Behavioural processes relevant to management of vertebrate pests (mammals and birds) of agriculture

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ABSTRACT. *Behavioural processes relevant to management of vertebrate pests (mammals and birds) of agriculture.-* With changes in landscape use consequent to expanding agriculture in India many species of mammals and birds are becoming serious pests although rodents continue to cause maximum damage. Weaver birds, parakeets, babblers, munias, doves, sparrows, pheasants, pigeons, rosy pastor, and crows are serious pests on cereals, oil palm, oil seeds, vegetables and orchards. Elephants, wild boar, jackals, monkeys and bats sporadically cause significant losses to crops. The present paper will highlight ethological approaches to management of these pests, management of birds by killing is not done due to ethical, aesthetic, ecological and legal reasons. Use of chemicals is limited to scaring or inducing food aversion learning. The lecture will elaborate types of distress calls emitted, factors which affect the application of bioacoustics namely repellency, habituation and regional dialects followed by field application and efficacy. Types of visual scarers such as reflector ribbons, biovisual ones like simulated eye balls, kites, predators, and human effigies which involve stimuli derived from other species, will be reviewed. Intraspecific stimuli such as alarm postures will be evaluated. Since no single method is satisfactory, an integrated approach including auditory and visual scarers, habitat management and cultivation of bird resistant strains will be emphasized. Since rodents can be effectively controlled only by poisoning which involves ingestion of baits, feeding behaviour and factors affecting food selection will be emphasized as they lead to formulation of attractive baits for mixing poisons. Behavioural adaptations of rodents to avoid/escape from traps and poisoning such as neophobia, bait shyness, transmission of food preferences and aversion learning will be dealt with. Since pheromones play an important role in feeding, acquiring food preferences. trappability, act as phagostimulants, attenuate both neophobia and bait shyness, induce behavioural stress, delay maturity, and reduce fertility leading to lower rates of reproduction, their role in rodent control will be briefly mentioned.

KEY WORDS. Management, Pests, Birds, Mammals

Introduction

Many vertebrates specially birds and mammals conflict with human interest throughout the world necessitating strategies for managing their numbers. Prior to planning techniques for their control it is vital to understand why some species become pests. Consequent to changes in landscape use due to intensive and expanding agriculture, introduction of exotic crops and continuous cropping throughout the world, the life and habits of several species of aves and mammals are affected. The shrinkage in their habitat and reduction or elimination of their

food sources forces such animals to seek out new pastures. The uniform habitat, continuous and abundant supply of nutritious food in cultivated fields not only attracts such displaced animals but also draws other grainivore and frugivore animals which prefer the agricultural lands for their food rather than search in the wild. When their feeding destroys significant amount of agricultural produce it become necessary to manage their numbers. However when vertebrate pests are to be controlled, the techniques should be selected and applied with discrimination and humanity, should be ecologically compatible and should not damage the environment. Nevertheless control of conventional pests which seriously affect agriculture and pose health hazards such as rodents continue to require lethal methods to reduce numbers. With this background the paper deals with non lethal, behaviour based methods of bird management advocating mainly vocal and visual scarers in the first phase and outlines behavioural manipulation of rodents to make chemical killing more effective in the second phase.

Birds pest management

Broadly bird damage can be prevented by (1) *Reducing pest number* (2) *Agronomic practices* and (3) *Physical protection.*

1. *Reducing pest number* can be achieved by shooting, trapping, use of lethal chemicals and by fertility control. *Shooting* is banned in many counties while *trapping* is laborious, time consuming and costly. More often only juveniles are trapped which are anyway excluded from feeding points by dominant males and are already at the risk of dying. *Lethal control* has to be justified on moral and ecological grounds i.e. animals killed should be the ones actually causing damage. Most of the time pest birds is seldom successful with population

exhibiting rapid responses to reduction measures, poison affecting non target species and chemical killing being inhuman both in terms of mode and time taken to death. Additionally pollution of environment is to be considered.

Fertility control is perceived as being more humane and morally acceptable since it acts by reducing birth rates than increasing mortality rates. Since chemosterilants are either non toxic or lowly toxic, hazards to non target species and secondary poisoning are almost nil. Chemicals capable of rendering target birds sterile for desired lengths of time render the method flexible for population manipulation. However the snag lies in lack of satisfactory delivery systems, low levels of acceptability of oral contraceptives, lack of information on breeding systems and behaviour of sterilized birds, safety and side effects of the chemosterilants.

