Studies on The Predatory Interference to Natural Populations of *Apis Dorsata (*Hymenoptera: Apidae) at Differnent Regions of South-Western Karnataka, India

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Abstract: Field investigations were conducted by employing direct visual count method and an all out search method to record the impact of predators to *A. dorsata* colonies at arid, semi-arid and malnad regions of south-western Karnataka during 2010 to 2012. Moreover, farmers, residents and common public were met personally to collect information about predators of *A. dorsata* population with the help of pre-tested questionnaire. Total 27 visits were made to record the prevalence of predators on *A. dorsata* colonies. Altogether 11 species which belong to insects (one species), birds (8 species) and mammals (2 species) have shown their predatory activity on *A. dorsata* colonies. Analysis of Variance between predator's interference and different regions of south-western Karnataka didn't showed significant variation. This has demonstrated the common prevalence of predators at *A. dorsata* colonies in south-western Karnataka. Further, Pearson's correlation between predator's interference and colony abandonment indicated the positive correlation. Thus, certain insects, birds and mammals became troublesome to *A. dorsata* population. They stealed the brood and hive products, hunted worker bees, thereby weakened the colony integrity and gradually initiated the process of colony desertification. Despite, elite strategies adopted while nesting under arboreal conditions by *A. dorsata*, loose its population considerably. Since, *A. dorsata* become a part of diet for several animals, its protection is need of the hour as it is one of the keystone pollinators, conservation is essential to restore local biodiversity.

Key words:* *Apis dorsata, predators, impact, south-western Karnataka, India

I. INTRODUCTION

All living organisms are subjected to infestation or attack by natural enemies or predators, and honeybees of the genus *Apis* are no exception to it. *Apis* species colonies both at natural and man-made ecosystems are attacked by various insects (e.g. Wax moth, hive beetles, ants, wasps etc.), amphibians, reptiles, birds and mammals, which affect bee hives and bring serious loss to beekeeping industry in tropical and sub-tropical regions of the world. However, the damage caused by these animals to honeybee colonies and the extent of loss vary among different geographical regions (Nagaraja and Rajagopal, 2009). Few reports are available on the impact of predators on dwarf honeybee (e.g. *A. florea*) colonies and notable threat has been reported by Seeley *et al*. (1982) in Thailand. *A. dorsata* is one of the most ancient honeybee species (Ruttner 1988; Oldroyd and Wongsiri 2006; Kastberger *et al*., 2010), commonly known as 'wild bee'. It nests in open arboreal conditions (Seeley *et al*., 1982), facing problems from predators such as wasps (Kastberger *et al*., 2008 and 2010), birds (Seeley *et al*., 1982; Kastberger and Sharma 2000) and mammals at its nesting niche (Viraktamath *et al*., 2005; Basavarajappa *et al*., 2009). In view of the amount and variety of nutrition offered by A. dorsata colonies, it is not surprising that numerous predators, enemies and pests set out to take a share of this concentrated high-value organic material i.e., honey (Hepburn and Radloff, 2011). Predatory animals target different parts of bee hive and hive contents. Certain species occasionally try to snatch small amount of hive contents (e.g. honey or pollen), while others extract significant part of the hive (e.g. brood). Thus, several predators, enemies and pests have created problems to *A. dorsata* colonies at various regions of India and other parts of the world. Certain Vespidae family members (e.g. *Vespa mandarina, V. tropica, V. orientalis, V. basalis, V. magnifica* and *Vespula vulgaris* are known to predate on *A. cerana* and *A.mellifera* colonies (Muzaffer and Ahmed, 1986; Chang *et al*., 1993; Ono *et al*., 1995; Srivastava *et al*., 1995). Moreover, several birds and mammals also interfere with the normal survival of *A. dorsata* population. Nagaraja and Rajagopal (2011) have recorded 40 species of birds which are known to prey on honeybees in the field. Ambrose (1990), Thapa and Wongsiri (2003) have reported the interference Drango and Swifts to honeybee colonies. Kastberger and Sharma (2000), Thapa *et al.* (2000) have reported the counter attack of bee-eaters (e.g. *Merops orientalis* and *M. persicus)*) on

