

# Culicidae (Dipt. Nematocera) of the Baltic Island of Öland

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## Abstract

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Only four culicid species were previously known from Öland. Of the twenty-two species recorded two are new to Fennoscandia (*A. (O.) refiki* Medsch. and *A. (A.) geminus* Peus) and additionally sixteen new to Öland. Short com-

ments on taxonomy are made. The distribution of the species in the Palearctic is mentioned. The peculiarities of the Öland biotopes and special demands on larval habitats are related to the zoogeographic characteristics of the island. The culicid fauna is classified as a typical one for deciduous forests with abundance of temporary pools in spring.

## 1. Introduction

The fauna and flora of the island of Öland in the South Baltic have attracted numerous biologists, which have mainly focussed their interest on the steppelike alvar. The biogeographically interesting position of the island, with the presence of southeastern and eastern species, the favourable climate and the island's geology, with ordovician limestone rich in fossils, slates and sandstones, have all given rise to this interest.

Since Wahlgren's (1917) review of the fauna of Öland — comprising about 800 species of vertebrates and invertebrates — many studies of the fauna of above all invertebrates have been made.

General excursions were reported on by Gislén (1947, 1951, 1954) and Ander (1955). A survey of Phyllopora was given by Ardö (1948). Among several excellent insect studies only that by Bruce (1964) on Coleoptera in temporary pools will be mentioned as it deals

with a habitat — the "vätar" — in which some early-emerging culicid species can be found. No special studies of culicids have, however, been made on Öland. Only four species, represented by a few adult specimens from early collectors (Zetterstedt 1838, 1850, Wahlgren 1915) were known from the island. Revisions were made by Edwards (1921b) and Natvig (1948). On Öland there are few permanent waters. Nevertheless the island is rich in suitable habitats for culicid development especially in spring.

Breeding conditions for some species exist in flat and sheltered parts of the shore with extensive *Phragmites* vegetation mainly on the western side of the island. On the central parts of the island precipitation collects on the impermeable limestone surface layers. These are often only covered by thin layers of earth or grassy ground. Both on the bare alvar and in the luxuriant deciduous forests with *Quercus*, *Fraxinus*, *Alnus*, *Betula*, *Corylus* and *Prunus spinosa* shallow temporary

pools form in spring and can in favourable years contain considerable amounts of culicid larvae. The present collections were made during a few days stay in spring in the years 1965, 1966, 1972 and 1973; and in August 1971. Mainly adults, but also larvae were collected and some species were reared. Because of the unpredictable conditions as to the precise developmental time of larvae not all species were found in the larval stage. Nevertheless the brief surveys of about 30 localities of which 18 gave culicids and of which some were revisited for several years, yielded about 300 adults and 60 larvae. Together with adults (about 30) belonging to the Entomological Museum Lund and to Dr. Bo Tjeder they form the base for the following records.

## 2. List of localities

The culicid localities of Öland hitherto studied (fig. 1) can roughly be separated into eight groups with regard to their surroundings and vegetation.

### a) exposed alvar with larval habitats

loc. 127 Vickelby RN-62711539, temporary pools on grass with mosses in the deepest parts, at most 50 cm. deep. Open.

loc. 111 Dröstorps mosse RN-62731546, 2 km south of Lenstad. Flooded ground at the edge of the fen with sparse vegetation of *Carex*, *Potentilla*, *Globularia*, *Pinguicula*, *Molinia* between limestone blocks. Open.

loc. 131 Bårby mosse RN-62521548, 1 km W Södra Bårby. Large marsh with extensive *Carex* and *Scirpus* vegetation in the central parts, at the edges flooded grass with sparse *Juniperus*, *Potentilla* and *Salix*. Open.