2. *Agronomic changes.* A great deal of bird depredation can be minimized or prevented by changes in cultural practices based on bird behaviour.

(a) Food preferences of the birds: many species of birds exhibit clear preference towards certain varieties of crops which could be physical or chemical characteristics of foods or its color or taste. Instead of such attractive if non preferred cultivars are grown damages can be prevented.

Both physical characteristics and chemical constituents of cereals influence selection of food by birds. Sorghum varieties with pendant heads, with large grains, loose heads with long and tight glumes or dark brown seeds and corn varieties with tight husk are reported to deter bird attack. Indigenous chemicals mainly tannins repel birds. However growing of such unattractive cultivars can prevent bird damage if alternatively sources of food exist. Such varieties may not be palatable to humans and livestock. Thus growing crops with indigenous repellents can be effective only in conjunction with other protective measures (Stone & Hood, 1979).

(b) *Cultural practices* include planting of crops to coincide with the availability of neutral foods preferred by birds, changing dates of planting and harvesting, planting seeds deeper in the soil, growing maize instead of small sized cereals etc prevent bird depredation.

(c) *Habitat management* is based on the principle of removing attractants from the field or luring birds away by providing diversion or sacrifice planting. By netting, by denying access to parches, water and by removing roosting sites the farmland can be rendered less attractive.

3. *Physical protection* can be achieved by netting, caging, repellents and scarers.

(i) *Netting* has limited applications as in the case of orchards with dwarf varieties, crops of breeding experiments while (ii) *Caging* is not practical.

(iii) *Repellents* can be *area repellents, contact repellents* or *chemical frightening agents*.

(a) Area repellents include naphthalens, dichlorobenzene and camphor which produce an aversive response to olfactory or taste stimuli without actual ingestion.

(b) Contact repellents have to be ingested and are based on conditioned taste aversion. Carbamates specially methiocarb induce aversion when sprayed on a variety or crops across wide geographical areas.

(c) Chemical frightening agents when ingested by a small proportion of birds in a social group utter distress cries and exhibit erratic movements. This deters the other members of the flock from feeding. Experimental evidence suggests that the birds do not feel any pain although their behaviour appears unpleasant. The repellency of a chemical can be enhanced by the addition of color or other obvious sensory cues. This enables the birds to detect the presence of chemical quickly, easily and at low concentrations.

(iv) *Scarers* deter birds by providing frightening stimuli mainly auditory and visual stimuli.

(a) Auditory scarers repel birds by inducing pain, fear, communication jam, disorientation, audiogenic seizures, internal thermal effects alarm or distress.

Since pain induction is inhuman it is not available while fear can be generated by mechanical, electrical and explosive devices. Although deterring effects are short lived best results can be obtained by presenting sound at random intervals, using wide range of sounds, moving the source of sound frequently, reinforcing sound with distress calls/visual scarers/shouting.

Dispersal calls can be effectively used to repel birds from crop fields and are called *Biosonic* or *Bioacoustics*. These are of two types: *Feeding calls* to attract conspecifics to food source and *warning calls* which are of two subtypes namely *Alarm calls* emitted in response to presence of predator or an unknown sudden stimulus and *Distress calls* when bird experiences discomfort and pain.

Distress call becomes an attractant when it is a cry for help or warning to other birds when it becomes repellent. Or it can startle the predator to loosen its grip. Dispersal calls repel birds from diverse habitats such as airports, fish farms, grassland, crop fields and dumps. In some case the distress call to be effective has to be reinforced with a visual scarer like owl (Conover & Perito, 1981) or cannon (Moerbeck et al., 1987). Although birds are claimed to respond to only calls of same species and sometimes only to those from the same geographical region (Marler, 1955), alarm calls of different species did show similarities. However distress calls did not have transpecific effects but birds were shown to be capable of learning to respond to distress calls of other races and species (Johnsgardd, 1972).