A. dorsata colonies in Assam and Nepal. Thapa and Wongsiri (2003) have observed the Oriental honey Buzzard, *Pernis ptylorhynchos* feeding on the brood and honey of *A. dorsata* in Nepal. Jadczak (1986) has reported the bears (e.g. *Helarctus malayanus*, *Melursus ursinus* and *Ursus thibetanus*) attack to *A. dorsata* in USA. Seeley *et al*. (1982), Thapa *et al*. (2000), Oldroyd and Wongsiri (2006) have recorded the attack of martens (e.g. *Martes flavigula* and *M. foina*) to the colony along with flying bees. Moreover, Seeley *et al*. (1982), Thapa *et al*. (2000), Basavarajappa (2011), Nagaraja and Rajagopal (2011) have reported the monkeys (*Macaca radiata*) occasional disturbance to *A. florea, A. cerana* and *A. dorsata* colonies. Further, the vertebrates such as rats, honey badgers, foxes, lizards and toads predation on honeybees has been reported by Caron (1978), Novogrodzki (1990) in London and Japan. Further, Abrol (2003), Nagaraja and Rajagopal (2011), Morse and Laigo (1969) have reported on predators, parasites, pests which cause severe damage to *A. dorsata* colonies at different parts of India and other countries. The greater wax moth, *Galleria mellonella* (Lepidoptera: Pyrallidae) infestation on the hive of *A.* dorsata has been published by Raghunandan and Basavarajappa (2010) elsewhere. The predator's intereferences to *A. dorsata* colonies studied by various researchers in India and other countries around the world are predicted in Table 1. Although, *A. dorsata* establishes colonies under arboreal conditions in the wild, which are free for frequent hunting. Concomitant to hunting, pests, predators and enemies interference is often common in the wild. Information on these intereferences amidst arid, semi-arid and malnad regions of south-western Karnataka is scanty. Moreover, intensity of all these problems occurred during different seasons in this part of the state is fragmentary. There is a lacuna of information on such type of studies in this region; therefore, present investigation was undertaken.

II. MATERIALS AND METHODS

Field observations were conducted by employing direct visual count method (DVCM) and an all out search method (AOSM) to record the impact of predators to *A. dorsata* colonies during 2011 and 2012. Farmers, residents and people at different sampling place located amidst arid, semi-arid and malnad regions were met personally by visiting these places periodically and collected the information with the help of pre-tested questionnaire. In each sampling place, minimum three to maximum four study sites were earmarked randomly by selecting trees hosted with *A. dorsata* colonies at road side, agri-horticultural ecosystems and man-made structures in residential areas. Altogether, 27 visits were made to record the prevalence of predators at the vicinity of *A. dorsata* colonies during rainy, winter and summer seasons separately. Different length (i.e., minimum 100 meter to one kilometer) variable width (i.e., minimum 10 meter to 100 meters) line transects (VWLT's) were earmarked on roads to record incidences of predators including other natural enemies to *A. dorsata* colonies by traveling in a car at a speed of 20 kilometers per hour. In some places especially at residential areas and agri-horticultural ecosystems an AOSM was adopted, where there was uneven distribution of trees and man-made structures with *A. dorsata* colonies. Per cent predatory interference occurred at *A. dorsata* nested sites are calculated by using standard formula as follows. Per cent Animal Predator's Interference (PAPI) = Incidence of predator's interference at/in *A. dorsata* colonies/combs x 100 / Total number of *Apis dorsata* nest sites observed. Predatory insects were identified as per Abrol (2003) and Nagaraja and Rajagopal (2011) and with the help of books and monographs as per Carpenter and Kojima (1997), Gullan and Cranston (2005). Moreover, predatory birds were identified with the help of information given by Ali (1941) and Grimmett et al. (2011). Further, predatory mammals were identified as per Menon (2014). Affected solitary colonies, colony aggregates and abandoned combs were photographed with the help of Canon-power Shot S21S, 8.0 Mega Pixels Digital Camera with 12X optical zooms. Collected data was complied and analyzed by using analysis of variance (ANOVA) and Pearson's correlations with the help of digital images and MS-EXCEL and SPSS software (ver 14.0, Chicago Inc., USA).

