continued to catch larger grain borer for as long as 12 weeks. In a more fully replicated trial in Honduras, Novillo (1991) found that trap catches were significantly higher during the first week of exposure but declined steadily for the next four weeks. No data appears to have been published on the range of concentrations of the two pheromones which are attractive to the larger grain borer. It seems at least conceivable that concentrations in the first days of exposure, or immediately next to the lure may be higher than optimal for attracting the beetle.

Three studies have been carried out involving the liberation and recapture of marked insects, with similar results. Rees *et al.* (1990), working in Yucatan, reported recaptures up to 250m from the release point (data presented verbally to meeting, not in abstract); Farrell (1990) reported recaptures at a distance of 340m in central Mexico and Novillo (1991) reported a maximum distance of 300m. Farrell concluded that *P. truncatus* can fly 20m directly upwind to a pheromone source and with some directional trend up to 50m; at greater distances initial flight was not perceptibly directional. In the latter two studies, most recaptures were made within 24hrs, with sharply fewer at 48 and 72hrs, and none thereafter. Farrell (1990) reported an average recapture rate of 2% and Novillo (1991) less than 1%. In Novillo's study, a considerable proportion of insects 'liberated' did not take flight and of those that did 5% were recaptured. Farrell used larger grain borer sifted from cultures on maize for the studies, while Novillo captured the insects in flight traps for re-release (having found that insects from laboratory cultures did not fly readily - personal communication).

The issue of what part of the total larger grain borer population responds to the aggregation pheromone, and under what circumstances, clearly needs to be investigated in more detail. The pheromone-baited traps were initially intended to detect low-density infestations in stores, with greater efficiency than direct inspection of grain (Hodges *et al.*, 1983b & 1984). However, there is increasing circumstantial evidence that larger grain borer infesting maize do not readily leave the grain in response to the pheromone; this might be due either to competition between natural and artificial pheromone sources or simply to the infesting population not being in a receptive physiological state. Certainly traps near to heavily infested stores appear to catch lower numbers of insects than those at a distance (Novillo, 1991; Ríos, 1991). Moreover, as noted in relation to distribution of the pest (above), the presence or abundance of larger grain borer in flight traps is not necessarily correlated with outbreaks in nearby stores (Herrera *et al.*, 1991; Ramírez *et* *al.*, 1991) and, similarly, captures of larger grain borer in traps placed in and around maize fields do not necessarily imply field infestation of that maize (Novillo, 1991).

It seems conceivable that traps placed within stores are not actually detecting infestations within stores, but rather trapping dispersing insects from the general environment. Preliminary laboratory olfactometer studies have investigated responses to the aggregation pheromone in terms of age, sex and previous mating experience (Obeng-Ofori & Coaker, 1990); reduced response was noted with habituation, though it is not clear how this observation would relate to the field situation. Controlled studies to investigate pheromone production and responses need to be greatly extended and corresponding field data collected. The practical implications of these results would be considerable since they will determine whether or not traps can be used to detect infestation in stores or in consignments of traded grain for subsequent selective treatment.

CONTROL METHODS

Synthetic pesticides

The early literature on testing of pesticides against larger grain borer was reviewed in some detail by Hodges (1986). At that stage the superior performance of synthetic pyrethroids against this pest had already been identified (Golob *et al.*, 1985), but only permethrin had been tested in a field trial. Subsequent studies confirmed the effectiveness of several pyrethroids (Makundi, 1986), especially deltamethrin and permethrin, though it was also apparent that permethrin gave only poor control of other major storage pests (Golob, 1988a). Application of dusts to cobs was largely ineffective though adequate control was achieved by spraying an emulsifiable concentrate on dehusked cobs, so long as the initial *P. truncatus* infestation was low (Golob & Hanks, 1990). As a result, the basic recommendation for the large-scale *P. truncatus* control campaign in Tanzania involved shelling the grain, storing it in bags or other closed containers and treating with a binary 'cocktail' consisting of 0.3% permethrin and 1.6% pirimiphos methyl, applied at 100g per 90kg bag (Golob, 1988a).

Various treatments and combinations of pyrethroids and organo-phosphorus compounds were also tested in Togo (Biliwa, 1988a & b). On shelled grain, pre-infested with *P. truncatus* and stored in sacks in a warehouse, a combination of pirimiphos methyl and deltamethrin (7.5 + 0.25ppm or 5 + 0.5ppm) or pirimiphos methyl and cyfluthrin (7.5 + 0.25ppm) gave good control of all insects after 11 months; trials with pre-infested cobs in granaries showed that deltamethrin (2ppm) and a mixture of fenvalerate and fenitrothion (7.5 + 37.5ppm) sprayed at 5 liters on 500kg of cobs, plus 1 liter on the structure provided adequate pest control for 10 months (von Berg & Biliwa, 1989a & 1990).

The protection of stored dried cassava has received less attention, probably because many farmers leave the roots in the ground until consumption or process it rapidly into other products. However, both dusting and dipping of roots have been tried on an experimental basis with some success. Senkondo (1984) in a laboratory study found that dipping in deltamethrin (0.5 and 1.0ppm) and dipping or dusting with permethrin (2.5ppm solution and 2ppm applied dust) gave adequate control after six months (supplementary data reported by Hodges, 1986). In Togo it was found that 1ppm deltamethrin, combined with chlorpyriphos methyl, pirimiphos methyl or fenitrothion in a dust formulation gave good control as did dipping for one minute in a solution of 0.0163% deltamethrin (Biliwa, 1988b; von Berg & Biliwa, 1989b). However, in the absence of information on the absorption of pesticides by cassava roots and the effective residue levels, these cannot be regarded as properly tested treatments, ready for field application.

The heavy reliance on only one group of pesticides, the synthetic pyrethroids, for control of larger grain borer brings with it a high risk of inducing pesticide resistance. The rapid selection of populations of larger grain borer resistant to permethrin has recently been demonstrated in the laboratory (Golob *et al.*, 1990b; Haubruge, 1990); however, there is so far no indication of this phenomenon in field populations of the pest. There are grounds for hope that the existence of considerable populations of larger grain borer outside the maize storage and production system, where the insects are unlikely to be exposed to heavy selection pressure for pyrethroid resistance, as well as the sporadic use of these products on maize stores in most of the affected countries, will delay the appearance of such resistance.

Another group of compounds which have recently been investigated for their effect on larger grain borer are the insect growth regulators diflubenzuron and trifluron, and their commercial formulations Dimilin and Alsystin (Hell, 1988; Laborius, 1990b). These products show little or no acute toxicity (to insects or mammals) but disrupt insect metamorphosis. In laboratory studies over 14 weeks diflubenzuron (5ppm) reduced *P. truncatus* populations by