collections of these insects will provide further useful informations on their distribution, endemism, intra-specific variations, bio-control potential *etc.*, from the state.

References

Ehrmann, R. (2002). *Mantodea: Gottesanbeterinnen der Welt.* Natur and Tier-Verlag, Munster, Germany (Praying Mantids of the world (in German)).

Mukherjee, T.K., A.K. Hazra & A.K. Ghosh (1995). The mantid fauna of India (Insecta: Mantodea). *Oriental Insects* 29: 185-358.

Sureshan, P.M., H.V. Ghate & C. Radhakrishnan (2004a). *Statilia nemoralis* (Saussure) (Insecta: Mantodea) from Maharashtra. *Zoos' Print Journal* 19(7): 1550.

Sureshan, P.M., Md. Jafer Palot & C. Radhakrishnan (2004b). New additions to the mantid fauna (Insecta: Mantodea) of Andaman and Nicobar Islands, India. *Zoos' Print Journal* 19(7): 1544.

Sureshan, P.M., H.V. Ghate and C. Radhakrishnan (2004c). Insecta: Mantodea, pp.227-232. In: *Fauna of Pench National Park Conservation Area Series* 20. Zoological Survey of India.

Sureshan, P.M., H.V. Ghate and C. Radhakrishnan (in press a). Insecta: Mantodea, pp.245-250. In: *Fauna of Tadoba Andheri Tiger Reserve, Conservation Area Series No.* 25. Zoological Survey of India.

Sureshan, P.M., H.V. Ghate and C. Radhakrishnan (in press b). Insecta: Mantodea. *In: Fauna of Sanjay Gandhi National Park. Conservation Area Series.* Zoological Survey of India.

Acknowledgement

The authors are grateful to the Director, Zoological Survey of India, Kolkata and the Officer-in-Charge, Zoological Survey of India, Estuarine Biological Station, Gopalpur-on-Sea for providing facilities and encouragement. We are also grateful to Dr. H.V. Ghate, Professor, Modern college, Pune for critically going through the manuscript and offering useful suggestions.

RE-EMERGENCE OF POLLINATING WASPS (HYMENOPTERA: AGAONIDAE) AFTER NATURAL POLLINATION OF FIGS

I.P. Abdulrazak [1] and U.C. Abdurahiman [2]

[1] Department of Zoology, Unity Women's College, Manjeri, Kerala 676122, India
[2] Retired Professor of Zoology, University of Calicut, Ulladanchalil, Kozhikode, Kerala 673008, India
Email: [1] razak-ip@rediffmail.com

Figs are urn shaped floral receptacles. As female flowers in the fig Syconia reach maturity and their stigma become receptive, pollen loaded female wasps attracted by host specific volatiles enter the fig cavity through the ostiolar bracts. Figs offer larval development sites and mating sites for these pollinators. The *Ficus* and its pollinator relationship is thus an instance of obligate mutualism (Galil & Eisikowitch, 1971; Wiebes, 1979; Joseph & Abdurahiman, 1984). Because of the closed structure of the fig, the pollinating wasps (= foundresses) are supposed to always die within the fig cavity after pollination (Hill, 1967; Galil & Eisikowitch, 1969; Bronstein, 1988). However, Grandi (1920) in his monograph on the pollinator of common fig *Ficus carica*, clearly stated that the pollinator, *Blastophaga psenes* L. may exit the figs they have entered. In this study on three fig species, we examined the incidence of the escape of foundresses from the figs after pollination, in order to ascertain whether this event occurs uniformly in all the three species.

Materials and methods:

The required data were collected from three most accessible *Ficus* species in Kozhikode and Malappuram districts of Kerala. Two species of monoecious figs, namely, *Ficus racemosa* and *F. drupacea* pollinated respectively by *Ceratosolen fusciceps* Mayr and *Eupristina belgaumensis* Joseph; and one dioecious species, *Ficus hispida*, pollinated by *Ceratosolen solmsi marchali* Mayr were selected for this study. For each species, figs were collected ten days after natural pollination had occurred. Owing to differences in phenology of the different fig species, they were studied at different times of the year with different sample sizes. Naturally pollinated figs were dissected under stereomicroscope. Foundresses were recorded as being found either inside the fig cavity or stuck in the ostiole. In the latter case, the position of the head which are orientated towards the ostiole outlet or directed towards the internal cavity of the fig, was also recorded. When no foundresses were found inside a fig, other traits were recorded that demonstrated whether or not the fig had been entered by one or more foundresses, i.e., the presence or absence of wings left on the fig's surface at the edge of ostiolar scales, tanning of the styles caused by injury from insertion of the ovipositor, and enlargement of the ovaries. Evidence of entry combined with the absence of a foundress indicate that foundress do exit from the figs.

