

3. Material and Methods

3.1 Study system

The study system consists of the two aphid species *Metopeurum fuscoviride* and *Macrosiphoniella tanacetaria*, which are monophagous on the common tansy (*Tanacetum vulgare* L., Asteraceae, Figure 1). The common tansy is a tussock-forming, perennial hemicryptophyte (Strasburger et al., 1991) native to Europe and Asia (Mitch, 1992). Tansy is naturally found along rivers. In Scandinavia, tansy occurs naturally also on islands in the Baltic sea. Nowadays, the natural habitats of tansy are becoming rare, but it is found frequently in habitats affected by humans such as roadsides and wastelands. Tansy propagates by both sexual and asexual reproduction. A single tansy plant (= genet) may consist of several shoots (= ramets). The number of ramets ranges from one to several hundreds. The height of the tansy genets depends on the water and/or the nutrient supply. It can grow up to 170cm (Weisser, pers. observation) and is very conspicuous in the field. However, some genets do not exceed the height of 5cm.



Figure 1: One tansy ramet shortly before flowering. One genet consists of one to several ramets.

Macrosiphoniella tanacetaria KALTENBACH (Homoptera: Aphididae) is a holocyclic, non-host alternating aphid species (Figure 2A). Its main host is *Tanacetum vulgare*; it is rarely found on *Chrysanthemum spp.* and *Matricaria spp.* as well. The aphids form aggregations on the upper parts of the stems, between the inflorescence and on the leaves. The aggregations contain up to several hundred aphids per ramet. The body size ranges from 3.2 to 4.1mm (Heie, 1980). The fundatrices hatch from over-wintering eggs in spring and produce viviparous parthenogenetic females. In autumn, oviparous wingless females (mating females) and winged males are produced. The production of males is suppressed by high temperature and/or long days to prevent them from being born too early (Heie, 1980). After mating, an over-wintering frost resistant egg is laid. Certain biotic and abiotic factors such as overcrowding, plant deterioration and occurrence of natural enemies stimulate the production of alate viviparous parthenogenetic females (winged asexual females, Dixon, 1998). Winged females can be produced throughout the season. Already in the fourth instar stage, wing buds are clearly visible. The winged morphs are specialised for dispersal and are usually less fecund (Heie, 1980).

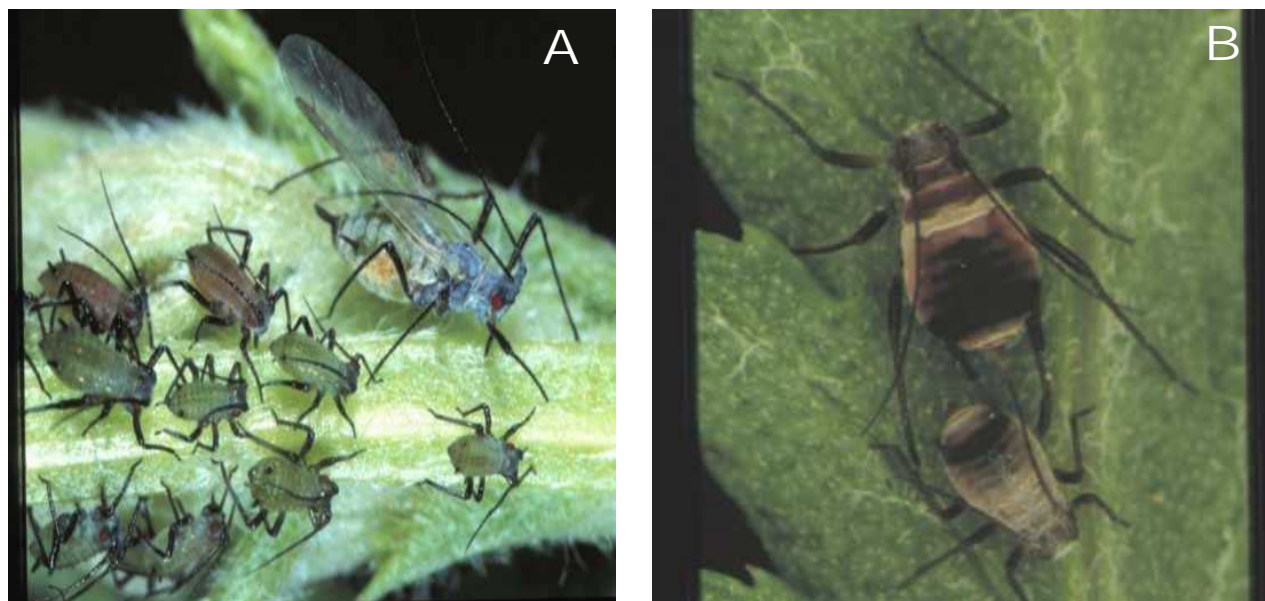


Figure 2: A) A colony of *Macrosiphoniella tanacetaria*, consisting of an adult (the winged asexual female) and larvae, feeding on tansy. B) One adult *Metopeurum fuscoviride* individual and one *M. fuscoviride* larvae feeding on tansy.

