Dipterans of economic importance on veterinary animals

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From biblical times man has suffered from the insects damage to crops, livestock and himself. Over a thousand species of insects, mites and ticks are reported to occur on animals worldwide but only a few are of economic importance on domestic livestock and poultry. Damage by insect pests on livestock is a major threat to health and productivity in animals. Though mortality occurs due to insect’s damage, the major manifestations are reduction in weight gain, increased susceptibility to infectious diseases and decreased productivity. These point out that veterinarian should not limit their interest to livestock production but should also concentrate on health care consequent to insects. In addition to causing direct damage, arthropods also act as vectors for disease like Trypanosomiasis, Theileriosis, Babesiosis and Anaplasmosis.

Among the insect orders that are of economic importance in livestock sector, the Dipterans are of concern. Over 20000 species of Dipterans are catalogued, only a small fraction of this are of veterinary importance, as they impact animal health by causing direct damage and serve as vector. The flies invade the wound, soars and body orifices of animals and cause myiasis that is an impediment in livestock production. The blood feeding insects affect productivity of livestock by causing exsanguination and anemia. Behavioural disturbance in animals caused due to feeding by biting flies interfere with feed consumption and efficiency of conversion to milk. The non-biting flies may not cause pain to livestock but annoyance caused by flies impact animal production. The order Diptera is divided into the sub orders Nematocera, and Brachycera.

Nematocera

In the sub order Nematocera, Ceratopogonidae, Simulidae and Psychodidae are families of economic importance to livestock. In Ceratopogonidae the genus Culicoides commonly called biting midges are of importance. Their mouthparts are adapted for piercing and sucking. They feed on blood from their host and rest with their wings closed over each other. There are over 1400 species of Culicoides and over 90 per cent of them are obligate bloodsuckers. Sixty-three species have been reported to be distributed throughout India. The flies are active in the late afternoon and early morning. Occurrence of these flies is higher near water bodies, damp places
near decaying vegetation (Narladkar et al., 2003). Occasionally swarms of this insect are observed in the evenings emitting a characteristic humming sound. In India, populations of *Culicoides* spikes during August and dip during March. The breeding season coincides with the monsoon. In addition to causing direct damage they also transmit diseases like blue tongue virus. Not all *Culicoides* species feeding on ruminants are vectors. The vector capacity is related to host preference, feeding rates, gonotrophic cycle and vector longevity (Prasad and Bhatnagar, 2000).

*Culicoides* are effectively managed adopting cultural practices like covering pools, stagnant waters, marshy areas and dung heaps (Narladkar et al., 2006). Proper hygiene and sanitation of animal sheds will aid to keep the vector population at a low level. As light trap attract both sexes and they could be effectively used for monitoring and managing the flies. Forecasting vector outbreaks by developing a model will be of immense use in controlling the blue tongue virus. The efficacy of bioagents like *Metarhizium anisopliae* on *Culicoides* was reported by Ansari et al., (2011).

**Brachycera**

The suborder Brachycera has 14 families of which Tabanidae is of veterinary importance. The four common genera in this family are *Tabanus* (Horse flies), *Haemotopota* (Clegs), *Chrysops* (deer flies) and *Pangonia*. Brachyceran antennae has annulations, presence / absence of spur, wing venation and brilliant coloration of the eyes. Tabanids are large (9-33mm) robust, with well-developed eyes. Males feed on nectar from flowers and females are bloodsuckers on large animals like horses, cattle, mules, camels, deer, elephants, tigers and occasionally time humans.

Tabanids lay their eggs in masses on vegetation overhanging water. The first instar moult on emergence and the second instar larvae does not feed. The third instar larvae are negatively phototropic and burrows into the substrate. They are carnivores and feed on small crustaceans and musquito larvae. The female on emergence mates before taking a blood meal. The whole life cycle is completed in 4 -5 months under favourable conditions.

Tabanid flies are facultative haematophagus ectoparasites of veterinary and medical importance (Fig.1). They are serious pests of horses, cattles, buffaloes, mules, ponies, camels, Indian elephants and carnivores like tigers, dogs and hyaenas. Among the carnivores, tigers are more susceptible to *surra* disease (Acharjyo,2000). Tabanids transmit more than 35 diseases of cattle and humans including *surra* or trypanosomiasis in India (Basu *et al*., 1952).
Hematophagous species of these families are pestiferous and vectors of viral, bacterial, protozoan and filarial diseases of man and livestock. Occurrence of *Trypanosomiasis* is high during monsoon, the higher load of flies cause severe mortality in animals.

