Final Project Report to the NYS IPM Program, Agricultural IPM 2007-2008

Title: **Evaluation of Two Parasitoids in Dairy Calf Greenhouses**

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Abstract:

Parasitoids are a critical component of a successful dairy fly IPM program. In the first year of this three-year study we compared individual species parasitoid releases. During year 2, we compared the best individual parasitoid from Year 1 (*M. raptorellus*) to a 50:50 ratio of *M. raptor* and *M. raptorellus*. Due to record breaking rainfall in 2006, we felt it was critical to have another year of testing to fully compare and understand the differences between the two types of parasitoid releases observed in the 2006 study. In 2007 (year 3), we again compared *M. raptorellus* to a 50:50 ratio of *M. raptor* and *M. raptorellus*.

Although spot cards have traditionally been used to evaluate house fly populations over time, we observed in this study that they fell well short of meeting our expectations in greenhouses. In 2007, spot card counts rose throughout the study but in no time period did spot numbers exceed the action threshold level of 100 spots per card. Interestingly, the average spots per card in 2007 were the lowest of all three years of the study, with the highest average being 57 spots per card. In 2007, stable fly numbers on the no-release farms were higher than the parasitoid release farms during both the release and post-release periods.

On no-release farms in 2007, *M. raptor*, a native NY parasitoid, accounted for 92% successful parasitism and *M. raptorellus* accounted for 9%. On *M. raptorellus*-release farms, the released parasitoid accounted for 77% successful parasitism, while *M. raptor* accounted for 23%. On *M. raptor/M. raptorellus*-release farms, *M. raptor* accounted for 54% successful parasitism, while *M. raptorellus* accounted for 46%. None to very low parasitism was identified during the pre-release period and the first week of releases. Successful parasitism immediately increased on the six release farms but remained low on the no-release farms for the duration of the study. Successful parasitism averaged 3% on the no-release farms, 54% on *M.raptorellus* farms and 44% on *M. raptor/M. raptorellus* farms during the release period. Total parasitism averaged 15% on no-release farms, 67% on *M. raptorellus*-release farms and 53% on *M. raptor/M. raptorellus*-release farms.

Based on the results from the past three years of this study, the release of *M. raptorellus* alone resulted in generally higher overall fly mortality. When releasing *M. raptorellus* alone, not only does it costs less than half of what it would to release the 50:50 mix of *M. raptor* and M. *raptorellus,* it also results in the highest level of fly mortality of the three different parasitoid releases tested.

Background and Justification

House flies, *Musca domestica*, and stable flies, *Stomoxys calcitrans*, are two important dairy fly cattle pests in New York. House flies transmit diseases and are annoying, while stable flies inflict a painful bite causing weight loss and discomfort to animals.

Previous research has documented that calf areas, most often the calf hutches, are the greatest source of fly breeding on dairy farms. The reasons for this include; a small animal unable to crush developing fly larvae, manure and spilled grain mixing with spilled water and urine, management practices that utilize straw bedding over wood chips, and a 6 to 8 week period between animal introduction and bedding removal.

Large, plastic covered, half-hoop structures, resembling Quonset buildings are now being used for holding large numbers of calves, replacing individual calf hutches on New York dairy farms. The benefits of these buildings are numerous (easier animal handling, healthier calves, and easier cleanup), however, there is also the potential for buildup of large numbers of fly pests. Farmers can spend thousands of dollars attempting to control flies in these facilities, usually with insecticides. However, chemical control is limited as most New York house fly populations are resistant to the majority of the currently registered materials as documented on New York dairies in 1987 and again in 1999 (Scott et al. 1988, Kaufman et al. 2001, Kaufman and Rutz 2002). Several farmers have reported that pest control operators are no longer willing to apply cyfluthrin, our most recently registered compound, because of house fly resistance. Reports of control failures appear even as the EPA and the chemical industry continue to cancel dairy pesticide registrations under the FQPA.

Biological control on dairy farms relies on either naturally-occurring parasitoids or inundative releases of the parasitoid *Muscidifurax raptor*. However, a recent addition to the catalog of commercially-available parasitoids is *Muscidifurax raptorellus*. This parasitoid has the advantage of producing multiple offspring, which can become established more rapidly and may cost less. Studies in poultry facilities and cattle feedlots have documented the benefits of *M. raptorellus* releases.

Calf greenhouses are fairly new to New York and until recently we have not had the opportunity to critically evaluate the effectiveness of our dairy fly IPM program recommendations under these conditions. Our 2000 and 2001 calf greenhouse studies, funded by NYS IPM, documented for the first time the dynamics of parasitoids in these facilities. Our results showed that when *M. raptor* was released, it became the predominant species. However, following an unintentional *M. raptorellus* release, this species established itself at a low, but stable population, suggesting its potential as a biological control agent in these systems. Their success was proven in year 1 of this project, with *M. raptorellus* release farms averaged 50% successful parasitism, while *M. raptor* release farms averaged only 22% (Figure 2). Based on those findings, *M. raptorellus* releases were compared to a 50:50 ratio of *M. raptor*/*M. raptorellus* releases in 2006 (year 2). In 2006, *M.raptorellus* release farms again averaged 50% successful parasitism and the 50:50 parasitoid mix averaged 48% (Figure 4). The 2006 study was repeated in 2007.

