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Identification of the breeding-sites of important species of butterflies and their natural habitats for future conservation in Gujarat and Rajasthan

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Abstract

Studies were conducted on identification of the breeding sites of ten species of butterflies (*Papilio demoleus, Eurema hecabe* , *Catopsilia pomona* , *Colias fieldii, Hypolimnas missipus, Danaus chrysipuss*, *E.core, Euchrysops cnejus, Catocrysops Strabo and Tarucus nara for their* future conservation based on their seasonal abundance under different habitats under naturally available wild conditions in Gir Protected Areas of Gujarat. Some important behaviour such as mud-puddling, gully-bottoming, sun basking, higher flying etc. are very common activities required to understand the natural breeding phenomenon of butterflies. The study conducted in natural wild conditions in GPA revealed that all the ten species of butterflies exhibited a significantly positive response in their population built up as well as in their survival rate which may be due to the availability of optimal requirements of food and shelter in the wild-conditions of GPA. Whereas in semi-wild conditions of the AFRI Model Nursery, the butterflies are restricted within a limited area with specific number of host-plants. In addition, these areas are lack of natural water source like rivers and ponds etc, and lack of such requirements bring changes in the behavior of butterflies and indirectly exert negative influence on their life- span. Hence, the wild behaviour, pertaining to their population build up and larval feeding, of these species is somewhat restricted in AFRI- Model nursery. Thus, it proves that stress in any form acts as a deterrent factor in normal behaviour of butterfly species as observed in wild form.

Key words : Breeding sites, seasonal abundance, habitats, butterflies conservation, stress, behaviour.

INTRODUCTION

In India, studies on the conservational aspects of butterflies are very limited and narrow in scope. Many species are strictly seasonal, preferring only a particular set of habitats. In spite of this, butterflies have been generally neglected by community ecologists and there are very few studies available on their community structures, population dynamics and the eco-climatic factors which affect them [1]. Butterflies are the good indicators of climatic conditions as well as seasonal and ecological changes. They can also serve in formulating strategies for conservation. Most of the work carried out so far pertains to regional and local faunal lists, phonological data and host plant documentation. Hence, it is essentially required to study the effect of introduction of additional larval host plants and nectar plants apart from the species usually utilized in the locality [2]. The Ministry of Environment and Forests, Government of India through various schemes encouraged researchers and organization to develop *'butterfly gardens'* through relatively simple methods involving introduction of appropriate, naturally occurring host plants and recreating the natural habitats and this becoming increasingly popular in many states in India, especially Kerala, Tamil Nadu and Karnataka [3]. One of the main causes for the decline in butterfly wealth is habitat destruction by deforestation for urbanisation, industrialisation and agriculturisation, which also causes changes in temperature, humidity and rainfall [4]. Measures of increased urbanization were associated with decreased butterfly species richness, and rare and specialized species were most affected. Butterflies are also good indicators of environmental changes as they are sensitive to habitat degradation and climate changes [5]. serious factor in the decline of many butterfly species is the extreme fragmentation of their habitats following decades of habitat loss and/or unsuitable management [6]. The major drivers of butterfly habitat loss and degradation are related to agricultural intensification. Changes in the management of non-agricultural areas, such as grasslands, are also an important threat. In spite of this, butterflies have been generally neglected by community ecologists and there are very few studies available on their community structures, population dynamics and the eco-climatic factors which affect them. However, where agri-environment schemes have been well designed and implemented, they have led to some positive results for butterflies [7]. In Wild Life Sanctuary and National Park, the increased frequency and intensity of fires, the development of tourism activities and urbanisation destroy important breeding habitat. From the conservation point of view this knowledge is of primary importance in planning conservation actions, yet these studies are rare.

In countries like the UK, USA and Papua New Guinea, butterfly farming and captive breeding is a well established industry. Such studies have established that the captive breeding is possible for many species of butterfly which can help conservation through scientific research and education of the public. India with its rich butterfly fauna holds great potential for butterfly farming enterprises [8]. Preliminary attempts to maintain butterflies in captivity were initiated at KFRI, Peechi in Kerala state during 1993-1996 [9]. According to him, the common rose (*Pachliopta aristolochiae*) and the southern birdwing (*Troides minos*) were breed on *Aristolochia indica* in field cages. More recently, a butterfly garden and a Safari have been established at Calcutta and Hyderabad respectively. The present findings aim to explore the possibilities to identify the breeding sites their natural habitats and future conservation of important species of butterflies which are commonly available throughout the year in Gujarat and Rajasthan States.