### b) exposed alvar without larval habitats

loc. 115 Borge hage RN-63041550, on grassy ground with *Adonis vernalis*, *Potentilla*, *Allium schoenoprasum*, *Juniperus*. Open.

c) open, flooded meadows in deciduous forest with larval habitats

loc. 132 Buserum RN-62771548, E of road, flooded meadow with grass, *Carex*, water level about 20 cm. In the central part an open pool, more than 50 cm. deep and at least semi-permanent with *Menyanthes* and *Ranunculus aquatilis* (fig. 2). The meadow was surrounded by *Betula*, *Corylus*, *Prunus spinosa* and *Juniperus*. Open onto a path with a ditch on which adults were found resting.

d) open meadows surrounded by deciduous forest without larval habitats in immediate vicinity

loc. 121 Södra Bäck, mosse RN-62831551, 500 m W of Södra Bäck. Marshy ground with *Carex*, grass, Orchidaceae, *Pedicularis palustris*, surrounded by forest of *Alnus*, *Betula*, *Pinus*, *Juniperus*, *Corylus* and *Quercus*. Open.

loc. 133 Byxelkrok RN-63581573, 50 m from seashore on meadow with *Orchis*; surrounded by *Juniperus*, *Pinus* and *Betula*. Open.

e) shaded temporary pools in deciduous forest

loc. 136 Buserum RN-62771547, W of the road, flooded meadow at deepest about 50 cm, with mainly *Carex*. Surrounded by deciduous forest, *Alnus*, *Betula* and *Salix*. At the edge of the forest small shaded temporary pools with the ground covered with dead leaves. Semishaded (fig. 3).

loc. 117 Ismantorp RN-62911551, beside Ismantorp borg, marshy ground with temporary pools in *Betula*, *Alnus*, *Corylus* forest. Pool bottoms covered with dead leaves. Shaded.

loc. 113 Stora Rör RN-62921543, N of road, beside a small stream on marshy ground with temporary pools, ground covered with dead leaves. Vegetation *Rubus Idaeus*, *Lysimachia vulgaris*, *Alnus*. Shaded

loc. 114 Ekerum RN-62961546, 1 km NW Ekerum near shore at edge of sparse *Quercus*, *Alnus* forest with ground vegetation of *Rubus Idaeus*, *Corydalis*. Small temporary pools, bottoms covered with leaves. Shaded.