The purpose of this 3-year study was to provide critical data to develop cost-effective recommendations for producers as to which species of parasitoid to purchase for biological fly control in their dairy calf greenhouses. Additionally, the results are also currently being presented in our extension training programs across NY and the Northeast.

Objectives
Year 1 (2003)

1. Determine the successful parasitism levels (parasitoids producing offspring) and parasitoid mortality (killed flies as a result of parasitoid attack) following releases of two *Muscidifurax* parasitoid species.
2. Observe fly population levels in facilities before, during and after parasitoid releases.

Year 2 (2006)

1. Compare releases of a 50:50 ratio of *M. raptor* and *M. raptorellus* to the parasitoid release from Obj. 1, 2003 that proved the most successful.
2. Observe fly population levels in facilities before, during and after parasitoid releases.

Year 3 (2007)

1. Compare releases of a 50:50 ratio of *M. raptor* and *M. raptorellus* to *M. raptorellus*.
2. Observe fly population levels in facilities before, during and after parasitoid releases.

Procedure

Nine dairy farms with calf greenhouses were utilized during each of the 3 years of this study. In 2003, three farms served as controls, three as *M. raptor* release farms and three as *M. raptorellus* release farms. In 2006, three farms again served as controls, three as *M. raptorellus* release farms and three as *M. raptor/M. raptorellus* release farms. One of the *M. raptor/M. raptorellus* release farms was not included in the pre-release data since they started releasing parasitoids before they agreed to be in our study. Also, one of the no release farms mistakenly started releasing a mix of *M. raptor* and *M. raptorellus* starting on 12 June 2006. Because of this, that farm was changed from a no release farm to a *M. raptor/M. raptorellus* release farm and was not included in week 2 of the pre-release data. Nine dairy farms were again used in the 2007 study. Three of these farms served as controls, three as *M. raptorellus* release farms, and three as *M. raptor/M. raptorellus* release farms.

Each farm received approximately 500 parasitoids per calf. The release rate for an individual farm was determined by averaging the numbers of calves on the farm during the two prerelease visits. Release levels (number of parasitized pupae delivered) were corrected using information on estimated percent emergence provided by the commercial insectary to achieve a more precise parasitoid release rate.

The study began on 12 June 2007. The study concluded 13 weeks later on 4 September, with final spot card and sentinel pupae bag collection on 11 September. House fly densities were monitored weekly with spot cards. Stable fly densities were monitored weekly by counting the numbers of flies on the legs of 15 animals per greenhouse. We monitored for natural parasitism for two weeks, followed by eight weeks of parasitoid releases and 3 weeks of post-release parasitism observations. The parasitoid release schedule followed the schedule recommended to producers through our extension program.

Parasitism rates were monitored weekly using the sentinel pupal bag method of Rutz and Axtell (1980). Sentinel bags (10 bags per facility; 8 X 8 cm, mesh density 5.5 squares/cm), each containing 30 live (1-2 day old) house fly pupae, were placed weekly just under the surface of bedding, under the calf water buckets, an area of high potential for fly breeding activity. Following a one-week exposure, pupae were returned to the laboratory and uneclosed flies were allowed to emerge. Uneclosed pupae were then individually gelatin capped and held for parasitoid emergence. After a minimum 30-day holding period, emerged parasitoids were enumerated and recorded. Percent successful parasitism (fly pupae producing an adult parasitoid) and percent total parasitism (fly pupae killed by parasitoid attack) were calculated. Parasitoids were purchased and distributed by Cornell personnel by shaking the parasitized pupae from a container just inside the calf pen along the length of the active calf areas. Sub-samples of releases were held and checked for emergence and parasitoid purity levels.

House fly populations were monitored using spot cards (7.5 x 12.5 cm white index cards) placed on 10 rafters down the center of the calf facility (2-3 m above the ground). Spot cards were replaced weekly and the numbers of spots (fecal and regurgitation spots) on 50% of the card were counted. Stable fly populations were monitored weekly by counting the numbers of flies on four lower legs of 15 standing calves per farm.

Release Farms – Farmers at the release farms were provided constructive feedback regarding fly breeding areas and instructed on the proper manure management guidelines to be followed. These included pouring waste water outside the building, removal of dead animals, bedding properly (gravel, wood chips, or saw dust) and using a nozzle on the end of the watering hose, to name a few. Actions not taken by the farmer were documented (i.e. improper disposal of water, etc.) to better explain variation in adult fly populations among farms. Insecticide applications were used only as a last resort and actions taken were recorded.

Control farms – Fly management actions taken by farmers were recorded. This included the uses of any insecticides, cultural/mechanical controls such as manure management tactics and sticky fly tapes. Releases of parasitoids were not allowed on these farms.

