3.3 Population dynamics of *M. fuscoviride* and *M. tanacetaria*

3.3.1 Population dynamics on initially colonised islands

Eight islands where tansy was growing were chosen in the beginning of June. The following criteria were considered: (i) presence of *M. fuscoviride* and/or *M. tanacetaria*, (ii) balanced number of islands with either of the species present (iii) fewer than 300 tansy genets and (iv) accessibility by motorboat within a few minutes from Tvärminne Zoological Station.

The eight selected islands were: AB, Algrundet 3 (AL3), Furuskär (F), Fyrgrundet (FY), Halsholmen (HH), Porsgrundet (P), Rovholmarna (R) and Storgrundet (ST). These eight islands are later referred to as initially colonised islands (Figure 4).

All tansy genets on all this eight islands were checked weekly for the presence of aphids. Each colonised ramet was labelled (Figure 5). In the subsequent weeks, the fate of the marked ramets was followed until the last data collection in the beginning of November. For each labelled ramet, the following variables were measured:

1.) Presence or absence of *M. fuscoviride* and/or *M. tanacetaria*

If one or both species were present, the following variables were measured:

1a.) Aphid colony size (for *M. tanacetaria* always by estimating the number of individuals, for *M. fuscoviride* either by estimating the number of individuals or by measuring the colony size in centimetres. These estimates were converted into colony size (see chapter 3.3.3))

1b.) Number of winged individuals and presence of fourth instar larvae with wing buds

1c.) Number of male individuals (for *M. tanacetaria*) and presence of male individuals (for *M. fuscoviride*)

2.) Presence or absence of predators (Ladybirds and ladybird larvae (Coleoptera: Coccinellidae), hoverfly larvae (Diptera: Syrphidae) and lacewing larvae (Neuroptera: Chrysopidae))

3.) Presence or absence of ectoparasitic mites (Acarina: Thrombiidae)

4.) Presence or absence of parasitoid mummies (*Lysiphlebus spp., Ephedrus spp., Aphidius spp.*)

5.) Presence or absence of tending ants (only for *M. fuscoviride*)

6.) The phenological state of the ramet (shoot, bud, flower, withered, seed, crippled, dead, Figure 5)