MATERIAL AND METHODS

10 species of butterflies viz., *Papilio demoleus, Eurema hecabe, Catopsilia Pomona* , *Colias fieldii, Hypolimnas missipus* , *Danaus chrysippus, Euploea core, Euchrysops cnejus, Catocrysops strabo* and *Tarucus nara* , were taken into account during the present studies All these species are commonly available throughout the year in wild and semi- wild conditions in Gujarat as well in Rajasthan States. Three types of experimental-sites were selected for the aforesaid study (1) Breeding sites/ habitats of common species of butterfly studied under natural wild conditions in selected study sites in Gir Protected Area, Gujarat,

(2) Breeding study- sites/ habitats of common species of butterflies, studied under semi- wild conditions at, Arid Forest Research Institute, Jodhpur Model Nursery, Jodhpur and (3) Breeding sites/ habitats of common species of butterflies, studied under captivity in Arid Forest Research Institute, Jodhpur under insectary condition.

Study Sites:

Under natural wild conditions in selected study-sites in Gir Protected Area, Gujarat: Butterflies were surveyed in all the 10 study- sites located in GPA (Dudhala, Devalia, Kamleshwar, Barwania, Janwadala, Chhodavadi, Banej, Ghodavadi, Raval Dam and Jasadhar) which are differing in their longitudes and latitudes. These sites were selected as the study sites as because they are highly differ in their habitat feature such as the composition of the soil (presence of minerals, ions *etc*.), presence of water source (river, dam or reservoir), variation in vegetation (presence of variety of food plants (natural present or artificially planted), denseness of forest (grasses, herbs, shrubs, trees), Disturbances (less, moderate, high).

Under semi- wild conditions at AFRI Model Nursery, Jodhpur: AFRI, Model Nursery is situated in Jodhpur, covering an area of about 1.8 hectare, having a variety of floral plants, medicinal plants, trees, herbs, shrubs, *etc*., provided with artificial water source with sandy soil texture.

Under captivity in insectary condition at AFRI, Jodhpur: An existing insectary (8m x 5m x 5m) covered with fine steel netting and provided with a double door was made use of for rearing purpose. Within the cage appropriate larval host plants were maintained to facilitate oviposition by the butterflies released. In addition to this, provision was also made to keep diluted sugar solution (10% honey in water) for sustaining butterflies. An area of approximately 0.5 ha surrounding the insectary was landscaped so as to produce different habitats such as dense vegetation open areas, bushes etc., in order to attract local species of butterflies which are commonly available throughout the year in Gujarat and Rajasthan and which have different habitat preferences. Potted plants of *Lantana camara, Clerodendrum paniculatum and Ixora speices* were also planted for adult feeding wherever is needed. The species planted in this area include *Lantana camara, Calotropis spp., Nerium indicum, Catharanthus roseus, Hibiscus rosa sinesis, Azadirachta indica, Prosopis cineraria* as well as *Citrus* sp., which serve as host - plants of several butterflies like *Euploea core, Papilio demoleus, Danaus chrysippus and sp. of Pieridae*. Regular observations were also made on butterflies visiting various plants. In addition, in order to assess the changes in abundance of a few species of butterfly such as *Danaus chrysippus, Papilio demoleus etc*. saplings of larval host- plants and adult nectar plants were used in the AFRI model nursery.

RESULTS

All the above mentioned ten species of butterflies were taken into account for the study on the identification of the breeding sites of important species of butterflies and study their natural habitats for future conservation based on their seasonal abundance under following three different habitats:

Under natural wild conditions in GPA: All the 10 test species of butterflies were assessed for their behaviour in the naturally available wild conditions in GPA, such as their mud-puddling behaviour which was restricted to males butterflies only, as males of many species assemble on spots on ground contaminated with animal urine or excreta. These butterflies absorb from these sites essential elements such as sodium that has been lost during copulation in the form of sperms this phenomenon has been observed in species of *Eurema hecabe* in many study-sites of GPA. Similar findings (1993) has been recorded [10]. The other phenomenon like floating were seen in *Papilio demoleus*, it was observed that during the hottest time this butterfly glide over the surface of shallow, non turbulent, slow running water of Singhora river in GPA. The same phenomenon has been recorded (2011) in the Western Himalayas region[11].

Gully-bottoming were also seen in several species of butterflies in Chodavadi study- site in GPA where the species such as *Catopsilia pomona* and the species of *Eurema* congregate in large numbers in shady riverbed during the hottest time of the day to cool themselves and avoid desiccation. The similar findings were also reported in (2011) on these species[11]. One species of Papilionidae *(Papilio demolus*) fly very high and cover a long distances by flying on the top of the trees around the check-post on tower near Kamleshwar Dam and within a very short span of time reaches the surface of the dam. They are the strong fliers and cover long distances. Larvae of *Danaus crysippus*, *Euploea core etc.* were seen along with their adults in a very high abundance on their host-plants in the Rawal dam region where there was a very high population of *Calotropis gigantum* and other floral plants.