III. RESULTS

Distribution of predatory animals, their order, common and scientific name and number of incidences recorded at *A. dorsata* normal colonies in arid, semi-arid and malnad regions of south-western Karantaka are represented in Table 4.2. Total, 13 species, which belong to three groups namely insects, birds and mammals. Amongst insects, only the giant wasp (*Vespa cincta*) incidence was common, predated on A. dorsata colonies at different regions of south-western Karnataka (Table 4.2). Birds belong to the order Coraciformes, Columbiformes, Passeriformes and Accipitriformes showed predatory behaviour on A. dorsata population. The Coraciformes members such as *Merops orientalis* and *M. persicus* (Family: Meropidae) and *Ocyceros birostris* (Family: Bucerotidae) have attempted to predate colony members of *A. dorsata*. Moreover, the Passeriformes such as *Dicrurus adsimilis* (Family: Dicruridae), *Acridotheres tristis* and *A. fuscus* (Family: Sturnidae), *Muscicapa para* (Family: Musicapidae) and *Corvus culminatus* (Family: Corvidae) have also shown predatory activity on *A. dorsata* colonies. The *Columba livia* (Columbiformes: Columbidae) and *Pernis ptylorhynchos* (Accipitriformes: Accipitridae) became trouble shooters to *A. dorsata* population (Table 2). Interestingly, mammals namely Funambulus palmarum (Rodentia: Sciuridae) and Pteropus giganteus (Chiroptera: Pteropdidae) have shown their predatory activity on the hive of *A. dorsata* (Table 4.2). However, the analysis of variance didn't showed significant variation (F=2.396; P>0.05) existed between different predators interferences and there was no significant variation (F=2.341; P>0.05) existed between arid, semi-arid and malnad regions and the incidences of predation by different animals (Table 2). Notwithstanding to this activity, Pearson's correlation between the incidence of predators (e.g. insects, birds, mammals) and *A. dorsata* colony abandonment indicated positive correlation (Table 4.2). In general, the interference was more (20%) by the Pteropus giganteus and it was followed by *A. tristis, V. cincta* and *M. orientalis* respectively 15, 11 and 9% (Fig. 1). The *D. adsimilis, C. livia* and *A. fuscus* have shown normal (7% each) predatory activity on *A. dorsata* colonies (Fig. 2). The *P. ptylorhynchos* and *M. para* intereferences was only 6% each. Both *F. palmarum and M. persicus* become trouble some to A. dorsata colonies 5% each. However, *O. birostris and C. culminutus* intereferences was very less (1% each) (Fig. 2). Overall, the predatory activity by the insects, birds and mammals to *A. dorsata* colonies at arid, semi-arid and malnad regions is shown in Figure 3. Interestingly, the predator's interference was almost same at arid and semi-arid regions and in malnad region it was 21%.

IV. DISCUSSION

Honeybees form a considerable part of the diet for several species of insects, birds and mammals. *A. dorsata* colonies both at natural and man-made ecosystems are disturbed by various insects (e.g. *G. mellonella* and *V. cincta*) (Basavarajappa et al., 2009; Nagaraja and Rajagopal, 2011), birds (e.g. *M. orientalis, M. persicus, O. birostris, D. adsimilis, A. fuscus, A. fuscus, M. para, C. livia C. culminates and P. ptylorhynchos*) and mammals (e.g. *F. palmarum* and *P. giganteus*) at different regions of south-western Karnataka. These animals predatory behaviour has caused considerable damage to *A. dorsata* population at arid, semi-arid and malnad regions. Predators have attracted to *A. dorsata* colonies due to their giant sized hive from which they offered sweet and energy rich high-value organic materials namely honey, brood and pollen for their nutrition (*Hepburn and Radloff*, 2011).