Habituation to distress calls occurs but at a slower rate compared to other sounds. Habituation can be delayed by changing the location of speaker regularly, alternating different calls, by mixing calls with inanimate sounds, or with raptor calls (Johnson et al., 1985), by using good quality recording and broadcasting apparatus, reinforcing calls with visual, acoustic or real danger (Inglis,

1980), by rendering the source of call easily detectable by birds (Slater, 1980) and finally creating super stimulus (Bremond, 1980). The super stimulus can be obtained first by identifying the critical parameters of the call which acts as the deterrent and later enhancing this signal. Bremond (1980) suggested that the effectiveness of the calls can be increased by increasing the frequency duration, intensity, harshness and by alternating distress and alarm calls. Recently Nicholls (1990) has described the creation of super normal versions of alarm and dispersal calls with computer sound processing. According to him computer software tools aids in quick analysis of calls, rapid and accurate editing and the computer can generate variations of a call very fast with the result birds can be continuously exposed to ever different calls stalling habituation.

(b) visual scarers are of two types based on novelty and alarm reactions of birds to predators.

Novelty based visual scarers: A bird's response to novel objects is either approach and exploration or fleeing. The behaviour is explained by arguing that birds build up a mental picture of their environment which conditions them to expect specific things in specific locations in their surroundings. If they suddenly encounter something different they become suspicious. The degree of difference between the expected and change determines whether a bird flees from or explores a strange object. A small difference leads to exploration and a large one causes avoidance (Sokolov, 1963; Bember & Earl, 1957). Scarers based on novelty have visual patterns and bright colors. These include flags, windmills, reflector ribbons, balloons, eye spot balloons and kites suspended in air. However birds rapidly learn to ignore such harmless scarers. To be effective the scarer should be an uncommon one and the rate of acquisition of information about it should be slow. This can be achieved by using them as infrequently as possible, using a variety of scarers, removing

ineffective scarers immediately, randomly shifting its position and by changing the timing of its exposure (Inglis, 1980).

A second line of approach to diminish habituation to visual scarers is based on avoidance conditioning. here the first stimulus namely the sight of a scarer is made to become a warning signal for the subsequent aversive stimulus mostly an auditory one like shouting or exploders with the result the bird learns to avoid the latter as soon as the warning stimulus i.e. the visual scarer is perceived.

Biovisual scarers are based on natural stimuli similar to those evoked during a pest bird's encounter with a predator. habituation to such devices is slower because of prey bird's genetically built in tendency to respond to cues associated with the presence of predators. Two types of biovisual scarers are in existence namely *interspecific* and *intraspecific* scarers. Interspecific models derive stimuli from a specific predator whereas intraspecific devices incorporate warning signals of pest species emitted on sighting a predator.

Interspecific devices include raptor models incorporating cues involved in predator recognition such as body outline and mode of flight while hunting. Although a biovisual scarer possessing super normal stimulus can elicit above normal aversive effects, experiments in this direction have proved unsuccessful. This failure may due to lack of research or super stimulus is not included in the inherent mechanism of predator recognition (Inglis, 1980).

Once an appropriated visual scarer is identified and fabricated, the nest step is to retard habituation. One way to achieved this is by eliciting mobbing response which is known to enhance fear of the scarer (Curio, 1978). Mobbing can be induced by designing predator models holding a prey model/tethered prey model accompanied by periodic playback of mobbing calls. The efficacy of a scarer can be enhanced by using inconspicuous supports

and rendering scarers movable by wind/mechanical/electrical means (Conover, 1970).

Human effigies or scare crows are not very effective as they fail to mimic the models accurately. However of late models of a three-dimensional human effigy with periodically moving out stretched arms (Inglis, 1980) and an inflated human effigy placed on a three-whell cart and drawn in fields and orchards have been found effective (Achiron, 196). Simple stimuli like eye spots or a person moving leisurely towards the flock of feeding birds moving his outstretched arms up and down induce flight in birds (Blest, 1957; Markgren, 1960). From time immemorial women labourer in India are hired to scare birds by walking leisurely in the fields, shouting and pelting stones at vulnerable stages of crop throughout the day. More recently Vickey & Summers (1992) found employing full time a person with a motorcycle in conjunction with alternate feeding sites could give a cost effective and practical means of alleviating Brent geese damage to winter crops in Britain. It appears the stimuli from a person engaged n a field is the best deterrent for bird pests.

Intraspecific devices can either mimic corpse or unnatural body postures of conspecifics or normal signals.