Manuscript 1545; © ZOO; Date of publication 21 December 2006
Received 01 April 2006; Finally accepted 10 September 2006

Results:

In all the three naturally pollinated figs studied, no foundresses were found left inside. The frequency of this event is, however, different among the three species (Table 1). In *Ficus racemosa*, visited figs without dead foundresses in the cavity accounted for 5-22%. In *F. drupacea* the number of visited figs without dead foundresses varied from 6-17%. However, in *F. hispida*, the rate is found very high, ranging from 67-89%. The dead foundresses found stuck in the ostiole were very high 16-24% in this dioecious species when compared with the two monoecious species. When the mean number of foundresses inside was high, visited figs with no foundresses inside were less frequently observed.

Table 1. Percentage of naturally visited figs with no dead foundresses inside and with dead foundresses having stuck head outwards in the ostiole.

Trees	No. of figs	% of figs without foundresses	% of figs with foundresses in the ostiole	No. of dead foundresses/ fig (Mean ± SE)
Ficus racemosa				
T_1	78	21.8	3.8	2.62 ± 0.29
T_2	55	5.4	7.2	2.47 ± 0.29
T_3	67	19.4	5.9	4.61 ± 0.37
T_4	50	22	0	9.20 ± 0.98
Ficus drupacea				
T_1	40	17.5	0	1.70 ± 0.221
T_2	50	6	10	2.06 ± 0.20
Ficus hispida				
T_1	37	67.5	21.6	0.44 ± 0.12
T_2	43	67.4	16.2	0.52 ± 0.15
T_3	45	88.8	24.4	0.11 ± 0.048

Discussion:

In the three species studied, we have observed the re-emergence of foundresses from the figs they have pollinated. The proportion of pollinator wasps escaping varies among species and crops. Comparable observations have been obtained from *F. hispida* (Abdurahiman & Joseph, 1976) and *F. lutea* (Ware & Compton, 1992). Some observations of foundress re-emergence are also available from two monoecious and one dioecious fig species (Gibernau *et al*., 1996). However, the present study revealed that wasps leaving the figs after accomplishing pollination could be a common phenomenon in quite a number of species. In all crops of *F. racemosa* we found that the mean number of dead foundresses ranged from 2.5-9 per fig and in *F. drupacea* it was two foundresses per fig. Re-emergence might be an efficient strategy for protecting against pathogens (Gibernau *et al*., 1996). The degree of incidence of such exit was found very high, up to 89% in *F. hispida*, irrespective of their sexes. While in another dioecious fig species, *F. carica* the degree of re-emergence is found different among male and female trees (Gibernau *et al*., 1996). The high rate of re-emergence of foundresses observed among figs with larger diameter in later receptive stage (Kjellberg *et al*., 1987). This cannot be an explanation for re-emergence of wasps, because the foundresses that re-emerged from the three species studied are not influenced by the fig diameter. However, in *F. pertusa* wasp re-emergence does not occur (Bronstein, 1988). Wasp re-emergences have direct consequences for fig tree fitness, which depends on the production of seeds and female pollinators. The fig tree may, however, have a limited control over ostiole tightness. This may vary from species to species. The ostiole size and shapes differ across species and hence some difference can be expected in the possibilities for the exit of the wasps.

References

Abdurahiman, U.C. & K.J. Joseph (1976). Observations on the biology and behaviour of *Ceratosolen marchali* Mayr. (Agaonidae). *Entomon* 1: 115-122.

Bronstein, J.L. (1988). Limits to fruit production in a monoecious fig: consequences of an obligate mutualism. *Ecology* 69: 207-214.

Galil, J. & D. Eisikowitch (1969). Further studies on the pollination ecology of *Ficus sycomorus* L.(Hymenoptera, Chalcidoidea, Agaonidae). *Tijdschritt Voor Entomologie* 112: 1-13.

Galil, J. & D. Eisikowitch (1971). Studies on mutualistic symbiosis between *syconia* and *sycophilous* wasps in monoecious figs. *New Phytologist* 70: 773-787.

Gibernau, M., M.H. Mc Key, M.C. Anstett & F. Kjellberg (1996). Consequences of protecting flowers in a fig: A one-way trip for pollinators?. *Journal of Biogeography* 23: 425-432.

Grandi, G. (1920). Studies morfologico e biologico della *Blastophaga psenes* (L). *Boll Lab Zool Portici* 14: 63-204.

Hill, D.S. (1967). *Figs of Hong Kong*. Hong Kong University Press, Hong Kong.

Joseph, K.J. & U.C. Abdurahiman (1984). Agaonid - *Ficus* interactions with special reference to pollination ethology. *Proceedings of Indian Academy of Science (Animal Science)* 93: 365-372.

Kjellberg, F., P.H. Gouyon, M. Ibrahim, M. Raymond & G. Valdeyron (1987). The stability of symbiosis between dioecious figs and their pollinators:a astudy of *Ficus carica*.L. and *Blastophaga psenes* L. *Evolution* 41: 693-704.

Ware, A.B & S.G. Compton (1992). Breakdown of pollinator specificity in an African fig tree. *Biotropica* 24: 544-549.

Wiebes, J.T. (1979). Co-evolution of figs and their insect pollinators. *Annual Review of Ecology and Systematics* 10: 1-12.