Nagaraja and Rajagopal (2011) have reported around 40 species of birds, known to prey on honeybees at different geographical regions. During the present study, bee eaters namely *M. orientalis* and *M. persicus* are fond of capturing foraging worker bees and rarely attack on *A. dorsata* colonies. They capture forager bees regularly and after that swish their beaks back and forth against a tree limb so as to remove the sting i.e., 'bee-rubbing' then engulf. The *Drango, D. adsimilis* is an opportunistic predator, predated on flying worker bees of *A. dorsata*. Similar type of observations were made by Ambrose (1978), Thapa and Wongsiri (2003). Further, flocks of M. orientalis were reported to launch coordinated attacks on *A. dorsata* colonies at low ambient temperatures when the worker bee's activity is less (Kastberger and Sharma, 2000; Thapa et al., 2000). Since, bee eaters and Drango beaks are adapted to catch bees easily during flight, dislodge the sting and remove the poison sac from the body of worker bees (Ambrose, 1990). The oriental honey Buzzard, P. ptilorhyncus attacked the nest and snatched the brood and honey. Sometimes, P. ptilorhyncus attack in pair, mislead the defending worker honeybees before attacking the combs. Thapa and Wongsiri (2003) have reported similar type of observations. In this way, several bird species become troublesome to A. dorsata population by stealing their brood, stored hive products (e.g. honey and pollen) and forager bees as well. Such troublesome activities might have perhaps weakened the A. dorsata colony integrity and gradually initiate the process of colony desertification.

Since, A. dorsata nests in an open arboreal conditions (Seeley et al., 1982), easily victimized by predators such as wasps (Kastberger et al., 2008 and 2010), insect pests (Basavarajappa et al., 2009; Viraktamath et al., 2005), birds (Seeley et al., 1982; Kastberger and Sharma, 2000) and mammals. Certain mammals (e.g. *F. palmarum*) feed on hive products (e.g. *Honey and beeswax*) (Basavarajappa et al., 2009) and few mammals (e.g. *P. giganteus*) interfered with the normal activities of *A. dorsata* population. Similarly, bird's frequent movement around A. dorsata colonies might develop a nuisance to nest mates in the colony. Since, predation develops a kind of physical and physiological stress and develops restlessness among the colony members. Concomitant to it, there was a positive correlation existed between the predator's intereferences with the normal colonies nesting by *A. dorsata*. Frequent appearance of predators at/or into the colonies would interfere with the normal working efficiency of foraging bees. It could alter the efficiency of nectar/pollen collection of foragers and may curtail the foraging activity. Further, hundreds of foragers become victimized to predators *like M. orientalis, D. adsimilis, P. ptilorhyncus* and thus contributing considerably to the process of colony decline and desertification. Further, periodic attacks by various bird species and intereferences of few arboreal mammals have developed continuous shimmering activity among the colony members and created considerable amount of stress. This has generated the repetitive social waves with anti-predatory impact among colony members (Weihmann et al., 2012; Kastberger et al., 2010). Despite this anti-predatory behaviour, individual foragers unable to overcome by the periodic attack of wasps, bird species and become prone to death. Seeley et al. (1982) have reported the similar type of intereferences from predators on *A. florea* colonies in Thailand. Similar types of observations were reported by Caron (1978), Novogrodzki (1990), Basavarajappa (1998), Thapa et al. (2000), Oldroyd and Wongsiri (2006), Nagaraja and Rajagopal (and 2011) and others. Thus, our observations are on par with the published earlier reports.

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Table 1. Animal predator's interference to *Apis dorsata* colonies studied by various researchers

