic pests. The giant crab spider is one such example of a beneficial "house guest".

3. DESCRIPTION OF THE PRACTICE/INNOVATIVE EXPERIENCE AND ITS MAIN FEATURES

Spiders are voracious predators of insects. They are well adapted to certain habitats because of their ability to withstand periods of low food availability and also to take advantage of periods of prey abundance. Spiders are important predators of pests of cotton, rice, apple, banana and various other crops and plantations.

In households, a particular spider known as the giant crab spider has been identified as an effective "tool" in controlling cockroaches and other insect pests found in the domestic environment. The mass multiplication of such spiders can be effected without any sophisticated equipment.

Giant crab spider – the cockroach controller

In India and other tropical countries, the giant crab spider, ***Heteropoda venatoria,*** is a commonly found predator. It gets its name from its size, which ranges between 20 mm and 25 mm, the curvature of its legs and the way it scuttles sideways like a crab.

Giant crab spiders are brown in colour and have a flat body. While they feed mainly on cockroaches, in human dwellings they also prey on house crickets and other domestic pests.

These hunting spiders do not use webs to capture prey. They seek out

their prey in a special way. Their flat body enables them to get into small cracks and crevices inhabited by cockroaches. Their great speed and strong fangs enhance their hunting efficiency. Giant crab spiders attack cockroaches from the rear, a clever way to prevent being bitten by the powerful mouth parts of the prey. After having captured the cockroach, they bite into its neck and paralyse it with their poison. They then begin to feed on it, sucking its body fluids and discarding the remains.

These spiders use a multiple-capture technique. While feeding, if another prey passes by, they capture that too and hold it under their abdomen. The number of victims a giant crab spider can hold at any given moment is proportional to the size of the individual spider and of the prey. The prey-handling organs of these spiders are so designed that they can handle only a particular size of prey. Larger spiders generally catch large cockroaches. As a result, competition with the young ones for prey is avoided.

Mass rearing of giant crab spiders

Male and female giant crab spiders can be collected from inside houses, where they are found in plenty. Normally, one can come across many of them in tiled houses and houses with thatched roofs. One male and one female can be put in a 2-litre container and allowed to mate. After mating, the male is removed. The females construct an egg sac within two weeks which hatches out in about 20 days. Females which have constructed egg sacs can also be caught from the wild. The spiderlings that hatch resemble the adults except for being smaller in size. They undergo 13 to 14 moults to attain maturity, with males sometimes requiring only 13 moults and females, 15 moults.

Feed

Spiderlings feed on different prey, hunting them actively. All the instar stages and adults feed only on live and mobile prey. They feed on *Tribolium* larvae, housefly larvae and adults, and *Drosophilu* larvae and adults.

Mass rearing of these spiders does not require any modern sophisticated technology. What is needed is just a few bottles, prey and a lot of patience. The newly hatched spiderlings are separated in small containers, the lid of which has a few small holes for aeration and one moderately big hole for feeding. A small strip of paper should be inserted into the container to give additional support to the spiderling. The bigger hole should be plugged with cotton.

The first instar spiderlings should be fed with small larvae, like the second instar larvae of houseflies, *Drosophilu* and *Tribolium.* Once these moult

to second instar, they can be fed with slightly bigger larvae of *Tribolium* and very small-sized cockroaches. These larvae should be given with the help of a brush. Once the spider reaches the seventh or eighth instar stage, it can be fed adult houseflies and medium-sized cockroaches apart from the other prey given earlier. From the 10th and 1lth instar onwards, adult cockroaches can be given. The hunger rate increases with each instar stage and reaches its maximum in the pre-adult stage. In the adult stage, predation is maximum after mating and after the egg sac is dropped once the spiderlings have hatched. During these periods, the spiders should be provided with enough prey.

The spiderling can be grown up to the fifth instar stage in this container after which it should be transferred into a 1-litre container where it is kept until the 10th instar. Tenth to fourteenth instar stages and adults should be grown in 2-litre containers. The containers should be numbered properly and a regular register should be maintained to note the date of moulting and other observations. The containers should be cleaned regularly. The spider should first be transferred to another container and the old one should be cleaned with soap water and sun-dried. The spiders should be protected from ants by either putting the containers in water trays or putting a cup of oil or water under the legs of the table on which the containers are kept.

Rearing of prey

As has already been mentioned, spiders feed only on live insects. *So* when an attempt is made to rear them, we need to also learn how to rear the insects on which these spiders could feed. The technology of rearing prey insects like houseflies, *Drosophilu* and cockroaches is hereby described.

Laboratory rearing of houseflies

Materials: A cage covered on all sides with a wire mesh, petri dishes, milk powder, cotton, rice bran, groundnut oilcake and buckets.

