

# First record of males, oviparae and eggs of the green spruce aphid *Elatobium abietinum* (Walker) in Denmark (Hemiptera, Aphididae)

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Sexual forms and eggs of *Elatobium abietinum* (Walker) are recorded for the first time in Denmark. Until now, this aphid species has been considered exclusively anholocyclic in Denmark but sexuales were found in Jutland in winter 1993 and 1995. Eggs were encountered for the first time in Sitka spruce plantations at several locations along the West coast of Jutland in winter 1995/96. Diagnostic characters of sexuales are given and factors likely to induce formation of sexuales are discussed.

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The green spruce aphid, *Elatobium abietinum* (Walker) commonly occurs in the north west and central parts of Europe where it feeds on the needles of *Picea* spp. The feeding causes discolouration and needle loss, and in mild, oceanic regions the aphid is regarded as a serious pest both in coniferous forests and in gardens. In some years heavy defoliation is experienced especially on the North American *Picea*-species: Sitka spruce (*P. sitchensis*), white spruce (*P. glauca*), blue spruce (*P. pungens*) and Engelmann spruce (*P. engelmannii*).

*E. abietinum* can develop holocyclicly or anholocyclicly. In areas with a continental climate and cold winters populations are holocyclic. Oviparous females and males are produced in October-December and the overwintering eggs hatch the following spring (von Scheller 1963, Kloft et al. 1964). In oceanic regions with a mild winter climate *E. abietinum* exists anholocyclicly. This anholocyclic development is the

reason of the aphid's status as a pest insect in these areas: Breeding can continue even at 0°C but significant mortality takes place when the air temperature falls below -8°C (Carter 1972, Powell & Parry 1976). Aphid survival and reproduction during especially mild winters enable an early spring build-up into high population levels, which are almost unchecked by natural enemies that mainly occur later in early summer. In addition, dormant spruce trees appear to be more favourable hosts than actively growing trees and the possibility of anholocyclic populations increasing during the dormant period gives excellent possibilities for an outbreak to occur in this species. With the exception of Iceland where population numbers - so far for unknown reasons - peak in late autumn/early winter, populations of *E. abietinum* peak in late May/early June in the oceanic regions of NW-Europe. Normally population levels during summer and autumn are very low.

In Denmark, *E. abietinum* has hitherto been considered exclusively anholocyclic. The species' biology and the influence of climatic factors, especially during the winter, have been thoroughly studied (Bejer-Petersen 1962) and the population development has been regularly followed, but in no case have sexuales or eggs been found.

The first sexual forms of *E. abietinum* in Denmark were found in November 1993 in Stenbjerg Plantation, Thy, when quite exceptional autumn attacks of *E. abietinum* occurred on single trees and in small groups of Sitka spruce (Harding 1994). Attacks during autumn causing defoliation and tree-killing had only been recorded once before in Denmark in November 1981 – interestingly in almost the same area (KVL, archive). In 1993 alates were quite frequent and alate males and alatoid male nymphs were discovered within the aphid colonies. In addition, apterous oviparae and alate viviparae were found, but although apterous viviparae are normally to be found at this time of the year they were notably absent. Samples collected in December three weeks later showed a total disappearance of viviparae.

The males of *E. abietinum* are alate, with a smaller abdomen compared with alate viviparae and can most easily be discriminated from the alate viviparous females by the presence of numerous (21-33) secondary rhinaria on the third antennal segment (von Scheller 1963). Females have only 3-16 rhinaria. The oviparous females have a yellowish colour, and in size resemble the apterous viviparae but differ in that the hind tibiae are strongly swollen and bear 50-60 scent plaques (Heie 1992).

The locality was revisited in November 1994 and again in November 1995, when also several other Sitka spruce stands along the West coast of Jutland were examined. In 1994 no spruce aphids were present, but in 1995 oviparae were found in all locations visited. Oviparae occurred only in slight numbers, however, and no males were found. The majority of the aphids were apterous viviparae.