Pigeon decoys with open wings, wood pigeon models with open wings or only a pair of pigeon wings are successful examples of utilizing unnatural body postures to deter bird attacks on crops (Murton, 1970; Hunter, 1974). Further work demonstrated that simply a pair of wood pigeon wing decoys with enhanced wing marks using white paint was effective eliminating the use of whole body or life like models (Inglis & Issacson, 1978). The vital requirements was identifying the appropriate sign stimulus to incorporate in the decoys.

Hunched, roosting postures if blue herons (Krebs, 1974) and head up postures of geese are examples of decoys using normal intraspecific signals and convey absence of high density of food in the fields (Drent & Swierstra, 1977). Similarly decoys of Brent geese depicting alarmed preflight postures with body angled upwards, next extending vertically and the beak pointing slightly upwards were effective in preventing birds landing in cereal fields (Inglis & Issacson, 1978).

Rodent control

Rodents are not only serious pests of agriculture, food storage, processing and serving industry but also transmit several hundreds of potentially fatal diseases to man and other mammals. They are such adaptive and intelligent animals that centuries of control attempts including poisons, traps, repellents, chemosterilants, bounties, predators, parasites and exclusion measures have not made a dent in their numbers and colonization of newer habitats -natural or man made. Although environmental factors play a critical role in their survival and success against control measures, several aspects of rodent behaviour both innate and learnt enables them to evade traps and poison baits. The following are some such behavioural processes:

(a) *Neophilia or active seeking of novelty*: The rat's urge to move in its home range even in the absence of internal and external stimuli termed 'Stimulus hunger' or 'Curiosity drive' by Barnett (1975) is exhibited both in favourable conditions and unfavourable ones. This compulsive exploratory behaviour enables the rat to learn about potential food sources, new objects in familiar environment, pheromonal markings and predator odors thus aiding in its survival.

(b) *Neophobia*: Although highly exploratory wild rats do not always respond to novelty by approach because exploration and curiosity will lead them to traps and poison baits. As an adaptation to

escape from such dangers rats have evolved a behaviour which is opposite to neophilia and which sometimes completely inhibits it. This behaviour involves avoidance of unfamiliar objects including heaps of nutritious food in their usual path (Shorten, 1954). The behaviour termed Neophobia may be elicited even by placing a familiar object in a new position. Neophobia is exhibited by several species of wild rodents across the world (Cowan, 1977; Sridhara, 1977; Advani & Prakash, 1979; Mathur & Prakash, 1980). Very little is known about the senses involved. Probably olfactory, visual and tactile path are involved. The behaviour has to be taken into consideration while trapping and poisoning. To be successful both operations need prebaiting for 3-4 days as the phenomenon was found to be temporary with habituation taking place in a few hours to few days. Drugs such as chlorpromazine (Mitchel et al., 1977; Sridhara, 1987), pentabarbitol (McGee et al., 1981) and conspecific urine have been shown to mitigate neophobia (Idris & Prakash, 1992).

(c) *Bait shyness*: Initial avoidance of new foods is followed by a tendency to sample due to temporary decline in curiosity or decrease in fear followed by a period of non feeding (Rzoska, 1953). If the ingested food contains poison further eating is stopped. On recovery from sublethal doses of rodenticide the animal learns to correlate the physiological illness experienced with the food ingested and avoids the poison bait on subsequent days. This behavioural adaptation is called bait shyness and is shown to extent to all components of the poison bait namely cereal, oil and poison. This behaviour is exhibited towards most of the acute rodenticides. Bait shy rodents continue to reject rodenticide associated baits for varying lengths of time from 10 days to 170 days (Prakash & Mathur, 1984). Suggestions to overcome bait shyness include employing a new bait-poison mixture, offering a choice of aversive food and poison in an inexperienced bait, fumigation of burrows of bait

shy rodents (Sridhara, 1983a, b), using a texturally different bait (Bharadwaj & Khan, 1979), adding 0.4% conspecific urine to poison bait (Prakash, 1985) and including a toxin flavour mimic in the prebait (Robbins, 1980).

(d) *Food preferences and bait formulations*: In spite of the tendency to sample all foods encountered/provided, rodents exhibit marked preference for some baits, slight preference for the others and they even prefer more favourable of the two or most preferable among several baits (Barnett & Spencer, 1953; Barnett, 1956). It is therefore essential that poison be mixed in the most preferred food/bait so that it is consumed in adequate quantities to cause death. Wild rodents are sensitive and discriminative about odors and tastes hence baits have to be formulated after thoroughly studying their food preferences. Even the texture i.e. whole, cracked or flour form influences bait choice. Additives like sweet from molasses, sugar, corn syrup and 3-10% vegetable oil enhance bait acceptance. Although addition of odoriferous attractants to baits have great potential, only raspberry essence to lure rabbits and volatile oils from unpolished rice to enhance food intake and mitigate bait shyness in the Philippine rice rat have been successful (Rowley, 1960; Bullard & Schumake, 1977).