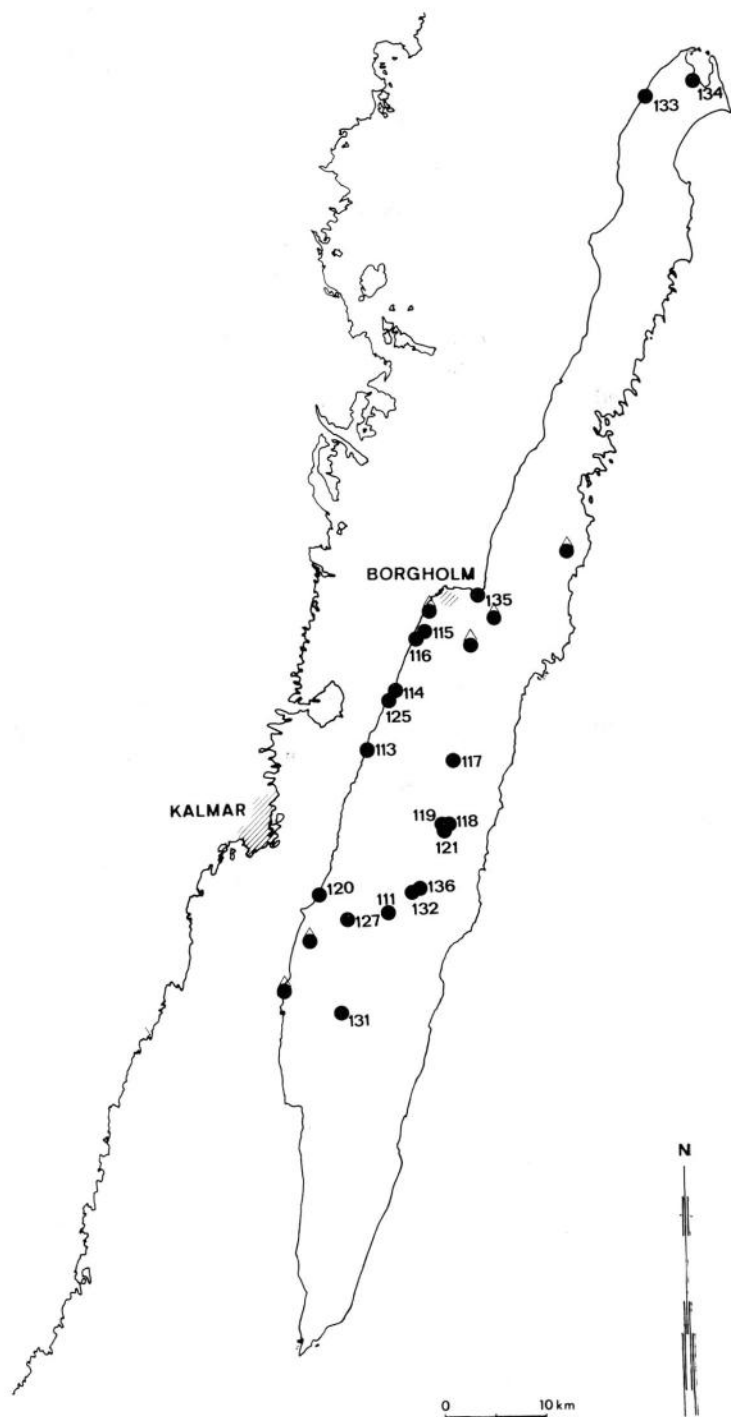


Fig. 1. Localities in which culicids have been collected on the island. ● — own samples; ▲ — previous collectors.

loc. 116 Borge hage RN-63041550, 500 m NW of Borge hage in deciduous forest, marshy ground with temporary pools, bottoms covered with dead leaves. Very shaded.

f) shaded temporary to semipermanent pools in mixed forest

loc. 134 Nabbelund RN-63581573, *Cladium mariscus* marsh with running water but probably only semipermanent, about 10–20 cm deep at the eclosion time. Surrounded by mixed forest of *Betula*, *Alnus*, *Pinus* with mainly *Rubus Idaeus* as ground vegetation. Very shaded.

g) shaded resting places of adults

loc. 125 Ekerum RN-62961546, 1 km NW Ekerum in dry *Corylus* thicket.

loc. 135 Köping RN-63071556, near sea-shore, on dense vegetation of *Lysimachia* and nettles, shaded by *Alnus*.

h) permanent waters

loc. 118 Södra Bäck RN-62841552, on open meadow, an old, stonepaved ground water pool which had a small, free water surface, obviously not drying out in normal years. Surrounded by *Typha*. Open.

loc. 119 Södra Bäck RN-62841552, along a meandering stream under dense vegetation of *Carex*. Open.

loc. 120 Eriksöre RN-62761538, on seashore with brackish water heavily polluted, dense vegetation of *Phragmites*.

### 3. Taxonomy

In the following, systematics are treated according to Stone et al. (1959) and Mohrig (1969). Old material recorded by Zetterstedt (1838, 1850), Wahlgren (1915) and revised by Edwards (1921 b) and Natvig (1948) is dealt with, for the case of synonymy only when it could be verified by first-hand studies of the material in the Entomological Museum Lund and Swedish Museum of Natural History, Stockholm. The faunistic survey is based on previously unpublished data from

material in the Entomological Museum Lund and my own collections, also deposited in the museum.

The present list comprises among other species also such, which in other areas have been recently studied as to taxonomy. In some cases this has resulted in detection of new forms or greater variability of important diagnostic characters. The Öland material has been studied with those results in mind. Necessary comments are made in the following.