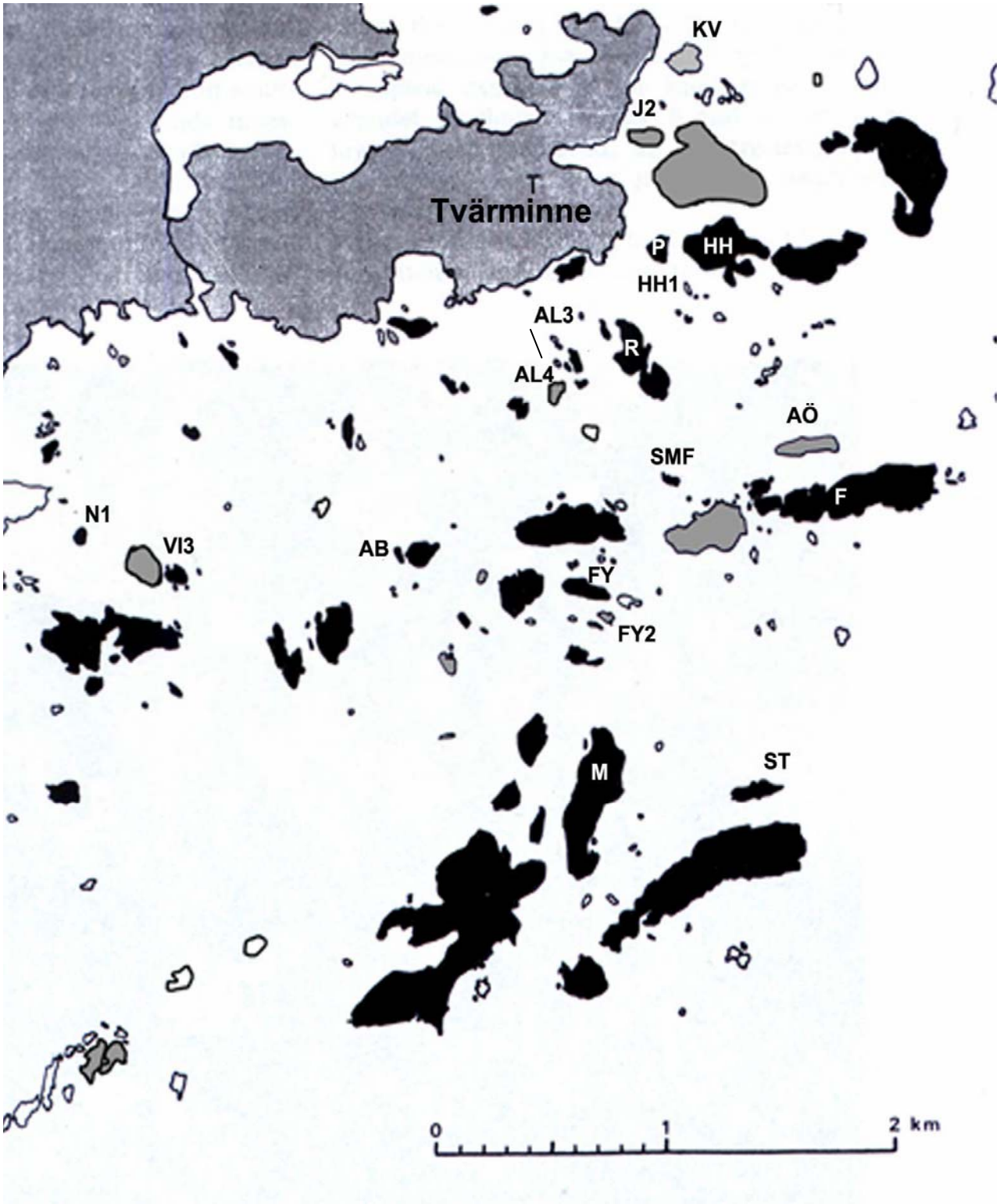

Figure 4: A map of the study area with all islands included in the survey. The initially colonised and the initially uncolonised islands are labelled with their abbreviations (HH = Halsholmen, F = Furuskär, FY = Fyrgrundet, ST = Storgrundet, P = Porsgrundet, R = Rovholmarna, M = Mellanskär, Table 2). On white islands no tansy were found. On grey islands tansy was present but no aphids were observed. On the black islands tansy and aphids were present. The islands which are not labelled were only included in the large survey and not in the study of the dynamics of the aphids.

Additionally, the presence of sexual individuals was recorded. The female sexual individuals were not distinguishable from asexual females in the field. The individuals had to be dissected to note the difference. Therefore, after the first appearance of male individuals, a certain number of adult females were collected from these colonies where I assumed that the collection would not drive the colony to extinction. The decision about the number of individuals to collect from each colony was based upon the personal estimation of how many individuals can be collected without driving the colony to extinction. Therefore, the number of dissected individuals differed from island to island and from week to week. The minimum number of collected individuals in one week on one islands was one individual for *M. tanacetaria* and two individuals for *M. fuscoviride*. The mean number of *M. fuscoviride* individuals collected per week, averaged over all initially colonised islands was 33.6 ± 6.6. The mean number of *M. tanacetaria* individuals collected per week, averaged over all initially colonised islands was 21.1 ± 3.4. The individuals were dissected in the laboratory and sexual, asexual and parasitised females were distinguished.

Table 1: The data associated with the weeks where data collection took place. The cross marks the weeks where data were collected. The initially uncolonised islands I are: N1, Mellanskär, SMF, FY2 and VI3 (Table 2). The initially uncolonised islands II are: HH1, KV, J2, AL4 and Allören (Table 2).

Week	Data	Initially colonised islands	Initially uncolonised islands I	Initially uncolonised islands II
Week 1	June 20th /22nd	X		
Week 2	June 28th /29th	X	X	
Week 3	July 4th /5th	X		X
Week 4	July 11th /12th	X	X	
Week 5	July 17th /18th	X		X
Week 6	July 25th /26th	X	X	
Week 7	August 2nd /3d	X		X
Week 8	August 8th /9th	X	X	
Week 9	August 15th /16th	X		X
Week 10	August 22nd /23d	X	X	
Week 11	August 29th /30th /31st	X		X
Week 12	September 5th /6th	X	X	
Week 13	September 12th /13th	X		X
Week 14	September 19th /20th			
Week 15	September 26th /27th			
Week 16	October 3d /5th	X	X	X
Week 17	October 10th /11th			
Week 18	October 17th /19th	X	X	X
Week 19	October 24th /25th			
Week 20	November 2nd /5th	X	X	X

The data collection started on June 20th/22nd (= week 1). At this time, the fundatrices had already hatched and initiated new colonies. The fundatrix was still present in almost every colony found in week 1. Thus, I assumed that eggs over-wintered successfully on the islands where aphids were found in week 1. Nevertheless, it is possible that some colonies found in week 1 were already present one or more weeks before the first check or that they were colonised in this week. This had to be considered in the analysis of the time of colonisation. The survey was continued until week 20 (November 2nd/5th) when no more *M. tanacetaria* and/or *M. fuscoviride* were observed, i.e. all colonies were extinct. Until the week 13, the survey was done weekly. Thereafter, ramets were checked only every second or third week. No data were collected in week 14, 15, 17 and 18 (Table 1).