(e) *Acquisition and transmission of food preferences*: The success of rodents as omnivores may be largely due to social transmission of information about foods, their palatability, location, acquisition and processing. Hence much research is focused on social learning of food preferences in rats. New born rodents are nursed up to 4-5 weeks but the litter start to take solid food in the third week. Many behaviour patterns are established by this time including neophobia. However evidence on how food preferences are acquired, how variable they are and mode of their modification are still to be understood completely. The evidence for food imprinting in birds in beyond doubt but in rodents a

few studies failed to detect effect of early ingested foods (KrishnaKumari, 1973; Bronson, 1966) and later workers demonstrated such influences (Capretta & Rawls, 1974; Porter & Etscorn, 1974; Galef, 1977; Sridhara, 1978). In 1977 Galef postulated that food preferences in rats are acquired through mother's milk and socially. The gustatory cues present in the mother's milk influences and help the pups to identify and prefer such foods when they become adults. Residual olfactory cues left at the feeding site by mothers aid in food selection and thirdly pups learn to feed on maternal food by the simple process of imitation. Leon et al. (1977) demonstrated that the maternal pheromone present in the caecotrophe excreted following parturition is qualitatively influenced by mother's diet and facilitates identification and selection of such food for pups. Foods experienced between 4-6 days after birth resulted in preference towards such foods in adult life in *Mus booduga* (Sridhara, 1983c). Later studies have shown that when faced with a choice among several novel foods, naive rats choose novel foods eaten by conspecifics with whom they had interacted previously (Galef & Wigmore, 1983). These effects were shown to be mediated through volatile cues present in the breath of interacting rats. The cue was identified as a combination of smell of the food and an endogenous odor, carbondisulphide (Galef & Stein, 1985; Galef et al., 1988). Addition of 0.1-10 ppm carbondisulphide to food enhanced food intake, increased entries into bait stations and time spent in them as well as increased exploration of traps and tracking powders (Galef et al., 1988). The chemical has also been shown to interfere with acquisition of bait shyness (Mason et al., 1988).

In a separate line of investigation Posadas-Andrews & Roper (1983) demonstrated that exposure of a rat to the smell of food, increased preference for that food similar to acquisition of preferences for foods eaten by conspecifics (demonstrators) with which the experimental rats (observers) interacted earlier. They attributed diet related odours carried on the fur or breath of demonstrators to be responsible for development of preference for demonstrator's food by the observer rats. According to them exposure to the odours of a diet and exposure to a demonstrator that have eaten a diet produced the same effect on the diet preferences of observers. This view was contradicted by Galef (1990) who found that eating a food and interacting with a demonstrator that had eaten that food were each sufficient to enhance preference for that food and eat was not necessary to consume particles of food clinging to the fur of demonstrators to achieve the same effect. Because rats exposed to demonstrators without any physical contact still exhibited enhanced liking for the diet of demonstrators. He emphasizes that is socially acquired food preferences, eating a diet, smelling a diet and interacting with a demonstrator that has eaten a food can have markedly different effects on later preference for that diet. The cues left by the excretory deposits of mature female conspecifics (Galef & Heiber, 1976), olfactory and excretory cues left by male conspecifics at the feeding site (Galef & Beck, 1985; Laland & Plotkin, 1990) are thought to be involved in the transmission of information about food preferences. Whether such acquired feeding behaviours can become fixed in wild populations is an interesting question. Laland & Plotkin (1990) suggest that when social learning is extended into repeated transmission episodes the information is likely to spread through a population. Employing retrieval of buried carrots as a form of social learning the authors generated evidence that social learning and transmission occurs in Norway rats in laboratory experiments. They argued that though it is premature to claim fixation of a novel behavioural pattern based on tests on unearthing buried carrots within a population, there is a good possibility of diffusion of certain patterns of behaviour including food preference acquisition amongst rat populations which need further detailed investigations. Further experiments by the same

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workers (Laland & Plotkin, 1993) showed that residual cues influencing diet preferences at the feeding site wane after 72 h, that a socially enhanced preference for one flavoured diet can be transmitted from one animal to the next along a chain but it was unstable for an alternative diet and finally socially transmitted food preferences become more stable when communication is reinforced with gustatory cues.

