Facultative parthenogenesis in *Cacopsylla myrtilli* (Wagner) (Hemiptera: Psylloidea) in northern Sweden: possible explanations for the occurrence of males

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Hodkinson, I.D. & Bird, J.M: Facultative parthenogenesis in *Cacopsylla myrtilli* (Wagner) (Hemiptera: Psylloidea) in northern Sweden: possible explanations for the occurrence of males. **[Fakultativ partenogenes hos *Cacopsylla myrtilli* (Wagner) (Hemiptera: Psylloidea) i norra Sverige och möjliga förklaringar till förekomst av hannar.]** – Entomologisk Tidskrift 127 (4): 157-160, Uppsala, Sweden 2006. ISSN 0013-886x.

The male of *Cacopsylla myrtilli* is recorded from Sweden for the first time. Systematic collecting along altitudinal transects in the Abisko area showed that populations at lower elevations within the birch forest consisted entirely of females, implying that this species reproduces parthenogenetically in these habitats. By contrast, males became frequent within the population at or beyond treeline, mirroring similar previous observations in Canada and Norway. Possible mechanisms triggering the switch from parthenogenetic to sexual reproduction are discussed.

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Jumping plant lice (psyllid) species almost invariably reproduce sexually, with males and females being present in approximately equal numbers within the population. Parthenogenesis is exceptionally rare among the 3000 or so described species and is apparently restricted to just a few examples (Hodkinson 1983). The most conspicuous case occurs in the holarctic boreo-alpine species *Cacopsylla myrtilli* (Wagner 1947), which feeds as larvae on the deciduous dwarf shrubs *Vaccinium uliginosum* L. and *V. myrtillus* L. *C. myrtilli* was described from a collection of almost 400 females made in Austria; a single male initially included in the type series was subsequently shown to be *Cacopsylla corcontum* (Šulc). It overwinters as an egg on the shoots of *Vaccinium*, develops through five larval instars, before producing adults in midsummer (Lauterer 1999). Single sex (female) populations have been found right across the species' range from Alaska, the Canadian Rockies to Siberia and N China, across northern Russia to northern Scandinavia and the mountains of Central Europe. Large collections have continually yielded only females and this is not related to the earlier emergence of females than males; larval populations show the same trend (e.g. Lauterer 1963, 1976, 1999, Hodkinson 1978, MacLean & Hodkinson 1980, Conci & Tamanini 1989). This led to the early conclusion that *C. myrtilli* normally reproduces parthenogenetically (Linnavouri 1951, Lauterer 1963, Ossiannilsson 1975, 1992).

This picture, however, has since become complicated by the sporadic occurrence of occasional males that have been found at geographically isolated sites in Shanxi Province, N. China, the Bieszczady Mountains of S. Poland and at sites in Russia, including North Karelia, Chanty-Mansijsk in the Ural Mountains and at Aborigen in the Kolyma Highlands of Eastern Siberia (Kuwayama & Miyatake 1971, Klimaszewski 1971, Ossiannilsson 1975, 1992, Hodkinson & MacLean 1980, Konovalova 1988). In addition, two high altitude populations, occurring at or just

Figure 1. ***Cacopsylla myrtilli*** *adult female.*
Cacopsylla myrtilli*, vuxen hona.*

above the treeline in the Rocky Mountains of Alberta, Canada and one in Southern Norway, have proved the exception to the rule, with males occurring abundantly and copulation occurring within the population, suggesting that normal sexual reproduction is taking place (Hodkinson 1976, 1983). This raises the question of what triggers the production of males and whether it is genetically or environmentally controlled. The female is already known to be polyploid in Finland (Anna Maryańska-Nadachowska *personal communication*).

During a recent (2006) visit to Abisko in Swedish Lapland we made large collections of *C. myrtilli* from mixed *V. uliginosum* and *V. myrtillus* communities at intervals along two altitudinal transects, from within the Birch forest to above treeline. The transects sampled were: along the Lapporten path from Abisko helicopter pad to above Báddosdievvá. (450 to 650m, 26 and 29 July) and along the path from Kaisapakte station up Bessesvaggi (450 to 650m, 31 July). Additional lower altitude collections were made in the lower birch forest at Abisko (360m, 25 June), at the start of the Gearggevaggi path above Låktatjåkka (500m, 28 July) and at the base of the Slåttatjåkka path (440m, 27 July).