Sl. No.	Research on predators intereferences on *Apis dorsata*	Place / Country	Reference
1.	Colony defense strategies of honeybees in Thailand.	Thailand	Seeley *et al*., 1982
2.	The predator-prey interaction between blue-bearded bee eaters (*Nyctornis athertoni* Jardine and Selby 1830) and giant honeybees (*Apis dorsata* Fabricius, 1798).	Assam, India	Kastberger and Sharma, 2000
3.	Flying predators of the giant honeybees, *Apis dorsata* and *Apis laboriosa* in Nepal.	Nepal	Thapa and Wongsiri, 2003
4.	Enemies of honeybees and their management – A Review.	-	Gulati and Kaushik, 2004
5.	Biology and seasonal incidence of the braconid wasp, *Apantales Galleriae* and its parasitization of greater wax moth, *Galleria mellonella*.	Dharwad, India	Viraktamath *et al*., 2005
5.	Asian honeybees: Biology, Conservation and Human Interactions.	-	Oldroyd and Wongsiri, 2006
7.	Social waves in Giant honeybees Repel Hornets.	Nepal, India	Kastberger *et al*., 2008
8.	Bees and Beekeeping in India.	Punjab, India	Abrol, 2009
9.	Complex social waves of giant honeybees provoked by dummy wasp support the special-agent hypothesis.	-	Kastberger *et al*., 2009
10.	Honeybees, Diseases, Parasites, Pest, Predators and their management.	Bangalore, India	Nagaraja and Rajagopal, 2009
11.	Special agents trigger social waves in giant honeybees.	Assam, India	Schmelzer and Kastberger, 2009
12.	Training for Defense? From Stochastic traits to synchrony in giant honeybees (*Apis dorsata*).	Nepal, India	Weihmann *et al*., 2012

Table 2. Predators of *Apis dorsata* normal colonies at arid, semi-arid and malnad regions of south-western Karnataka

Animal Group	Animal predators							No. of incidences recorded at different regions			Total	'F' value
	Sl. No.	Order	Sl. No.	Family	Sl. No.	Common Name	Scientific Name	Arid	Semi-arid	Malnad		
Insect	1.	Hymenoptera	1.	Vespidae	1.	Giant Wasp	*Vespa cincta*	44	84	45	173	**2.396****
Birds	2.	Coraciformes	2.	Meropidae	2.	Green Bee eater	*Merops orientalis*	55	72	21	148	
					3.	Blue cheeked Bee eater	*Merops persicus*	12	66	0	78	
			3.	Bucerotidae	4.	Grey hornbill	*Ocyceros birostris*	0	09	06	15	
	3.	Columbiformes	4.	Columbidae	5.	Blue rock pigeon	*Columba livia*	78	31	05	114	
	4.	Passeriformes	5.	Dicruridae	6.	Black Drango	*Dicrurus adsimilis*	44	45	27	116	
			6.	Sturnidae	7.	Common Myna	*Acridotheres tristis*	79	96	57	232	
					8.	Jungle Myna	*Acridotheres fuscus*	79	18	16	113	
			7.	Musicapidae	9.	Fly Catcher	*Muscicapa para*	43	14	36	93	
			8.	Corvidae	10.	Jungle Crow	*Corvus culminatus*	31	42	22	95	
	5.	Accipitriformes	9.	Accipitridae	13.	Honey Buzzard	*Pernis ptilorhyncus*	07	03	02	12	
Mammals	6.	Rodentia	10.	Sciuridae	14.	Squirrel	*Funambulus palmarum*	40	34	06	80	
	7.	Chiroptera	11.	Pteropdidae	15.	Flying Fox	*Pteropus giganteus*	126	101	84	311	
Total								**638**	**615**	**327**	**1580**	-
'r' value								**0.915**	**0.845**	**0.947**	-	
'F' value								**2.341****			-	

Note: Each value is a mean of 18 observations. ** Not Significant.
'r' is Pearson's correlation value.