Method: Houseflies that are collected in the field are introduced into the cage. Both males and females feed on the same food such as milk, sugar solution, etc. Hence milk made from milk powder with sugar is kept soaked in cotton for the flies to feed on. The females should be provided with ovitraps inside the cage which should simulate the breeding conditions of the houseflies. Rice bran and groundnut oil paste, in a ratio of 40:60, kept in the cage attracts the females to oviposit. The milk food and ovitrap must be changed every day. The ovitrap kept in a small petri dish should be transferred into a

bucket with more of the breeding medium. After four days of larval development, the larvae pupate inside the bucket. After three days of development inside the pupa, the adult emerges. But before this takes place, the bucket should be filled with water, so that the pupae float in it. They are collected and kept in the cage for emergence. The cage should be emptied once a week and cleaned with spirits.

Life cycle of houseflies:

(a) **Egg:** The eggs are banana-shaped, white in colour and of 1 mm size. Their morphology can be studied under a dissection microscope. The incubation period is 12-14 hours.

(b) **Larva:** There are three larval instars. The larvae feed on the decaying material present in the breeding medium and need moisture for their survival. Larval duration lasts for 3-5 days and when the development is over, the larva moves out of the moist medium and pupates. To avoid this, buckets are used so that the larvae will not be able to crawl up the bucket and will thus pupate inside, making the collection of pupae easier.

(c) **Pupa:** These are initially white in colour and slowly darken to coffee brown after a day or two. Imagines emerge out of the pupae, breaking the anterior part.

(d) **Adult:** Two days after emergence, the adults mate and then start feeding.

Rearing of cockroaches

Materials: Buckets with lids, muslin cloth, wire mesh, chart papers, biscuits and cotton.

Method: Holes are made on three sides of the bucket (2-inch diameter) and are covered with wire mesh and muslin cloth. Chart papers are glued to the bottom of the bucket in a circular fashion. **A** hole is made on the lid of the bucket and plugged with cotton to provide enough light and oxygen to the cockroaches.

Cockroaches and oothecae are introduced into the bucket and biscuits are provided for the roaches to feed upon. Any edible material can be given to the cockroaches, as they are scavengers.

Life cycle: The oothecae are purse-shaped, consisting of around eight eggs. Small nymphs hatch out of the oothecae in about a week which resemble the adults in all aspects except wings and reproductive organs. It takes three months for the nymphs to attain maturity. The life cycle continues inside the bucket.

Drosophila *rearing*

Materials: 50-ml containers with tight lids, agar, jaggery, wheat powder, distilled water.

Preparation of the medium: 420 ml of distilled water is boiled and 25 g of jaggery is dissolved in it. To this solution is added 25 g of agar and wheat powder. Stirring should be done while heating. After cooling to 40°C, yeast powder is smeared on the top to avoid fungal infection.

Rearing: The prepared medium is poured into 50-ml containers and after 24 hours, adult Drosophila sp. are introduced into the containers. Females deposit their eggs in the medium and the larvae that come out feed on the medium. Male and female Drosophila adults also feed on the same medium.

Life cycle: The whole life cycle is completed in a week. The eggs laid by the female hatch within a day. The larval instars take three days to enter into the pupal stage where they remain for 3-4 days. The adults which emerge mate and feed in two days, thus continuing the life cycle.

Points to remember while rearing spiders

(a) Spiders have cannibalistic tendencies, i.e., when there are many of them in a single container, they may tend to attack or prey upon others. Hence, they should be separated and maintained in individual containers.
(b) Small air-holes should be provided in the containers. A bigger hole, plugged with cotton, should be made for introducing prey.
(c) For the smaller instars, food like *Tribolium* larvae (the small worms found in rava, maida flour), fruitfly larvae and housefly larvae can be given. After they have grown a little bigger, cockroaches can be given.
(d) Ensuring the cleanliness of the containers is a must. The prey remains and the moulted skin should be removed periodically.
(e) Two sets of containers should be kept. After transferring the spiders to fresh containers, the old containers can be cleaned with soap and water and dried.
(f) Regular observations like on the date of moulting, pattern of feeding, etc. should be made.
(g) It is very important to keep ants away. The containers in which the spiders are reared can be kept in a plate on a tray filled with water. This plate should not be allowed to float on the water. If the containers are to be placed on shelves, then the legs of the shelves should be placed in small cups containing water or oil.

The mass rearing technology described above is for the giant crab spider, which is a cockroach controller. This technology has currently been extended

to other spiders found in other ecosystems. While extending this technology to other spiders, certain modifications have to be made to suit the needs of a particular species. However, the basic technology can be the same for various species.

4. DESCRIPTION OF THE INSTITUTION RESPONSIBLE AND ITS ORGANISATIONAL ASPECTS

The Centre for Indian Knowledge Systems is an institution devoted to exploring and developing the contemporary relevance and application of traditional Indian knowledge systems. One of the major activities of the centre has been action research and training programmes on the use of natural products for pest control and crop protection. A number of plant products, including neem, have been tested out in farmers' fields. The institution currently conducts a fairly large number of training programmes for farmers and non-governmental organisations (NGOs) on the use of non-chemical methods for pest control and crop protection. Besides this, it produces a number of publications on pest control and sustainable agriculture. The centre also works on setting up rural gene banks, development of the use of biological control agents such as spiders, research on the applications of Vrkshayurveda (Indian plant science), and work on indigenous breeds of cattle.