Results

Average house fly densities (as indicated by spot card counts) are presented in Figure 7 for the pre-release, release and post-release periods. The spot card results from 2003 and 2006 are also shown for comparison purposes. In 2007, spot card counts rose throughout the study but in no time period did spot numbers exceed the action threshold level of 100 spots per card. Interestingly, the average spots per card in 2007 were the lowest of all three years of this study, with the highest average being 57 spots per card. Although spot cards have traditionally been used to evaluate changes in house fly populations over time, we observed in this study that they did not perform well in greenhouses. The success of spot cards in a greenhouse setting is not reliable due to number of confounding factors.

As an alternative, we walked up and down a greenhouse aisle holding a sticky ribbon. That too, was unsuccessful in giving us a reliable fly monitoring tool. The flies were disturbed by the person walking, but were able to avoid getting caught on the sticky ribbon. Also, testimonials from participating farmers did not always give the same results as the spot cards indicated. One farm in particular did not show fly control by use of spot cards, but the farmer was most pleased with the amount of fly control the parasitoids were providing. A better fly monitoring method needs to be developed for use specifically in calf greenhouses.

In 2007, stable fly numbers on the no-release farms were higher than any other release farms during the release and post-release periods (Figure 8). Stable fly numbers were also highest during the release period for all farms. Stable fly adults are difficult to control at point sources because their breeding areas are often found not only across the farm, but also in the non-farm environment. One of the *M. raptorellus* release farms is not included in the stable fly counts due to an unusually large outbreak of stable flies whose origin could not be determined. There was some stable fly breeding in this greenhouse itself, but the location of the farm makes it an ideal location for flies moving in on storm fronts. There are also many other barns and feed bunkers at this farm that could have been contributing to the large number of stable flies in their greenhouse.

We placed 5,200 sentinel pupae on the nine farms during the pre-release period, 20,600 during the release period and 7,600 during the post-release period. Given such large numbers of pupae, we have not been able as of yet to identify all of the parasitoids. For the purpose of this report, single emerged parasitoids are assumed to be *M. raptor* and any double or more emerged parasitoids are assumed to be *M. raptorellus*.

Successful parasitism in 2007 during the pre-release and release period are presented in Figure 6. None to very low parasitism was identified during the pre-release period and the first week of releases. Successful parasitism immediately increased on the six release farms and remained low on the no-release farms for the duration of the release period. Figures 1 and 2 are from 2003 and Figures 3 and 4 are from 2006 and are shown for comparison purposes.

On no-release farms in 2006 and 2007, *M. raptor*, a native NY parasitoid, accounted for 95% successful parasitism and *M. raptorellus* accounted for 5% (Figure 9). On *M. raptorellus*-release farms, the released parasitoid accounted for 84% successful parasitism, while *M. raptor* accounted for 16%. On *M. raptor*/*M. raptorellus*-release farms, *M. raptor* accounted for 53% successful parasitism, while *M. raptorellus* accounted for 47% of pupae that produced a live parasitoid.

When looking at only the release period, successful parasitism for 2007 averaged 3% on the no-release farms, 54% on *M. raptorellus* farms and 44% on *M. raptor*/*M.raptorellus* farms (Table 1). The *M. raptorellus* release farms consistently show the highest percent successful parasitism over the three years at 51%, 63%, and 54% for 2003, 2006 and 2007, respectively.

Release Period			
Year	Treatment	% Total Parasitism	% Successful Parasitism
2003	*M. raptor* release	37	21
	M.raptorellus Release	65	51
	No Release	10	4
2006	*M.raptor/M.raptorellus* Release	76	57
	M.raptorellus Release	78	63
	No Release	18	5
2007	*M.raptor/M.raptorellus* Release	69	44
	M.raptorellus Release	84	54
	No Release	12	3

Table 1. Percent total and percent successful parasitism during the release period for each year of the three-year study.

Total parasitism in the 2007 study averaged 15% on no-release farms, 67% on *M. raptorellus*-release farms and 53% on *M. raptor*/*M.raptorellus*-release farms (Figure 5). These season long data indicate that the parasitoids were killing from 60-84% of the flies from the calf bedding areas on *M. raptorellus*-release farms and 46-69% of the flies from *M.raptor*/*M.raptorellus* release farms (Figure 5).

In conclusion, based on the results from 2006, *M. raptorellus* and the 50:50 mix of *M. raptor and M. raptorellus* provided similar fly mortality, but *M. raptorellus* in 2007 consistently provided increased fly mortality, particularly during the release period. A colony of *M. raptor* and a colony of *M. raptorellus* costs the same, but when considering the difference in total cost, parasitoid biology must be considered. *M. raptorellus* is a gregarious parasitoid producing approximately 4 adult parasitoids per pupa, while *M. raptor* is a solitary parasitoid, producing only one parasitoid per parasitized pupa. To release the *M. raptorellus*, it costs less than half of what it would to release the 50:50 mix and it provided the highest level of fly mortality of the three different parasitoid releases tested over three years of this study.