The study revealed that in the wild habitat, all the ten species, exhibited a significantly positive response in their population built up as well as their survival rate which may due to the availability of optimal requirements of food and shelter in the wild-conditions under natural forests in GPA. The above finding also suggests that the GPA has tremendous scope for conservation of the above species of butterflies.

Under semi-wild conditions, at AFRI Model Nursery, Jodhpur: All the 10 species of butterflies with details of their host plants which are common in AFRI Model nursery, Jodhpur and Gir Protected area in Gujarat have been taken into account in order to study their breeding sites and their natural habitats for their future conservation under semi- wild condition in AFRI Model nursery, Jodhpur. All the, 10 species of butterflies belonging to the families Papilionidae, Nymphalidae, Lycaenidae and Pieridae were observed to feed on their respective host- plants in the above experimental study-area. The flower heads of *Lantana camara*, *Golden deuranta* were found to be very much preferred and suitable for breeding by a few species of butterflies belonging to Papilionidae (*Papilio demoleus*) and Pieridae (*Catopsilia Pomona, Colias fieldii*) and Lycaenidae (*Tarucus nara, Catocrysops strabo*). The Danaids, *Danaus chrysippus, Euploea core*were found to aggregate in large number on the *Calotropis gigantum.* Though, the larval stages of *E. Core* were noted to feed on *Nerium indicum* and subsequently, completes its life cycle successfully in wild form in AFRI, Model Nursery but

Table 1: List of butterflies, commonly available throughout year in Gujarat and Rajasthan and studied in wild, semi- wild and under captive condition

Sl.No.	Family	Species	Host- Plant	Remark
1.	**Papilionidae**	*Papilio demoleus*	*Lantana camara*	4- 5 individuals visiting flower heads in the morning and afternoon
2.	**Pieridae**	*Eurema hecabe*	*Vernonia cineria*	Several individuals feeding at flowers
3.		*Catopsilia Pomona*	*Vernonia cineria*	Several individuals feeding at flowers
4.		*Colias fieldii*	*Golden duranta*	8-10 butterflies visiting the flowers.
5.	**Nymphalidae**	*Hypolimnas missipus*	*Hibiscus rosa-sinensis*	1-2 butterflies visting the flower
6.		*Danaus crysippus*	*Calotropis gigantum*	4-5 butterflies visting the flower
7.		*E.core*	*Nerium indicum*	
8.	**Lycaenidae**	*Euchrysops cnejus*	*Tephrosia purpurea*	A few butterflies (6-8) visiting the foliage
9.		*Catochrysops strabo*	*Tephrosia purpurea*	A few butterflies (6-8) visiting the foliage
10.		*Tarucus nara*	*Zizyphus species*	A few butterflies (6-8) visiting the foliage

the durations of immature stages prolong considerably and this may be due to the meagre availability of food plants in the AFRI Model nursery in comparison with that of GPA. Thus, it proves that stress in any form acts as a deterrent factor in normal behaviour of any butterfly species as observed in wild form. These species of butterflies were observed to lacerate the leaf surface by scratching and then lick the exuding sap The larvae of a few species belonging to family Nymphalidae *e.g*., *Hypolimnas missipus* and *Danaus chrysippus* were noticed to feed voraciously on *Hibiscus rosa sinensis* and *Calotropis gigantum*. Up to 10 butterflies were noted to feed gregariously on a single plant and heavy incidence of butterflies led to the wilting of plants. Danaid butterflies are also reported to feed on plants containing alkaloids[7].

An evaluation of the establishment of various butterflies in the study area was also made by examining the larval host plants for the presence of their immature stages. The plant of *Calotropis gigantum* contained eggs, larvae and pupa of *Danaus chrysippus*. Similarly, the immature stages of lime butterfly, *Papilio demoleus* was noted on *Citrus spp.* Data gathered have shown that, in general, the number of butterflies present, was high during the months September to December when the average temperature and relative humidity ranged from 10^{0}C to 24^{0}C and 40 % to 54 % respectively. The butterflies showed a heavy reduction in population during in summer months June to August when the average temperature and relative humidity ranged from 36 ^{0}C to 47^{0}C and 45 % to 55 % respectively. The butterfly species, found in the AFRI Model Nursery were restricted within a limited area with specific number of host plants. In AFRI Model nursery, certain species such as *Papilio demoleus*, *Hypolimnas missipus* and *E. core* do not found most preferred and favourable habitat for breeding in comparison with that of study-sites selected in GPA whereas absolute wilderness is available to fly and breed by these species of butterflies. Hence, the wild behaviour, pertaining to their population build up and larval feeding, of these species is somewhat restricted in AFRI Model nursery.