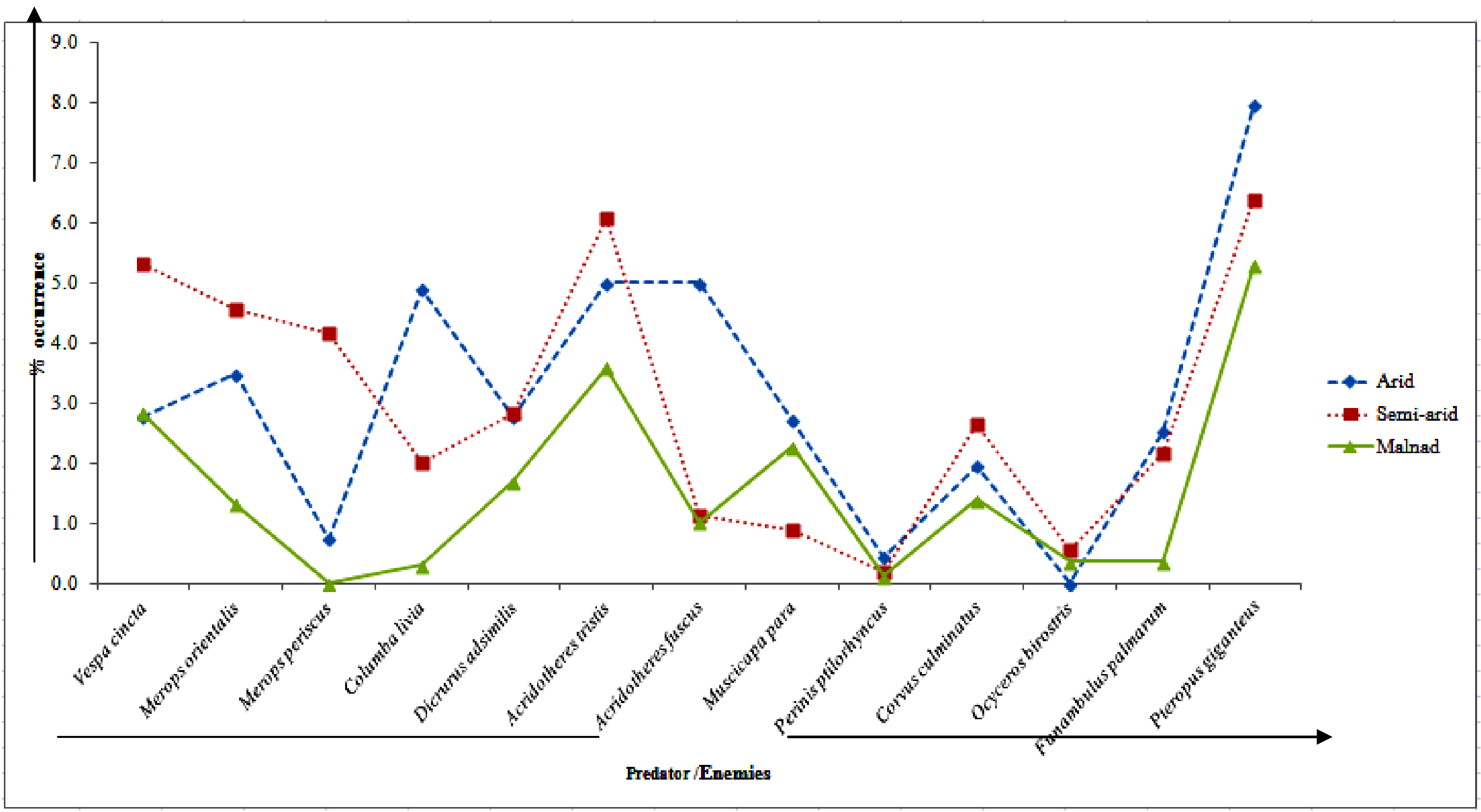

Fig. 1. Per cent occurrence of predators of *Apis dorsata* colonies at different regions of south-western Karnataka