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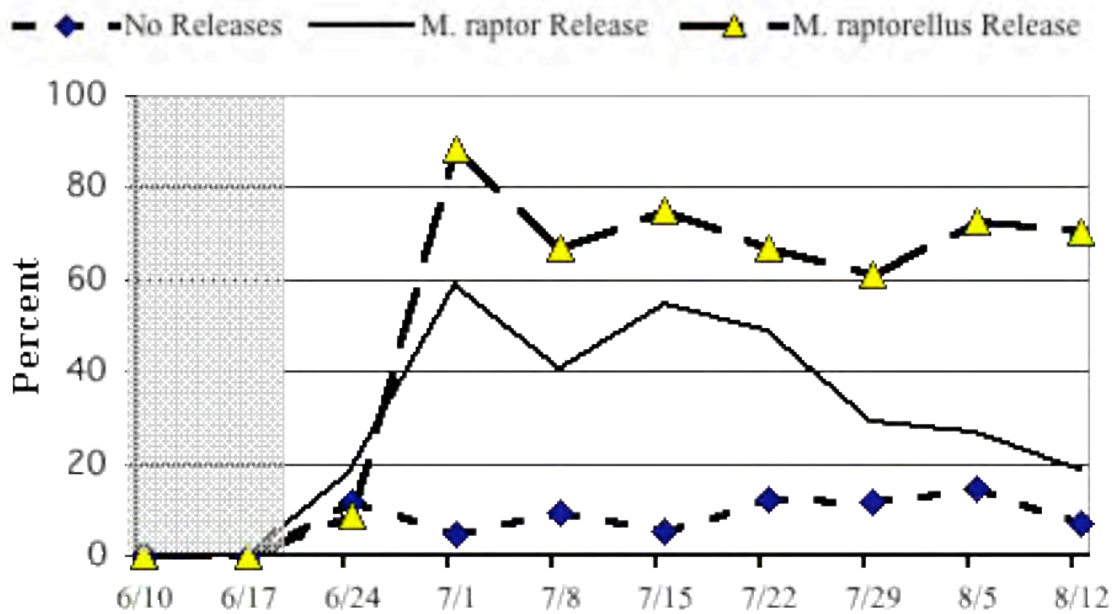

Figure 1. Total parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2003. Pre-release period identified by the shaded area.

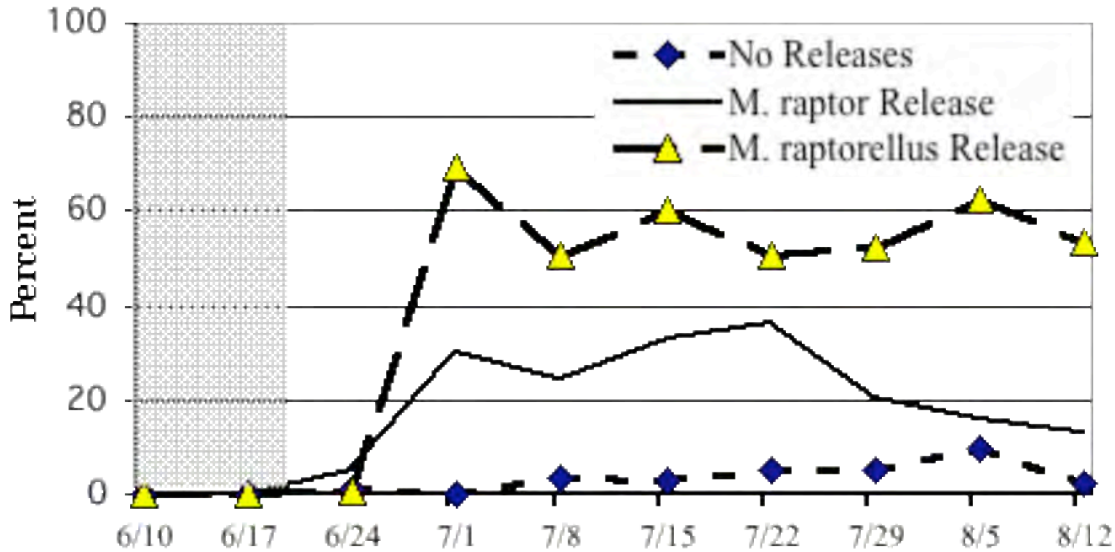

Figure 2. Successful parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2003. Pre-release period identified by the shaded area.