From the above observation, it is also revealed that the survival rate of such species is proportionally declining in this type of habitats as they have very limited area. As a result of which, it is noticed that the butterflies do not fly for a long distance as the food plants are located within a limited vicinity. Secondly, these areas are lack of natural water source like rivers, ponds so, these also brings changes in the behaviour of butterflies and indirectly limit their life span.

The mud puddling, behaviour as well as floating and Gully-bottoming were completely lacking in the AFRI Model Nursery which was seen in hottest time in GPA, hence, these species could not protect themselves from the extreme hottest days as the water were available for a limited time and period through sprinkling pipes, leading to their mortality and decrease in the abundance of population.

Under captivity in AFRI, Jodhpur Insectary: All the ten species of butterflies (*Hypolimnas missipus, Papilio demoleus, Colias fieldii, Catopsilia pomona, Eurema hecabe, Danaus chrysippus, Catocrysops Strabo, Tarucus nara, Euchrysops cnejus* and *Euploea core)* which are commonly available in Gujarat and Rajasthan were farmed under captivity in AFRI insectary, Jodhpur. The adults and immature stages of these butterflies were released under captivity in outdoor wire-meshed cages of insectary where appropriate larval host-plants of each of these butterflies have either been established or provided in earthen pots. Sufficient water as well as diluted sugar solution was also kept as food materials in separate containers for feeding these

Table 2: Details of butterflies released in the insectary.

Sl.No.	Species	Stage	Number and date of release	Remarks
1.	*Catopsilia pomona*	Adult	7 Nos. 02-03-12	Found dead on 10-03-12
2.	*Colias fieldii*	Larvae	6 Nos. 24-09-12	1 died in larval form, pupation from 25-09-12 to 27-09-12. Adult emergence from 4-10-12 to 6-10-12. One adult emerge as deformed and died by evening.
		Adult	4 Nos. 24-09-12	Found dead on 29-09-12
3.	*Papilio demoleus*	Adult	4 Nos. 05-02-12	Found dead on 10-02-12
4.	*Danaus chrysippus*	Larvae	6 Nos. 20-09-12	Pupation from 23-09-12 to 25-09-12. Adult emergence from 2-10-12 to 4-10-12. One pupa did not develop into adult.
		Adult	5 Nos. 21-09-12	Found dead on 26-09-12
5.	*Euploea core*	Larvae	4 Nos. 15-10-12	One died in larva form, 3 pupated on 20-10-12. Adult emergence on 30-1012.
		Adult	2 Nos. 17-10-12	Found dead on 21-10-12.
6.	*Hypolimnas missipus*	Adult	2 Nos. 10-10-12	Found dead on 13-10-12
7.	*Eurema hecabe*	Larvae	10 Nos. 20-10-12	Pupated from 24-10-12 to 26-10-12, mortality of 3 in pupae form while rest emerge as adult from 2-11-12 to 4-11-12.
		Adult	12 Nos. 15-10-12 to 17-10-12	Found dead on 20-10-12
8.	*Euchrysops cnejus*	Adult	3 Nos. 15-10-12	Found dead on 21-10-12
9.	*Catocrysops strabo*	Adult	7 Nos. 16-10-12	Found dead on 20-10-12
10.	*Tarucus nara*	Larvae	4 Nos. 15-09-12	3 died in larval form. 1 pupate on 17-09-12 and adult did not emerge out.
		Adult	6 Nos. 11-09-12	Found dead on 15-09-12

mature and immature stages of butterflies.

The butterflies were collected from the field and later released in the out- door wire- meshed cages of insectary. The butterflies, thus released, survived for a maximum period of 4 to 5 days, but in no instance of mating and egg-laying were noticed. This may either be due to the limited area available which is insufficient to induce mating response or may be due to the impact of atmospheric temperature and humidity within the insectary-cage. More or less, similar observation was reported in 2007 in case of the butterfly farms established in Tanzania under enclosure (covering over 100 m^2) so as to provide as much natural space as possible[12]. Even in this case, the natural build up of butterflies population could not be achieved satisfactorily due to the aforementioned facts. Details of butterflies released into the out-door cage of insectary is given below:

The adult survival days of most of the butterflies in cages has been reduced as compared to the data available for their survival in wild. Some of the larvae of butterflies such as *Tarucus nara, E. core* did not pupate and died in larval form or been eaten by predators such as ants, rodents etc. while pupae of *Eurema hecabe, Tarucus nara, Colias fieldii etc*. did not emerge into adult, whereas some emerge in deformed state and has been