3.3.2 Population dynamics on initially uncolonised islands

To examine whether initially uncolonised islands are colonised, I chose 10 islands where (i) neither *M. tanacetaria* nor *M. fuscoviride* was found in week 1, (ii) the number of tansy genets was less than 30, to minimise the possibility of overlooking the aphids, (iii) the access from the station was possible. The chosen islands were: N1, Mellanskär (M), SMF, Vindskären 3 (VI3), Allören (AÖ), Fyrgrundet 2 (FY2), AL4, HH1, J2 and Kvarnskär (KV, Figure 4). These islands, later referred to as initially uncolonised islands, were checked every second week for the occurrence of *M. tanacetaria* and/or *M. fuscoviride*. If aphids were detected, the genet with the colony (or colonies) was labelled and the fate of this genet was followed until week 20 when no aphids were observed anymore. Note that in contrast to the study executed for the dynamic of *M. fuscoviride* and *M. tanacetaria* on the eight initially colonised islands, the genet and not the ramet was labelled. For each labelled genet the following variables were measured:

1.) Presence or absence of *M. fuscoviride* and/or *M. tanacetaria*

If one or both species were present, the following variables were measured:

1a.) Number of aphid colonies per genet

1b.) Colony size (for *M. tanacetaria* always by estimating the number of individuals, for *M. fuscoviride* either by estimating the number of individuals or by measuring the colony size in centimetres, see chapter 3.3.3)

1c.) Number of winged individuals

1d.) Number of male individuals (for *M. tanacetaria*) and presence of male individuals (for *M. fuscoviride*).

2.) Presence or absence of predators (the same natural enemies were recorded as on the initially colonised islands, see chapter 3.3.1)
3.) Presence or absence of ectoparasitic mites
4.) Presence or absence of parasitoid mummies (the same parasitoid species were recorded as on the initially colonised islands, see chapter 3.3.1)
5.) Presence or absence of tending ants (for *M. fuscoviride* colonies).

The first check of the presence or absence of the two aphid species took place in week 1. Data collection started for five islands in week 2 and for the other five islands in week 3. The data collection lasted until week 20 (Table 1). No data were collected in week 14 and 15 (Table 1).

3.3.3 Estimation of the colony size

The number of aphids was estimated in the field by counting all the individuals. For *M. fuscoviride* colonies with more than 100 individuals, the length of the colony was measured in centimetres. To correct for the counting errors and to associate the length of the colony to a number of individuals, I collected 50 colonies with different numbers of *M. tanacetaria* individuals and 50 colonies with different numbers of *M. fuscoviride* individuals on the mainland. These colonies were counted or measured in the field as it was done for the studied colonies. After the counting and the measuring, each colony (together with the ramet) was put separately in a plastic bag and stored in the freezer. When the aphids were dead, they were counted in the laboratory. The equation of the regression line was calculated for the relation between the estimated number and the measure of the colony length for *M. fuscoviride* and between the estimated number and the actual number for both species. These regression equations were used to correct the field data.

3.3.4 Analysis

All statistical analysis were done with SPSS (Version 10.0, SPSS Inc, 1999). Mean values are presented as the mean ± standard error of the mean. Means were compared with a t-test for metric data with equal variances (Levene's test of variance) and with a Mann- Whitney-U test for data without equal variances. The Pearson correlation coefficient (r) was calculated for data with equal variances and the Spearman rank correlation coefficient (r_s) for data with unequal variances.

The mean colony size was calculated as the total number of individuals on an island per week divided by total number of ramets occupied on the island. The extinction week was defined as the first week without aphids; the colonisation week as the first week at least one aphid was found. For the colonisations in week 1, it was impossible to distinguish between colonies which were colonised in this week and colonies which already existed one or more weeks before. The survival time was defined as the number of weeks a ramet, genet, group or island was occupied by *M. fuscoviride* or *M. tanacetaria*. The survival time was calculated the following way: extinction week minus colonisation week. The survival time was corrected because no data were collected in the weeks 14, 15, 17 and 19 (Table 1). The corrections were the followings: If the extinction week was week 16, then one was subtracted from the survival time because the extinction could have taken place in week 14, 15 or 16; if the extinction week was week 18 or 20, then 0.5 was subtracted from the survival time because the extinction could have taken place in week 17 or 18 and 19 or 20 respectively.

The data for the initially uncolonised islands were collected at a two-week interval. Each colonisation or extinction event could have taken place in the week of the data collection or one week before. No survival time was calculated for the initially uncolonised islands. If not mentioned explicitly, the results are calculated only from the data collected on the initially colonised islands.