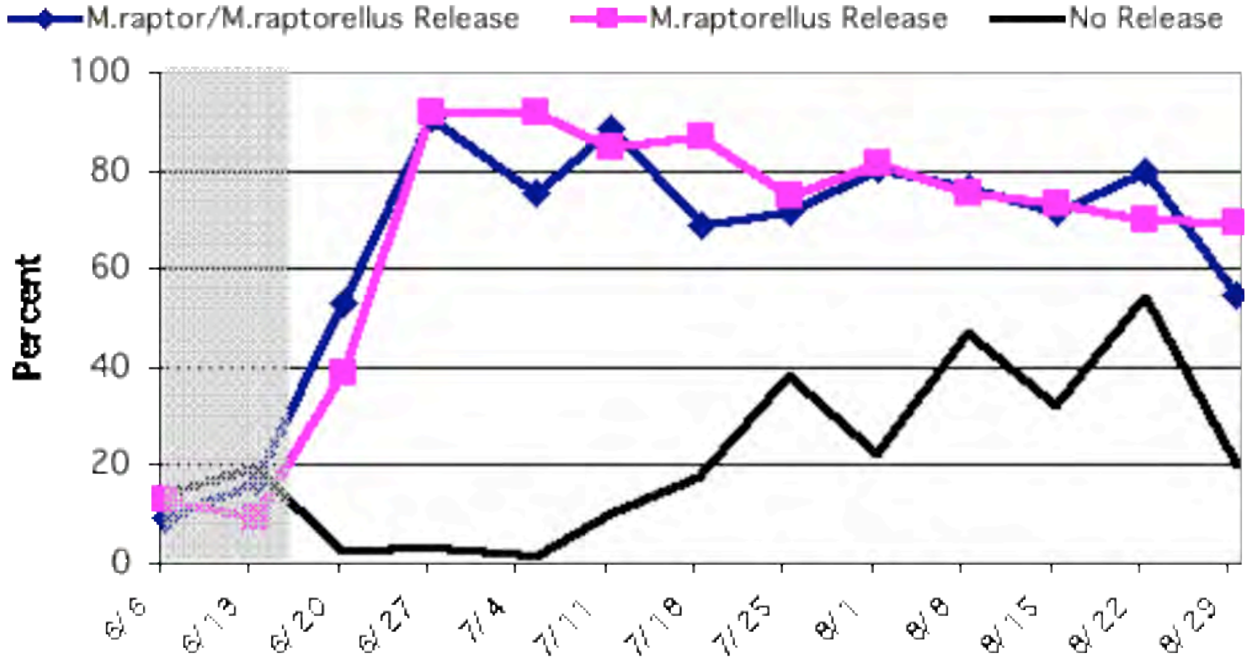

Figure 3. Total parasitism from sentinel bags at nine New York dairies under three parasitoid release programs in 2006. Pre-release period identified by the shaded area.

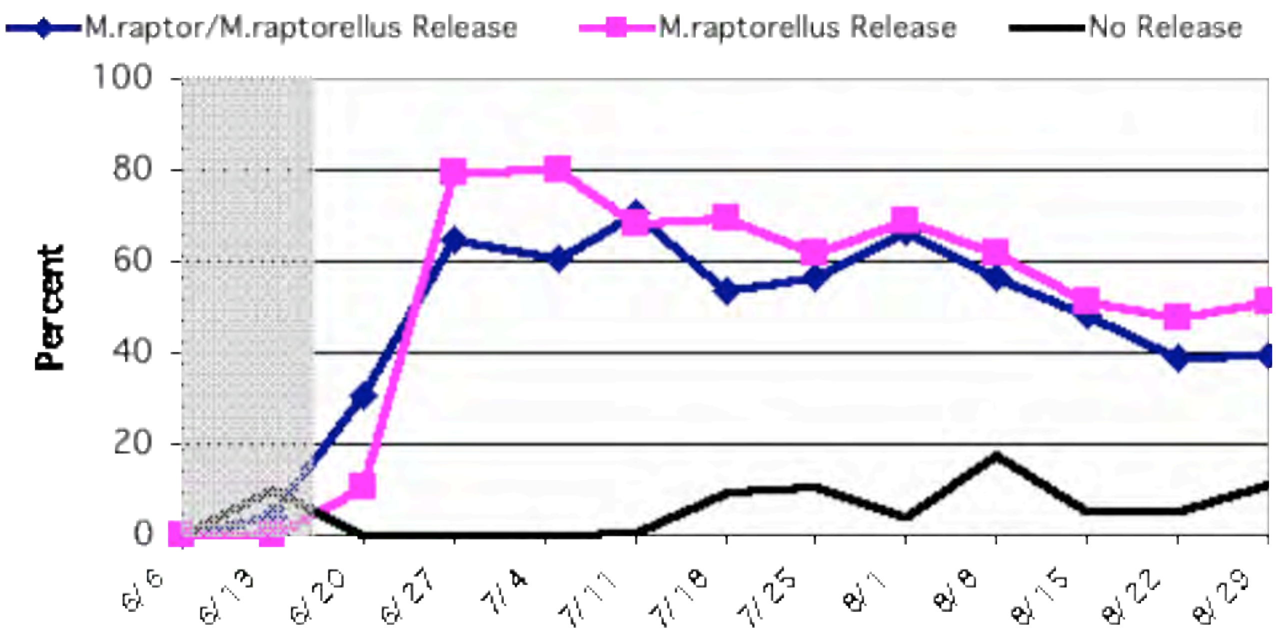

Figure 4. Successful parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2006. Pre-release period identified by the shaded area.