Metopeurum fuscoviride STROYAN (Homoptera: Aphididae) is a holocyclic aphid, monoecious on *Tanacetum vulgare* (Heie, 1980, Figure 2B). *Metopeurum fuscoviride* aggregations are mainly found on the stems and on the undersides of the lower tansy leaves

(Heie, 1980). The body size ranges from 2.2 to 2.9mm. *Metopeurum fuscoviride* colonies are attended by different ant species, e.g. *Lasius niger*. The ants protect the aphids from natural enemies (e.g. Banks, 1962), they may improve their feeding rate by the removal of the honeydew (e.g. Herzig, 1937), they may make the aphids feed more continuously (e.g. Way, 1963) and ant-tending may reduce the risk of fungal attack (e.g. Nixon, 1951). *Metopeurum fuscoviride* individuals tended by *Lasius niger* have a higher fitness even if no predators are present (Flatt and Weisser, 2000). The life cycle of *M. fuscoviride* is similar to the life cycle of *M. tanacetaria*. The differences are the followings: (i) The production of winged females takes only place until the third generation after hatching from over-wintering eggs (Völkl, pers. comm.). (ii) The males are wingless, but easy distinguishable already in the instar stages because of the smaller body size (1.5-1.6mm) and the pale green colour of the abdomen.

In my thesis, I use the term colony to refer to all aphids living on a single tansy ramet. Thus, on the level of genets, there can be as many colonies as there are ramets. The tansy genets are often associated to a tansy group. A tansy group is defined as all genets within an area where no tansy genets are further apart than five meters from each other. The distance of five meters was chosen, because I did not expect wingless aphids to disperse further than five meters. Additionally, the tansy genets subject to my study are growing on different islands. Thus, this aphid-tansy system consists of four spatial levels: the level of the ramets, the genets, the groups and the islands.

3.2 Study area

The study area comprises a part of the archipelago of the southern Gulf of Finland lying in the immediate vicinity of Tvärminne Zoological Station of the University of Helsinki, Finland (59°50'N, 23°14'E). The Tvärminne archipelago consists of several hundred islands which differ extremely in their size (Figure 3). Most of the islands in my study area belong to the Tvärminne Zoological Station or to the Jussarö Strict Nature Reserve (Halkka et al., 1971). These islands are protected and the human impact is relatively low. Tansy genets are not mown on any of the islands.

The archipelago is a dynamic system. Land upheaval, caused by the melting of the continental ice shield 8000 years ago, amount to about 42cm in 100 years (Halkka et al., 1971). New islands are emerging and the existing ones are getting larger. Sometimes adjacent islands merge. The vegetation changes following the land upheaval (Halkka et al., 1971). The islands of the inner archipelago zone are large and the forest (mainly *Pinus silvestris*) often stretches down to the sea. In general, larger islands are older and had therefore more

time to accumulate soil. Additionally, these inner islands are mostly well sheltered from wave action (<http://rontti.helsinki.fi/tvea/>). In the inner archipelago zone, the distance between the islands is generally rather small. In the outer archipelago towards the open sea, the islands are getting smaller and the distance between them increases (Pokki, 1981). The vegetation on these outer islands is scarce or absent at all.

From year to year, the climatic conditions vary considerably. In general, the climate is relatively mild and maritime. The temperature varies less than the precipitation during the growing season (Halkka et al., 1971). Especially in summer, the sea reduces variation in temperature. A characteristic feature of this area is the low rainfall in the first half of the year. In June and July, low rainfall combined with the high temperatures results often in severe droughts. However, late summer and autumn are characterised by strong winds and heavy rainfalls (<http://rontti.helsinki.fi/tvea/>). If it is warm enough in this period, tansy is able to produce secondary ramets which are often not able to set seeds. In autumn, the risk of flooding increases. Flooding can cause the death of tansy genets growing close to the sea shore or affect them with splashes of spray water from the sea (Härri, pers. observation).



Figure 3: An aerial view of the Tvärminne archipelago and the Hanko peninsula.