### Anophelinae

#### Anopheles (Anopheles)

##### A. (A.) claviger (Meigen) 1804 s. l.

Syn.: *A. bifurcatus* Zetterstedt 1850, *A. bifurcatus* Edwards 1921, *A. bifurcatus* Wahlgren 1922.

During the last ten years it has been shown by Coluzzi (1960) and Coluzzi et al. (1965) that *A. claviger* (Meig.) in the Mediterranean actually consists of two species *A. claviger* (Meig.) and *A. petragnanii* Del Vecchio. The latter seems to be a southern species. It has not yet been found in Central Europe or in England (Service 1973). The most reliable characters for differentiation of the two species are found in the larval stages III and IV. The females are particularly difficult to separate. Thus material from Fennoscandia is better treated in a wider sense until detailed studies have shown the actual taxonomic status.

##### A. (A.) maculipennis Meigen 1818 s. l.

Before the taxonomy of the species complex had been worked out for certain, Ekblom and Ströman (1932) gave a detailed account of *maculipennis* s. l. from Sweden. The species was also reported from the Oslo region (Natvig 1929). Ekblom (1938) gave a fairly detailed account of the Swedish distribution of *A. m. maculipennis* Meigen, *A. labranchae atroparvus* Van Thiel and *A. m.*

*messeae* Falleroni (nom. acc. to Stone et al. 1959).

At least one of the species of the complex occurs on Öland. But there are only a rather worn female and some I and II instar larvae at hand. Without access to eggs, a determination is thus impossible.

## Culicinae

### Culicini

#### **Aedes (Ochlerotatus)**

##### *rusticus*-group

#### **A. (O.) rusticus** (Rossi) 1790

Syn.: cf. Natvig (1948)

The adults of the group are distinguished by the flat, round, white and black scales on the postpronotum and the larvae by the dorsal setae of the siphon. Other species of the group are *subdiversus* Mart., *lepidonotus* Edw. and *albescens* Guts., Pend. (1972).

The females of *rusticus* caught in the same locality vary considerable in the extension of the white-scaled midline on the tergites of the abdomen. There are specimens which have only a faint white indication of a stripe on the last segments and others with a more pronounced pattern. Thus with only females at hand, it could be difficult to distinguish single specimens from *refiki* Medsch. (Mohrig 1969), especially as there were also specimens with occasional few white scales on costa and radius in otherwise typical patterns. The only previous record from Sweden, Scania (Ardö 1952) based on females, distinguished by "their long palps, about 25—30 % of the proboscis and their much widened abdominal bands and their size" is uncertain, as the material is lost.

#### **A. (O.) refiki** Medschid 1928

The males differ from *rusticus* by the flattened hairs and two stout setae on the basal lobe and by the absence of many hairs

on the inner side of the "gonostylus" (nom. according to Knight and Laffoon 1971). Identification of single females may be difficult, but in *refiki* the white scales on the tergites never form a median stripe. In denuded specimens the analysis of the female genitalia will provide sufficient differences (Mohrig 1967). The larvae can be separated from *rusticus* by the absence of a free pecten tooth on the siphon.

##### *intrudens*-group

#### **A. (O.) intrudens** Dyar 1919

Syn.: cf. Natvig (1948).

Males and larvae of the species are easily identifiable (Natvig 1948, Mohrig 1969), whereas the females may be difficult to separate from females of the *communis*-subgroup, if the hypostigmal scale patch is worn off.

#### **Ochlerotatus s.str.**-group

##### *dorsalis*-subgroup

#### **A. (O.) dorsalis** (Meigen) 1830

Syn.: *dorsalis* Zetterstedt 1850; *dorsalis* Natvig 1948.