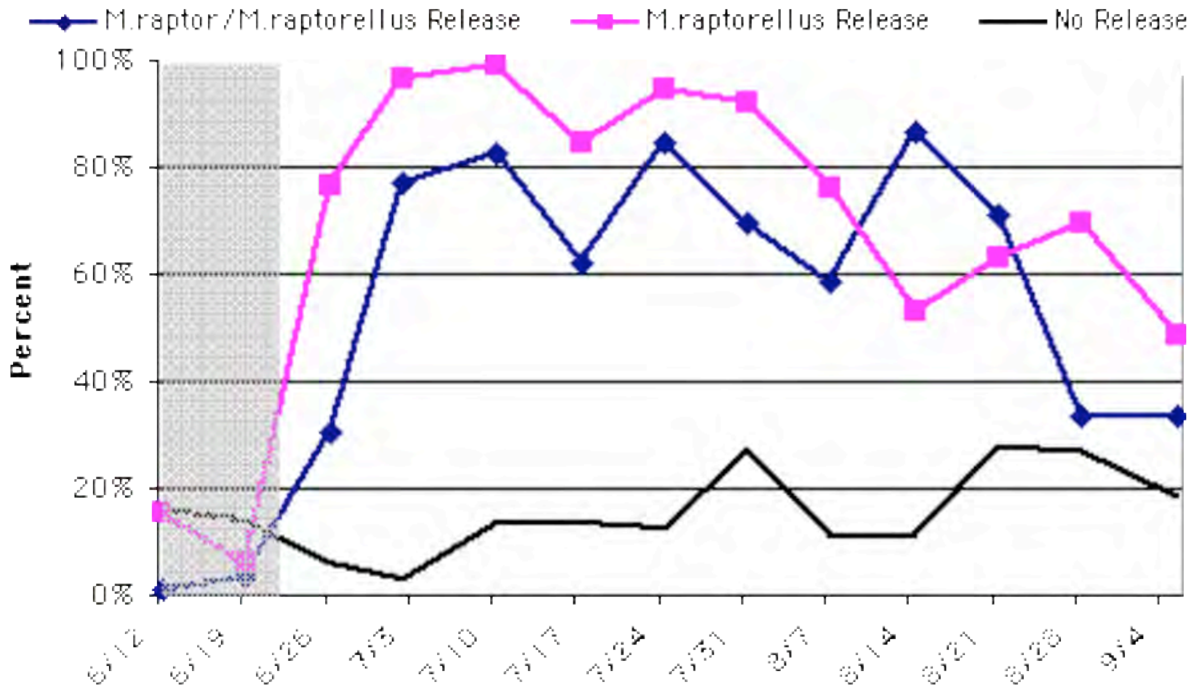

Figure 5. Total parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2007. Pre-release period identified by the shaded area.

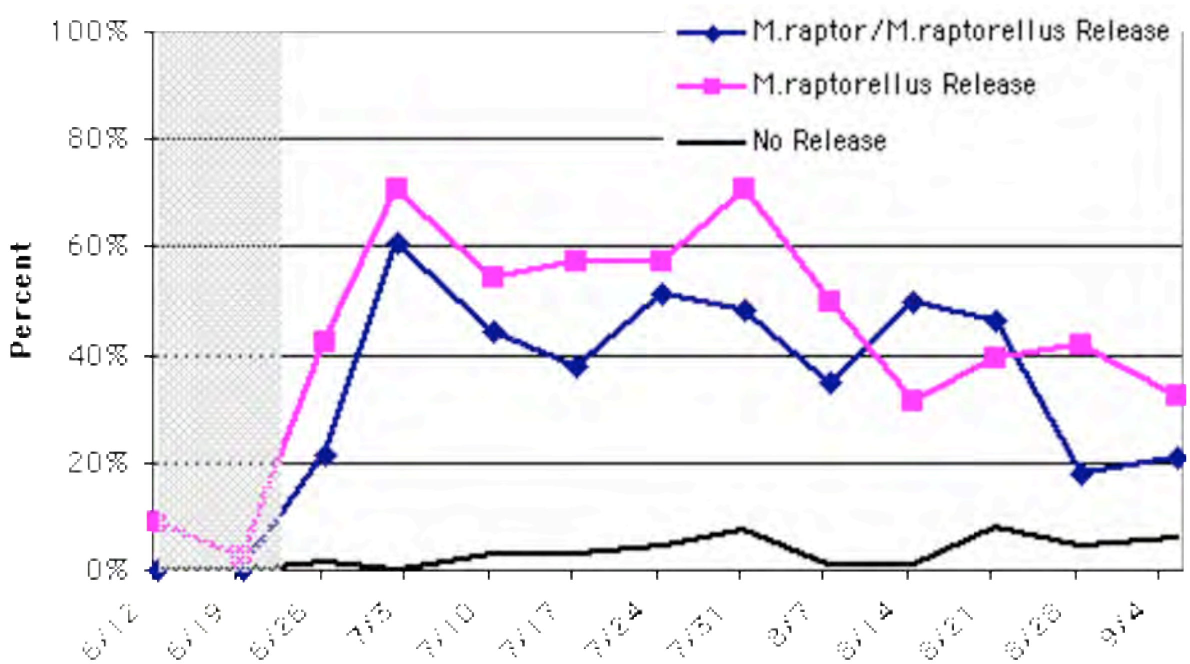

Figure 6. Successful parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2007. Pre-release period identified by the shaded area.