Managing the tabanids is difficult as females spend only four minutes feeding on a host. Considering their complex life cycle where a section of the biostage of the tabanids is independent of livestock, it’s essential to adopt integrated methods for management. Area wide control met with limited success due to quick mobility of the insects. Preventing movement of cattle from the sheds during bright sunshine hours of the day during peak fly season (Narladkar and Patil, 2012). Placing Manning trap, Malaise trap, Manitoba trap baited with carbon dioxide is effective in attracting flies. Application of pyrethroids and use of ear tags impregnated with cyhalothrin causes mortality of tabanid flies. The breeding areas of tabanids can be destroyed by application of kerosene over water bodies as it impacts tabanids skimming over water. Fly proof nets in animal houses prevent the entry of flies (Narladkar and Patil, 2012).

The section Calyptrate under suborder Brachycera includes both biting and non-biting flies. Muscidae is the second largest of the calyptrate with about 4000 species. It includes non-biting *Musca* and biting *Stomoxys, Haematobia, Haematobosca* and *Stygeromyia*. In addition to *Musca domestica*, the important species distributed in tropical and subtropical countries are *M. vivina, M. nebulot* and *M. sorbens* (Greenberg, 1973). Those species that occur commonly in bazars and houses in India are *M. vicina, M. nebulot, M. yerburyi, M. sorbens* and *M. vetustissima*. They coexist with humans in their dwellings and are active during the summer and rainy seasons. The flies that live in close association with humans are termed *synanthropi* and those associated with cattle are called *synbovine*.

Most species of *Musca* are oviparous, of which *M. autumnalis, M. gibsoni* and *M. pattoni* lay eggs with a long pedicel. *M. bezzi, M. convexifrons, M. greeni* and *M. lusoria* are larviparous and they deposit their larvae on their host. *M. domestica* feed and oviposit on decomposing and rotting organic matter, an act by which they encounter excreta, carcasses and garbage after which they contaminate the food of humans (Fig.2) (Greenberg, 1973).

In addition to aiding in mechanical transmission of disease, they cause annoyance to livestock, poultry and humans. *Musca* spreads diseases like mastitis, conjunctivitis and anthrax. The facefly, *M. autumnalis* feeds on secretions from eyes, nose and mouth and on wounds caused by biting flies and transmit bovine kerato conjunctivitis (Krafsur and Moon, 1997).
Inadequate hygiene is the cause for incidence of flies. Reduction of larval habitats by removal of debris and elimination of breeding sites is essential for managing fly populations. Placing the pheromone cis-9-tricosane, oviposition attractants coupled with fermenting proteins attract flies. Insecticides used as spray, granules, or ear tags cause reduction in fly population. Insect Growth Regulators (IGR) inhibit the formation of new cuticle in fly larvae and interferes with chitin deposition that prevents shedding of old skin in adult flies.

The stable fly/biting fly/dog fly, *Stomoxys calcitrans* feeds on warm blooded animals by inflicting painful bites and acts as a vector for protozoal and helminth diseases of animals (Fig.3). Severe damage by this insect causes a reduction in milk production to the tune of 40 – 60 %. The females scatter eggs on contaminated straw and the females require several blood meals to complete their ovarian development. The efficacy of the insecticides and repellents used to contain the stable flies are short lived. While applying the toxicants care is to be taken to apply it thoroughly over the coat and on the lower extremities where the stable flies feed.

As no single control method is effective, the use of vector management strategies is recommended for the control of stable flies. Sanitation in livestock farms reduces stable fly populations. Decomposing vegetative material or manure, old manure under fences, and poorly drained areas are breeding sites of larvae. Elimination of breeding sites brings down stable fly population.

Pupal parasitoids in the family Pteromalidae (Hymenoptera) such as *Spalangia* spp. have a high potential for the biological control of stable flies (Kovgard and Steenberg, 2002, Brikemoe et al., 2009). The parasitoid wasps lay their eggs in immature stable flies. The resulting wasp offspring feed on the stable fly maggot or pupa and eventually kill it.