Regarding the role of social learning in conditioned taste aversion Galef (1989) found that interaction with conspecifics previously fed a diet can attenuate subsequent learning of an aversion to that diet. The extent of such socially mediated attenuation of aversion learning increases with a decrease in the strength of toxicosis. Thus a naive rat is protected from developing food phobia to safe, novel foods by prior interaction with conspecific that had eaten these foods. He further suggests that something more than simple latent inhibition was responsible for social attenuation of aversion learning. This naturally leads to the question as to whether naive rats will avoid foods eaten by ill conspecifics. Experiments conducted in this direction revealed that not only rats fail to avoid unfamiliar foods eaten by ill demonstrators, but increasingly prefer foods eaten by them (Galef & Wigmore, 1983; Galef et al., 1983; Grover et al., 1988; Galef, 1990). It looks as if the communication from demonstrators to observers concerning food ingested is limited to which foods to eat but not to avoid toxic foods (Galef, 1985).

(f) *Pheromones*: Although pheromone induced manipulation of behaviour plays a major role in insect pest control, very few attempts have been made to involve them in rodent pest management. This lack of endeavour to utilize pheromones in rodent control is unexplainable as they play a wide array of roles in the biology and reproduction such as detection of estrous female, castrated male, mother, litter, stressed and non stressed individuals, success/failure in detecting food, induce estrous/ovulation/aggression/abortion, inhibit estrous/ovulation/pregnancy/aggression, accelerate/decerelate sexual maturity and synchronize estrous (Dominic, 1976).

Pheromones can be involved at least at four levels to render rodent control more effective namely repellency of social odours to destabilize populations, reproductive hormones to retard and/inhibit breeding, using sex attractants to lure them to bait points and finally maternal pheromones to break the mother-young bond during the critical periods of growth.

Scent marking in the owner's territory is known to inhibit strangers from establishing themselves in beavers (Muller-Schwarze & Heckman, 1980), hamsters (Johnston, 1974) and mice (Desjardins et al., 1973). Similarly fighting is reported to be mediated by certain testosterone related anogenital substances (Fass et al., 1981). Aggression is also elicited by pheromones originating from preputial glands (Christiansen, 1976). Using synthesized pheromones of this nature aggressive behaviours can be enhanced leading to unstable populations susceptible to diseases and other mortality risks.

Pheromones involved in reproduction such as those originating from male and affecting female maturity, estrous, implantation, though yet to be proved in wild populations, not that they do not occur simply because no one has ventured into the line, hold great promise in fertility control of rodent pests.

Pheromones specially sex attractants are useful in poisoning and can be used to lure rodents to poison baits, to overcome neophobia and bait shyness. Several experiments have shown that extracts of preputial glands of both sexes (Gawienowski et al., 1975; 1976), vaginal secretions of female golden hamsters (Singer et al., 1976), body odours of male (Gawienowski, 1977; Gawienowski et al., 1975; 1976), urine of female Indian gerbil (Idris & Prakash, 1983), urine of both sexes of rats (Price, 1977) are attractive to opposite

sexes. This could be a fruitful line of investigation for rodent control not only to attract rodents to bait points but also to overcome neophobia and bait shyness (Idris & Prakash, 1992).

Finally maternal pheromone by which female rodents maintain the cohesion of their offspring prior to weaning has been shown to be synthesized in the caecum by microbial action during the production of caecotrophe or soft faecus for reingestion (Leon, 1984). The mother, young and the nest get scented with this odour which has two important functions namely to inhibit young from straying far away from the nest and secondly to provide the litter with odour cues of foods ingested by mothers thus influencing diet selection of pups later in life. If the production of maternal pheromone is affected by an externally administered agent the mother-young bond could be broken and hence affect population numbers.