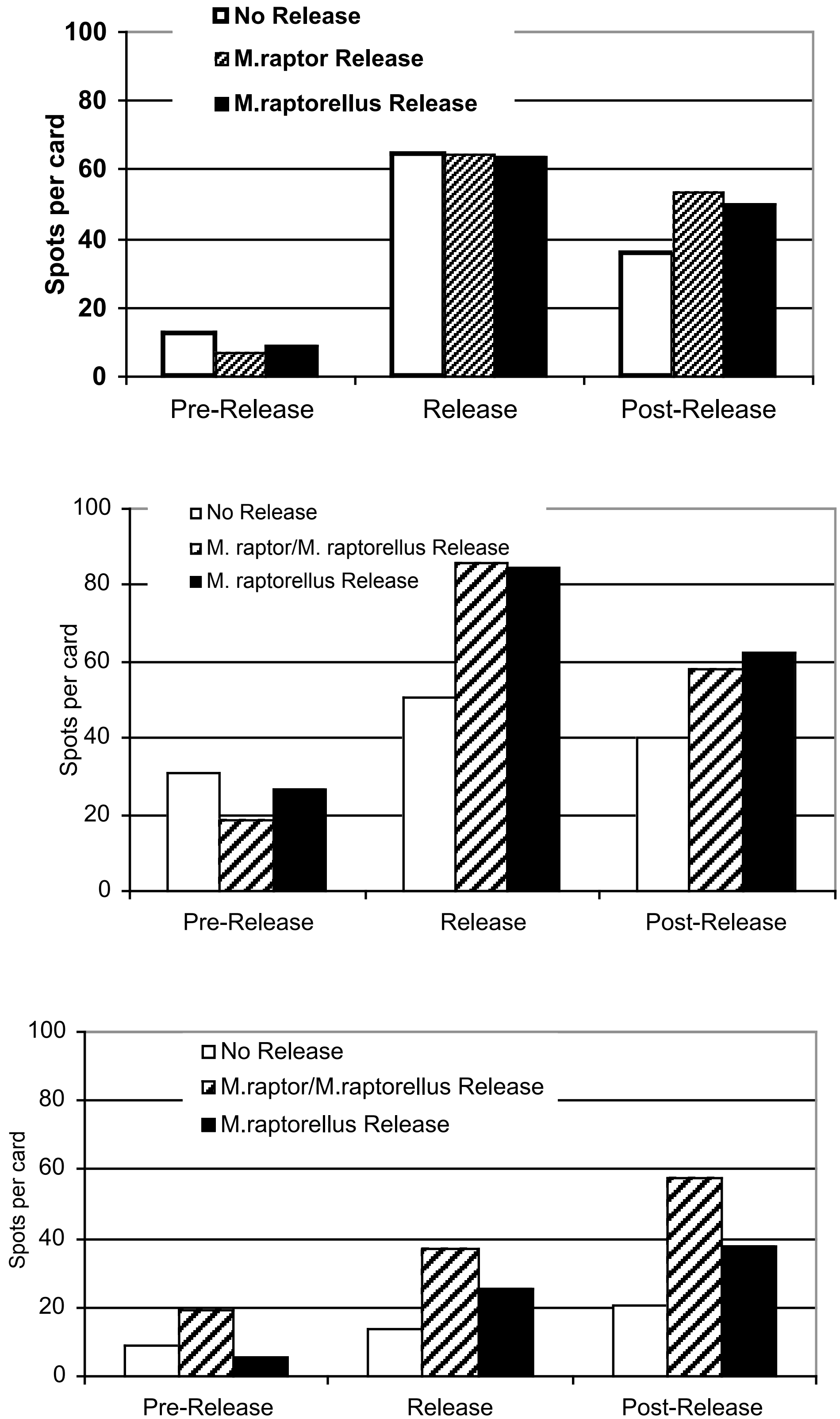

Figure 7. House fly population densities relative to release period and type of parasitoid released on nine New York dairies in 2003, 2006, and 2007.