Populations within the birch forest, along each transect, consisted entirely of females but males made their appearance at treeline and above, often becoming relatively abundant. All other samples from the lower birch forest similarly consisted entirely of females. This is the first record of males from Sweden, notwithstanding the species' wide distribution within the country (Ossiannilsson 1992). Taken with the earlier Canadian and Norwegian samples, a pattern is emerging of parthenogenetic reproduction taking place where *Vaccinium* grows within the forest understorey but males being produced and sexual reproduction potentially taking place at and above treeline. How can such an apparently abrupt shift in reproductive strategy be explained? Clearly, sexual reproduction increases genetic variability. This may be necessary for survival in more exposed and climatically stressful habitats above treeline than in more benign habitats within the shelter of the forest. In the latter habitat, clonal reproduction may allow more effective exploitation of the more abundant food resource.

The stimulus for the shift from asexual to sexual reproduction may result directly from differences in the microclimate to which *C. myrtilli* is exposed or from differences in the quantity and quality of the host plant in the contrasting habitats. Recent experimental work at Abisko demonstrates that *Vaccinium uliginosum* grown under slightly warmer conditions shows increased biomass but reduced foliar nitrogen concentration whereas *V. myrtillus* showed increased nitrogen but little change in biomass. Phenolic concentrations are unaffected (Press et al 1998, Richardson et al 2002). Elevated UV-B levels, as might be experienced in exposed locations, similarly produces differences in host plant including reduced leaf thickness in both host species, reduced frost tolerance in *V. myrtilli* and reduced trichome numbers in *V. uliginosum* (Johanson et al 1995, Semerdjieva et al 2003, Taulavouri et al 2005). Levels of defoliation by chewing herbivores increased in *V. myrtillus* but decreased in *V. uliginosum* (Gwynn-Jones et al 1997). Collectively, these experiments demonstrate significant differences in the suitability to herbivores of host plants that may potentially occur at the treeline and that might act as potential trigger mechanisms for the switch from parthenogenetic to sexual reproduction.

The precise mechanism by which this switch is achieved, however, remains uncertain. Whether it occurs during the summer and involves environmental effects on larvae or adults or whether it results from temperature differences acting on winter eggs is unknown. There is thus considerable scope for a detailed study on sex determinism in *C. myrtilli*.

*Figure 2. Open habitat above treeline at Abisko where males of **Cacopsylla myrtilli** are typically found.*

*På kalfjället kan man hitta hannar av **Cacopsylla myrtilli** medan det nedanför trädgränsen enbart tycks finnas honor.*

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Svensk sammanfattning
Hanen av bladloppan *Cacopsylla myrtilli* har för första gången hittats i Sverige. Systematiska observationer längs en höjdgradient vid Abisko visade att populationer nere i björkskogen enbart bestod av honor. Det tyder på att arten reproducerar sig partenogenetiskt (med jungfruföd-sel) i detta habitat. Ovanför eller vid trädgränsen däremot, blev hanar vanliga, ett fenomen som observerats tidigare i både Kanada och Norge. Eftersom sexuell förökning ger större genetisk variation skulle detta kunna vara fördelaktigt i de kärvare klimatlägena högre upp på fjället. Den exakta mekanismen som ger upphov till dessa skillnader i fortplantningsstrategi är dock okänd.

Du håller i ett försenat nummer av Entomologisk Tidskrift
[A delayed issue of Entomologisk Tidskrift]

Nummer 4 av Entomologisk Tidskrift ska normalt bjuda prenumeranten på läsning under julen. Så blev det inte år 2006, vilket undertecknad beklagar. Anledningen var ett datahaveri ovanpå ett redan ganska tajt tidsschema. Ett par veckor innan nummer 4 skulle gå iväg till tryckeriet dog min dator och tog med sig många värdefulla ettor och nollor in i döden. “Backup då?” frågar den kloke läsaren... Och redaktören kan pinsamt nog bara erkänna att detta inte hade skötts särskilt bra, så de flesta artiklar fick respektive författare åter skicka in filer till, med ny korrekturomgång. Jag vill tacka författarna för deras tålamod med detta och för snabba svar.

Jag hoppas även att ni läsare har tålamod och överseende med denna försening (det är tyvärr inte första gången i ETs historia). Till nästa nummer ska förseningen vara intjänad så att häftet kommer i början av maj. Ett A4 med inbetalningskort och information för prenumerationen 2007 ska finnas bifogat i detta häfte. (Samma info finns fö. alltid på frampärmens insida).

English summary
The editor apologise for the delay of this issue of Entomologisk Tidskrift. The main reason is a computer crash combined with slight backup of the files. Next issue shall be in time (May).

Mats Jonsell, ET-redaktör