Traps have been used for monitoring and management of fly populations (Heath, 2002, Taylor and Berkebile, 2006). Olfactory stimuli such as carbon dioxide, ammonia, and phenylpropanoid compounds attract the stable flies (Gibson and Torr, 1999). ATSB (Attractive Toxic Sugar Bait) method attract and kill the flies (Beier et al., 2012).

**Chrysomelidae**

The Oriental latrine fly, *Chrysomya megacephala* is a common blowflies in India (Fig.4) and Egypt (Gabre 1994). It is a dipteran vector of enteric pathogen Greenberg (1973) and helminth parasite eggs (Sulaiman et al., 1989). On the positive side, *C. megacephala* is an
important pollinator of mango in Australia (Anderson et al., 1982) and India (Hu et al., 1995). *C. megacephala* develop on catfish, toads, frogs, lizards and pigeons (Roy and Dasgupta, 1971).

**Sarcophagidae**

Flesh flies Sarcophagidae are distributed throughout the world. The Sarcophaginae includes four Indian genera; *Sarcophaga*, *Sarcophila*, *Agrio* and *Wholfartia*. The species of *Sarcophaga* commonly encountered in India are *S. ruficornis*, *S. dux*, *S. carnaris* and *S. haemorrhoidalis*. They breed on flesh and carcasses of small and large animals. They deposit their larvae in the wounds of humans and animals. These flies are medium to large sized and grey or black in color with chequered abdomen (Fig.5). The sexes are differentiated by eyes and are larviparous. The adults are harmless, while the larvae cause cutaneous myasis in humans and animals.

**Oestridae**

The bot flies belonging to Oestridae are obligate myiasis causing parasites. *Oestrus ovis*, commonly called sheep nasal fly, attacks sheep and goat. It is a major pest on sheep in India. The flies are more prevalent in summer and hide in crevices and corners of walls. Adult flies are long and dark grey color and larviparous depositing larvae around the nostrils of sheep and goat. The female fly ejects a fluid containing larval mass near the nostrils. The larvae crawl upto the central sinus and at times up to the base of the horns. The mature larvae are expelled through violent sneezing by sheep. The flies cause annoyance to the sheep resulting in the cessation of feeding. These flies are managed by oral administration of ivermectin @30 mg/kg body weight of the animal.

**Hippoboscidae**

The flies belonging to Hippoboscidae are called louse flies. The flies have a flat body and leathery integumentation. The legs are short and armed with claws which are markedly adapted for a parasitic life. They live on the blood of mammals and birds. These flies are pupiparous as the females lay larvae that are ready to pupate. The genera of veterinary importance are *Hippobosca*, *Melophagus*, *Pseudolynchia* and *Lipoptena*. The flies congregate near the hind leg and cause irritation to animal while feeding. Heavily infested animals show emaciation and anemia. They transmit non pathogenic *Trypanosoma theileri* and mechanical carrier of anthrax in horses and *Hemoproteus* in birds. They are managed by application of permethrin, deltamethrin and repellents.
CONCLUSION

In India, the knowledge generated on dipterans of economic importance on livestock and fisheries is limited to veterinary and fisheries institutes. Collaboration between entomologists, veterinary and fisheries scientists can synergize attempts to device management strategies of Dipterans on veterinary animals.

Insecticides are widely used in the management of Dipterans, the indiscriminate use of chemical pesticides lead to undesirable side effects to animals, producer, consumer and bystanders. The traditional knowledge is to be exploited developing safer alternatives that are clean and green technologies so as to overcome the ill effects caused by use of insecticides.

Dipteran pest on veterinary animals need not be viewed as a menace alone. They could be exploited for the benefits they provide. Currently 10 percent of global fish production goes to fishmeal to be used in aquaculture. Insects can effectively replace this as they are an alternate source of protein for aquaculture and livestock. The search for alternative and sustainable protein proves that insects are an attractive feed option.

With the knowledge on spatio-temporal distribution of the Dipterans that are a vectors, forecasting models are to be developed to contain the occurrence of disease spread by managing the vectors. The ethology of the dipterans can further be exploited to develop robust chemo ecological methods to manage the flies.

The information furnished in the review will stimulate more research on the management of Dipetrans of veterinary importance.

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Fig. 1 Tabanids feeding on bullock

Fig. 2 Adult of *Musca domestica*

Fig. 3 – Adult of *Stomoxys calcitrans*
Fig. 4. Adult fly – *Chrysomya megacephala*

Fig. 5 – Adult of *Sarcophaga* sp.