The centre is also involved in research and publications on medicinal plants. From time to time, training programmes on the use of traditional medicine for various groups are conducted. The centre also currently publishes newsletters, manuals and monographs on traditional health care and traditional agriculture.

5. PROBLEMS OR OBSTACLES ENCOUNTERED AND HOW THEY WERE OVERCOME

People either get repulsed by or ignore the sight of a spider. But these spiders do not deserve such a response. Most spiders are harmless, beneficial, colourful predatory creatures. The initial problem faced in using spiders as biological control agents was thus how to clear the misconceptions regarding spiders. Detailed awareness programmes had to be conducted amongst school-children, rural folk and the general public. They were taught that most spiders in India are not fatal to human beings and are in fact very efficient predators in a variety of agroecosystems. After the awareness programmes were conducted, the fear amongst most people disappeared and they were willing to accept spiders as an organism with which they can live in harmony.

6. EFFECTS OF THE PRACTICE/INNOVATIVE EXPERIENCE

The use of spiders in the domestic setting for control of cockroaches would bring down the use of the extremely poisonous substances conventionally used to control such pests. Surveys conducted in Madras revealed that nearly 60% of people interviewed were willing to introduce natural pest controllers like spiders as an alternative to insecticides. The public-health benefits of a more widespread use of such natural agents cannot be doubted.

In agricultural areas, a programme based on the use of spiders would naturally lead to a decline in the use of poisonous chemicals. In any case, both (spiders and toxins) cannot go together as the pesticides would eliminate the spiders. Studies on the effect of pesticides on spiders have shown that most of the pesticides currently used in agroecosystems kill off many spiders. Studies have also been made on the effect of various plant-based pesticides on spiders. These are not fatal to spiders. Spiders can also be conserved in agroecosystems by providing hedges which can serve as a habitat when there are no standing crops. To increase the number of spiders in an agroecosystem, spider egg sacs can also be collected and covered with hay and placed around the standing crop. When the young ones hatch, they go to the crop in search of pests. An agricultural programme that is based on the use of predators like spiders would also create suitable environments for the return of several other beneficial insects which are unable to tolerate the presence of pesticides.

Currently there are a number of people who use these spiders in the household setting to control cockroaches. There is another group of people who do not put spiders to use specifically but leave them alone whenever they encounter one. They have learned to live in harmony with the spiders. In the agricultural fields also, farmers have started accepting and acknowledging the role of spiders as biocontrol agents. The misconception that all spiders are deadly has been cleared by the awareness programmes and farmers have started recognising their importance. Farmers also realise that once they stop using pesticides, the population of spiders in their fields is found to increase.

7. SUITABILITY AND POSSIBILITY FOR UPSCALING

The multiplication **of** biological control agents is location-specific. Once local species are identified, they can be multiplied as per the available space and number of people. The technology is simple and the practice can be implemented in a small garage or one's own backyard. This technology can be important to rural women and schoolchildren. The former can undertake this as a private entrepreneurial activity which can serve as a source of additional

income for them. This technology can also be taken up by schoolchildren as a hobby which earns them pocket money.

8. SIGNIFICANCE FOR (AND IMPACT ON) POLICY-MAKING

The activities of man play a decisive role in the survival of spiders. Indiscriminate use of pesticides has wiped off whole populations of several species. The destruction of whole habitats such as the species-rich tropical rainforests threatens the survival of numerous spider species as well as all other animal inhabitants of those areas. Although this is not very apparent since man is at the apex of most food chains today, his dangerous activities will eventually boomerang on him. If these disastrous activities are not curtailed, stopped and reversed, man is likely to head the list of early departures of life forms from this planet. Hence it is very essential to take up efforts to conserve biocontrol agents such as spiders immediately. The use of biocontrol agents for control of pests is already recognised public policy in several countries, including India. Use of spiders as biological control agents has already proved to be a great success in countries like China and Japan. Once this technology gains visibility and acceptance, it can be incorporated in the national biological control programme.

9. POSSIBILITY AND SCOPE OF TRANSFERRING TO OTHER COMMUNITIES OR COUNTRIES

Knowledge of the use of biological control agents such as spiders can be easily transferred from community to community. The technology is simple and can be taught to children, women and youth. It can also be transferred to other countries when needed.

10. OTHER COMMENTS

K. Vijayalakshmi has authored a book on spiders. Part of it deals with their use as biocontrol agents. A small manual on the use of spiders for cockroach control has also been published by the Centre for Indian Knowledge Systems for distribution. Besides these, a number of popular articles have been written by the author on this subject. A project was undertaken to train children and rural women in rearing spiders. A project is also ongoing to study the utilisation of spiders for the control of pests in the paddy ecosystem.

The book on spiders is entitled *Spiders: An Introduction* by K. Vijayalakshmi and Preston Ahimaz. It is published by Cre-A: No. 12, 4th Cross Street, Karpagam Gardens, Adyar, Madras 600 020, India.