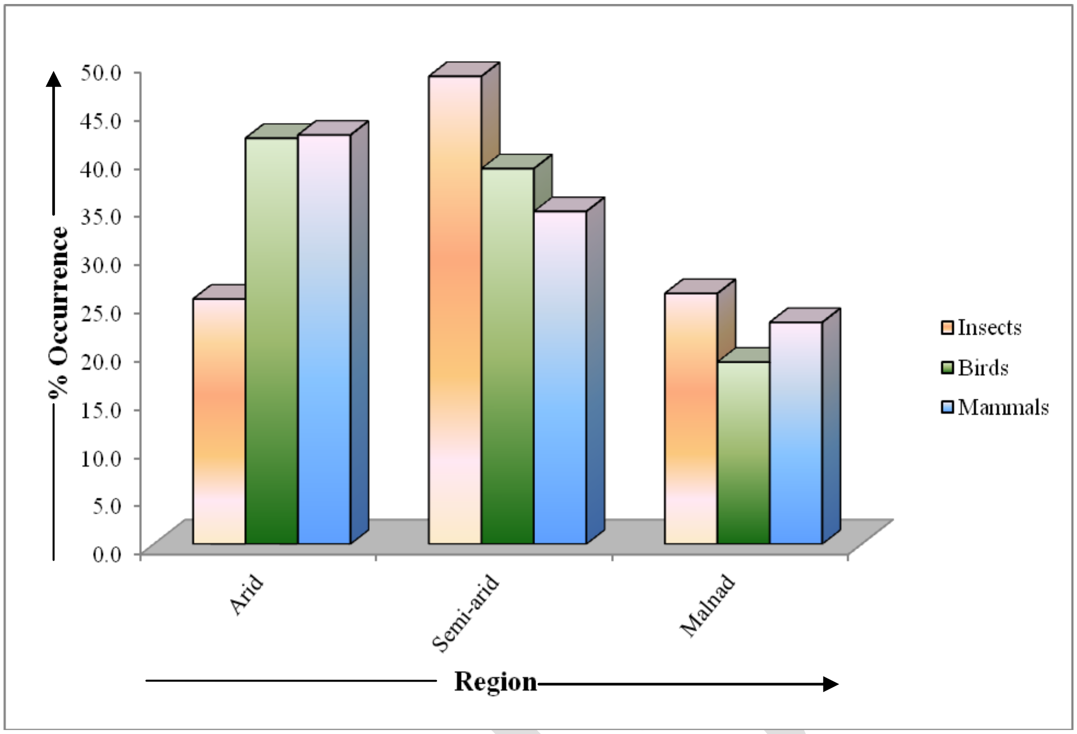

Fig. 2. Per cent occurrence of different groups of predators to *Apis dorsata* colonies at south-western Karnataka

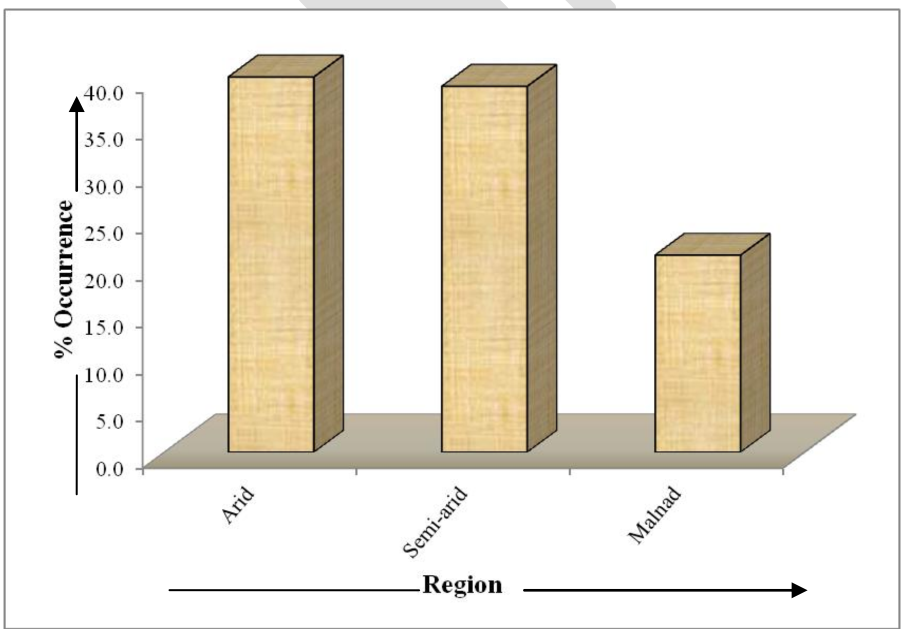

Fig. 3. Per cent occurrence of predators to *Apis dorsata* colonies at different regions of south-western Karnataka