Table 3: Comparison between the available breeding conditions in different test habitats for common species of butterflies

Factors	Naturally selected study- site	AFRI- Model Nursery	Captive breeding
Food source	Unlimited	Limited	Selective
Water source	Naturally available (river, ponds) for longer period	Artificially available for limited lime period.	Available in very less amount and for very limited period.
Breeding site	Available in adequately as per demand of particular species of butterflies	Available but not adequate as per demand of particular species of butterflies	Available but only for very selective species of butterflies
Space	Unlimited	Limited	Very less

killed by the lizards and other insects.

DISCUSSION

Though, these artificially provided wire-meshed cages have adequately large dimensions but still do not sufficient to support the strong flyer butterflies for their breeding behaviour. Predation by lizards and infestation by micro-organisms were also among the major factors for the declining of their population being maintained in the field cages. Instances of 'inbreeding' leading to a loss of vigour due to loss of heterozygosity and fixation of homozygous alleles have been reported in continued breeding programmes of certain species of butterflies (built up of selected species of butterflies such as *Catopsilia pomona, Papilio demoleus and Eurema hecabe* as much their requirement and as a result of which their numbers remain limited [7]. Since most species of butterflies have more than one host-plants, so, the most preferred host- plants were placed in the insectary, but they were not sufficient to allow the population

For tropical butterflies, such as *Danaus chryssipus, Catopsilia pomona etc., the* average temperature (25°C) and an average relative humidity (70-80%) is required for their survival, but this temperature could not be maintained continuously in the captivity which was artificially provided in the insectary of AFRI experimental field, as compaired in natural field conditions where butterflies maintained themselves very well by resting in cool, dark places under dense forest cover or by gliding on shallow river. A continued supply of both nectar plants for the adults, food plants for the larvae along with artificial food source of dilute solution of honey and water was given to the butterflies and its larvae in the insectary was maintained, but still it does not help in maintaining the population of butterflies and this may be due to insufficient number of host- plants. Plants such as *Lantana* spp. which flower almost continually are placed in the insectary. Since the flowers of these plants have nectaries close to the surface, nectar is very easily accessible to the butterflies of the families such as Lycaenids and Pierids with short proboscis prefer smaller flowers (*e.g.,* Compositae) while for the larger Papilionidae butterflies, *Hibiscus rosa- sinensis* potted plants *were placed*. When there was scarcity of flowers, for artificial feeding, sugar/honey solutions (10%) are presented as soaked pads of cotton wool or in a tube fitted with a coloured corolla. Suitable dimensions for a flight arena relate to the wingspan of the species (x) as follows: length 20-25 x; height 10-15 x; depth 10-15x [13]. However, very large cages are to be avoided because some species tend to disperse to the roof and sides and ignore potential mates [13]. The emergence of adults is extended over too long period, the optimum periods may not synchronize and it was difficult to secure pairings.

Captive populations in insectary were exposed to a greater degree of inbreeding depression than natural populations. Inbreeding depression manifests itself in deterioration in vigour and health, as a consequence of a rapid loss of heterozygosity and the fixation of homozygous disadvantageous alleles through inbreeding. However, since many natural colonies of butterflies are isolated, small and have persisted in this manner for many generations. The amount of inbreeding in captive colonies, whose populations may be many times larger than their natural counterparts, is unlikely to be a problem [14].

The founding stock did not survive and did not reproduce under captive breeding conditions, as they are not adapted to existing new environment in the insectary. Most of the time and maximum species of butterflies enable it to survive the transition from natural to captive conditions. Genes that confer fitness in the field may not confer fitness in captivity [15]. Hence, the above studies suggest that the population of a few speciesof butterflies such as *Papilio demoleus, Eurema hecabe, Catopsilia pomona*, *Danaus chrysippus*, *Euploea coreetc., can* be maintained in captivity providedsuitable breeding conditions *viz.,* sites, sufficient water supply and host-plant etc., species could be made available in the artificial breeding sites in captivity.

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CONCLUSION

Studies were conducted on identification of the breeding sites of ten species of butterflies for their future conservation based on their seasonal abundance under different habitats in Gir Protected Areas of Gujarat. The study conducted in natural wild conditions revealed that all the ten species of butterflies exhibited a significantly positive response in their population built up whereas in semi-wild conditions, the butterflies are restricted within a limited area with specific number of host-plants. Thus, it proves that stress in any form acts as a deterrent factor in normal

behaviour of butterfly species as observed in wild form.

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