Among the northern culicids occurring in Fennoscandia the two closely related species *dorsalis* and *A. (O.) caspius* (Pallas) are easily identified in the adult stage by the apical and basal white bands on the legs and in the larval stage by the extremely short anal papillae. A survey of the differentiating characters between the species is given by Mohrig (1969). There is some disagreement about the specific status of the two species. They are sometimes defined as two species (Stone et al. 1959) or sometimes as one, *caspius caspius* and *caspius dorsalis* (Gutsevich et al. 1970). Only studies of the whole distributional areas of both forms and the recent distribution along the Baltic shores could prove Mohrig's suggestion that the lighter species *dorsalis* is of more northern origin.

## c o m m u n i s-subgroup

Formerly the species with entire black tarsi and those with white banded tarsi were treated as two different species groups (Edwards 1932, group G and B). Mohrig (1967, 1969) on base of female genitalia, joined these and group E of Edwards under the name *communis* and ranked them as subgroup under the *Ochlerotatus* s. str. -group. Within the *communis*-subgroup larval and hypopygial structures indicate the presence of some well-defined species complexes (Dahl 1974 a).

Recently Ellis and Brust (1973) showed that *communis* (DeG.) in the Nearctic consists of three sibling species. In Lu. Lpm material I found only *communis* DeG. s. str. according to Ellis and Brust (Dahl 1973).

**A. (O.) communis** (DeG.) s.l.

Syn.: cf. Natvig (1948) and Stone et al. (1959).

The species was most probably described on Swedish material. The species was revised by Edwards (1921 a) and synonymized with *nemorosus* Meig. Zetterstedt (1850) records *nemorosus* as common in Scandinavia. His, and other older material, has not yet been revised on the basis of the differentiation of *communis* and *A. (O.) punctor* (Kirby) by the hypopygial scale path, a character used first recently (Knight 1951, Mohrig 1969). Quite recently it was shown that *A. (O.) pionips* Dyar, known from the northern USSR (Gutsevich et al. 1970), also occurs in North Sweden (Dahl 1974 a, 1974 b). As the females are rather similar to *communis* females, a revision of older museum material is also necessary on this point. An analysis in regard to sibling species is also needed for the species here referred to as *communis* (DeG.) s. l. The Öland material is too scanty for an analysis for sibling species.

**A. (O.) punctor** (Kirby) 1837

Syn.: *C. fuscus* Zetterstedt 1850, nec *A. punctodes* Dyar 1922; cf. Natvig (1948).

After Natvigs basic work on Fennoscandian Culicidae two more species, closely related to

*punctor* were found in North Fennoscandia. One is *A. (O.) hexodontus* Dyar 1916 (Vockeroth 1954), the other *A. (O.) punctodes* Dyar 1922. For taxonomic characters differentiating these species see Dahl (1974 a). Thus Fennoscandian museum material from the northernmost provinces probably contains all three species under the name of *punctor*. In South Sweden neither of the two species *hexodontus* and *punctodes* was found, and thus they are not likely to occur on Öland.

**A. (O.) leucomelas** (Meigen) 1804

Syn.: *leucomelas* Natvig 1948.

The species is very similar to *A. (O.) cataphylla* Dyar in the adult stage. The females can be separated by the light scaling of the midpart of the proboscis, the males by the slender, longer and more gracile claspette and claspette filament. The species is rare in southern Sweden, therefore no analysis of variation in the above-mentioned characters has yet been possible.

**A. (O.) cataphylla** Dyar 1916

Syn.: var. *rostochiensis* Martini 1920; *prodotes* Wesenberg-Lund 1920; cf. Edwards (1921 b).

For taxonomic differences with respect to *leucomelas* see that species. *A. cataphylla*, a rather common species on Öland, exhibits no instability in scale patterns or hypopygial features in populations from the island.

## a n n u l i p e s-subgroup

**A. (O.) annulipes** (Meigen) 1830

Syn.: *annulipes* Zetterstedt 1850; *annulipes* Edwards 1921 b.