Summary

The paper presents several suggestions of behavioural manipulation to manage bird and rodent pests of agriculture. Since birds become pests because of reduction and/or destruction of their habitat and cause damage only for short periods during crop maturity it is advocated that only non lethal methods be employed to prevent damage. Emphasis is laid on deterring birds from fields by using repellent auditory and visual stimuli. The efficacy of two types of bird calls employed for repelling namely alarm and distress calls is elaborated followed by suggestions to overcome the problem of habituation. The merits of novelty based and biovisual scarers are discussed with more importance being attached to the latter type where a variety of raptor models including human effigies and pre flight alarm postures of pest birds which have been shown to repel birds from a variety of cropping systems.

Rodents on the other hand being conventional pests albeit highly intelligent and adaptive have been evading traps and poisons from centuries. Their control by oral, poison ingestive methods can be made more effective by manipulating their behaviour by several ways. Their neophilic behaviour i.e. active seeking of novelty can be exploited for luring them to new baits while neophobia, their genetically acquired suspicion of novel stimuli protects them from blind urge of exploration. To overcome this two to three days of prebaiting with non poisonous food is advocated. Similarly the attenuation of the learnt, behavioural adaptation of bait shyness wherein rats surviving from sub lethal doses of rodenticides learn to avoid subsequent ingestion of poison/poison associated foods has been elaborated. Since rodent control is by oral chemical ingestion factors influencing feeding behaviour namely food preferences and social transmission of food preference acquisition in rats are discussed. Finally the potential of pheromones in disrupting populations, reproduction, mother-young bond and potential of sex attractants from urine, vagina to lure the pests to baits, to overcome neophobia and bait shyness are projected.

The review thus highlights how both harmful and attractive stimuli derived from outside the organism, from other species and conspecifics can be effectively utilized to non lethal management of bird pests and effective poisoning of rodent pests.

Resumen

Procesos comportamentales relacionados con el manejo de plagas (mamíferos y aves) de la agricultura.

El artículo presenta algunas sugerencias de

manipulación del comportamiento para el manejo de plagas agrícolas causadas por aves y roedores. Ya que las aves llegan a ser plagas debido a la reducción y/o destrucción de su habitat y causan daños solamente durante los cortos periodos de maduración de la cosecha, se ha propuesto que se empleen únicamente métodos no letales para impedir el daño. Se hace enfasis en el uso de repelentes auditivos y estímulos visuales para disuadir a las aves de que permanezcan en los campos. Se explica detalladamente la eficacia de dos tipos de llamadas de aves, empleadas para la disuasión, como son la de alarma y de peligro continuándose con sugerencias para superar el problema de la habituación. Se discuten las ventajas de la novedad y de los sistemas biovisuales para asustar, dándole mayor importancia a estos últimos, de los que con varios modelos de depredadores, incluyendo figuras humanas y posturas de alarma de prevuelo de aves, se ha demostrado que las asustan en diversos sistemas de cultivo.

Los roedores, por otra parte, han sido considerados convencionalmente como plagas, no obstante, altamente inteligentes y con capacidad de adaptación, han estado eludiendo las trampas y venenos durante siglos. Su control por métodos de ingestión de veneno vía oral, se puede hacer mas efectivo manipulando su comportamiento de distintas formas. Su comportamiento neofílico, es decir, búsqueda activa de la novedad, se puede explotar atrayéndolos a nuevos cebos, mientras que la neofobia, su sospecha genéticamente adquirida ante estímulos nuevos, les proteje de su impulso ciego a explorar. Para superar esto, se recomienda precebar dos o tres días con alimento no envenenado. De igual forma, se ha analizado la atenuación de lo aprendido, adaptación comportamental de asustarse ante el cebo, mediante la cual las ratas que sobreviven a dosis subletales de rodenticidas, aprenden a evitar la subsecuente ingestión de veneno o alimentos asociados a éste. Dado que el control de roedores se lleva a cabo mediante la ingestión oral de productos químicos, se discuten los factores que influencian el comportamiento alimentario, como las preferencias alimenticias y la transmisión social de adquisición de estas preferencias en ratas. Finalmente, se resalta, para evitar la neofobia y el miedo al cebo, el potencial de las feromonas para trastornar las poblaciones, la reproducción, y el vínculo madre-hijo y el potencial, como atractor sexual, de la orina y la vagina para atraerlos a los cebos.

La revisión así, destaca cómo ambos estímulos, el nocivo y el atrayente, provenientes de fuera del organísmo, de otras especies y de coespecíficos, pueden ser utilizados con efectividad para un manejo no letal de plagas de aves y un envenenamiento efectivo de plagas de roedores.

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