In 1995 eggs of *E. abietinum* were found for the first time in Denmark. The eggs are 0.6-0.7 mm long and ca. 0.3 mm wide. Newly deposited eggs are pale yellow, but they gradually turn black (von Scheller 1963). The eggs were found in several localities in plantations of Sitka spruce along the West coast of Jutland, where also oviparae were encountered. Most samples contained both yellow and black eggs, but the vast majority were black. Of 152 eggs counted from one sampling location in Tved Plantation, Thy, 137 were black. The eggs were typically deposited singly on the needles which is in accordance with von Scheller.

Although very uncommonly, sexuales and eggs of *E. abietinum* have been encountered during winter in other oceanic regions, namely Norway and the British Isles (Carter & Austarå 1994). In these specific years, heavy attacks have occurred during the preceding spring and the autumns have been unusually dry. From this the authors suggest that dry conditions during autumn might be an important factor inducing the production of sexuales. This hypothesis is based on the fact that in dry autumns shoot extension terminates sooner and hardening-off of shoots and needles takes place earlier. Thus under decreasing daylight regime, the change in nutritional quality of these plants at the onset of dormancy would be favourable for colony development (Carter & Nichols 1988) and the induction of sexual forms (Fisher 1982).

In Denmark, the autumn of 1993 was rather wet and very cold, however, mean temperatures from August to November being about 2°C below the normal. In August precipitation was normal, in September above average. In 1995 August was very dry, September precipitation above average. The autumn was warm, August being 2°C warmer than the normal and October having record-breaking temperatures. Due to this warmth shoot growth continued for so long in several tree species that dormancy was not initiated at the onset of winter frost, resulting in heavy winter

frost damage. The only previous serious autumn attack by *E. abietinum* recorded (1981) occurred in an area where August was extraordinarily dry but during the following months precipitation was higher than normal; autumn temperatures were normal.

The climatic conditions in Denmark that were coincident with the occurrence of minor autumn population peaks and of sexuales and eggs do not appear to agree with the hypothesis suggested and other factors are likely to be involved. In certain aphid species on herbaceous plants it has been shown that the length of photoperiod and temperature regimes that occur from August onwards can cause a more or less complete switch from parthenogenetic to sexual forms (Lees 1959). However, in the case of several root-feeding aphids that occur on woody perennial plants, sexual forms do occur regularly in the autumn when photoperiods are diminishing although the aphids are not exposed to daylight (Swenson 1971, Carter & Danielsson 1991). From this it would appear that a climatically mediated host-plant factor is influencing sexuales induction.

The explanation as to why *E. abietinum* occasionally produces sexual forms in Denmark and in other areas with mild winters cannot be given. Photoperiod alone cannot be a decisive factor since holocyclic and anholocyclic populations exist in oceanic and inland regions in Europe along the same latitude. In a laboratory experiment Carter & Austarå (1994) demonstrated the production of sexual forms in November within an anholocyclic population exposed to shortening photoperiod and a regime of continental autumn temperatures, but no eggs were produced in that particular experiment. Although some, but not all, instances appear to follow a pattern of climatic events (dry autumns, especially August) there may be genotypes within this essentially parthenogenetic species that could have different response thresholds to environmental factors through host plants of different genetical origin.

## Dansk sammendrag

### Første fund af hanner, ovipare hunner og æg af sitkabladlusen *Elatobium abietinum* (Walker) i Danmark.

Hanner og ovipare hunner af sitkabladlusen *Elatobium abietinum* (Walker) blev fundet for første gang i Danmark i Thy i November 1993. I vinteren 1995/96 blev æg konstateret for første gang i flere sitkagranbevoksninger langs den jyske vestkyst sammen med ovipare hunner. Arten er hidtil anset for at være udelukkende anholocyklisk i Danmark. De kønnede former beskrives, og faktorer af betydning for induktion af sexuales diskuteres.

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