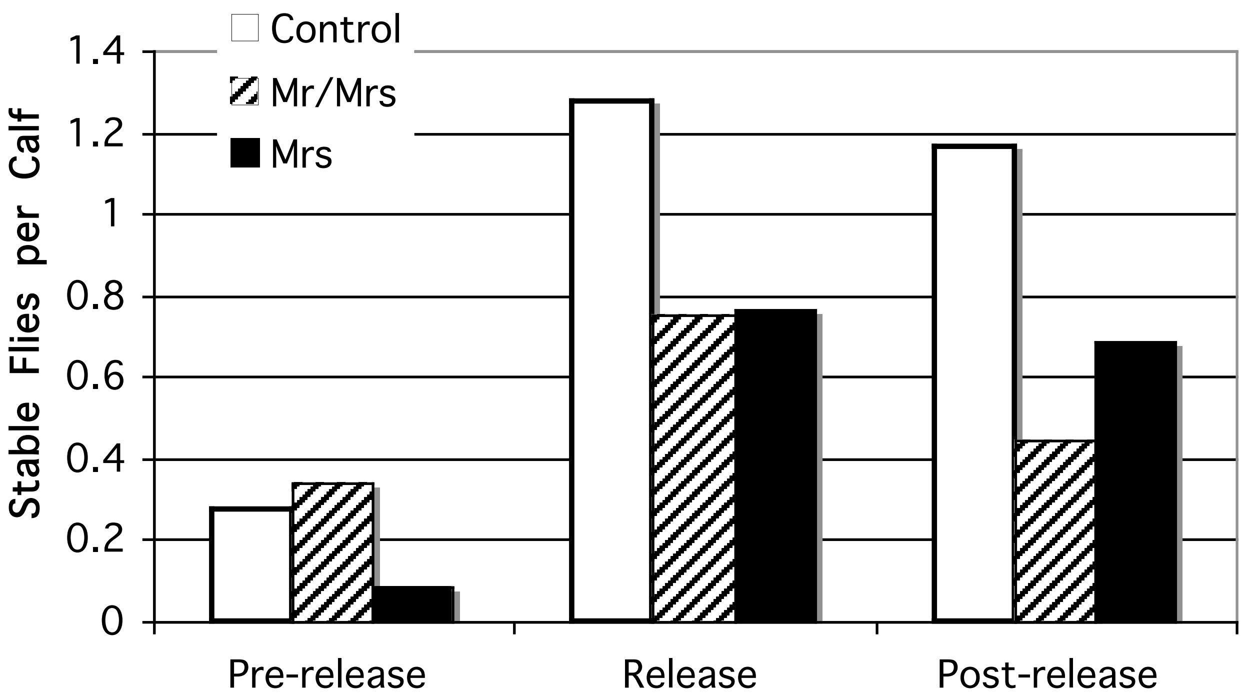

Figure 8. Stable fly population densities relative to release period and type of parasitoid released on nine New York dairies in 2007.

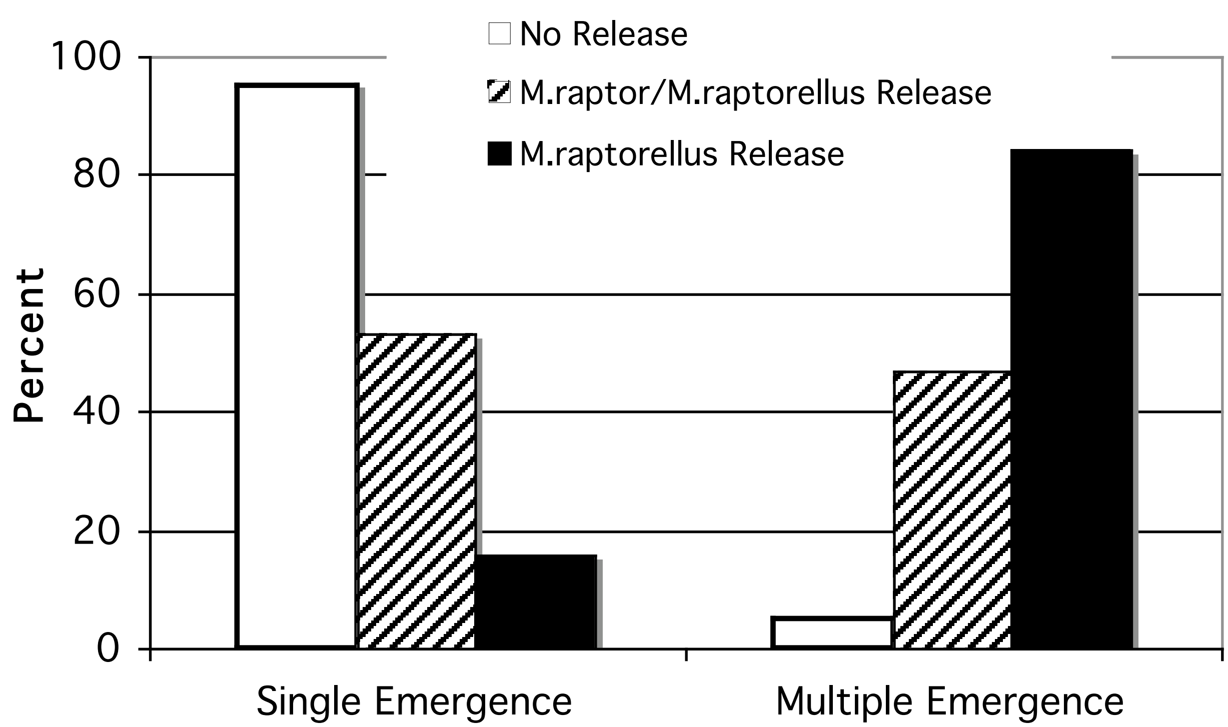

Figure 9. Percentage of species recovered from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2006 and 2007 averaged.