According to hypopygial features the species found in the Palaearctic may be grouped into three categories: those with extremely protruding basal lobe with a strong spine (*cantans*, *riparius*); those with less pro-

nounced basal lobe, but with a strong spine (*flavescens*) and those with only the setae of the former basal lobe on the inner side of the "gonostylus" (nomenclature according to Knight and Laffoon 1971) and without a prominent spine (*annulipes*, *excrucians*). The males of *annulipes* and of *A. (O.) cantans* (Meigen) are thus easily separable, but the females and larvae offer considerable difficulties. For survey of taxonomic characters for females and larvae see Mohrig (1969). He refers to Monchadskii (1951), who differentiates the larvae of the species by the number and shape of seta 4 -x (according to Knight and Laffoon 1971). Peus (pers. comm.) identified larvae of *annulipes* by the longer siphon in relation to *cantans*.

**A. (O.) cantans** (Meigen) 1818

Syn.: nec *cantans* Zetterstedt 1838, cf. Natvig (1948); *maculatus* Edwards 1921 b according to Natvig (1948); *cantans* Zetterstedt 1850 partim.

For taxonomic characters cf. *annulipes*.

**A. (O.) riparius** Dyar and Knab 1907

Syn.: *semicantans* Martini, in Edwards (1921 b); cf. Natvig (1948).

The larvae are distinguished from those of *intrudens* by the larger number of free setae 4 -x, the 2—3 branched head hairs and the smaller number of comb scales. The males can be separated from those of *cantans*, the nearest related species, by the shape of the basal lobe and the claspettes. More difficult is the recognition of females among *cantans* material. Mohrig (1969) has given a survey of differentiating features. In the Öland material the colour and shape of the postpronotal scales, which are not so whitish and more narrow than in other species of the complex, were found to be reliable for distinction.

From USSR another form *riparius ater* Gutsevich 1955 has been described, but that seems to be a different species (Gutsevich et al. 1970).

**A. (O.) excrucians** (Walk.) 1856

Syn.: *cantans* Zetterstedt 1938; *abfitchii* Felt 1904 in Martini 1920; *excrucians* Edwards 1921 b; *excrucians* Natvig 1948.

The resurrection of *excrucians* from *annulipes* was made by Edwards 1921 a. Since then the shape of the hindclaws of the female is used for identification of *excrucians* females. The larvae are distinguished by the thick, hooklike spine, seta 9-S on the siphonal plate. The males are separated from those of *annulipes* by the longer and more slender claspettes and the shape of the claspette filaments.

**A. (O.) flavescens** (Müller) 1764

Syn.: According to Stone et al. (1959); *lutescens* Edwards 1921 b partim; see also Natvig (1943).

Natvig's (1943) revision of Edwards determinations of the Stockholm specimen, as well as those in coll. Zetterstedt, Lund are fully correct, which also his fig. 67 (1948) confirms.

The males are separable from *A. (O.) cyprius* Ludl. among other characters by the shorter and stouter claspette stem and the deviating shape and setation of the basal lobe. The larvae resemble those of *excrucians* closely, but have weaker setae 9-S on the stigmal plate. The females are distinguished by the unique — among northern culicids — pattern of uniform brown mesonotal and white mesosternal scales.

**A. (O.) cyprius** Ludlow 1919 (1920)

Syn.: *freji* Edwards 1921 a; *lutescens* Edwards 1921 b partim; *C. annulipes* Zetterstedt 1850 partim.

During the latter half of the nineteenth century the females of *cyprius* were placed under various names. Zetterstedt (1850) also considered *lutescens* Fabr. and *lutescens* Meig. The first species is synonym with *flavescens* and by the second, I suppose he

meant *luteus*, a species now ascribed to the genus *Culex*. Natvig (1943) quite correctly revised the Swedish material of *cyprius* and *flavescens* in the Stockholm and in the Zetterstedt collections. The species is so characteristic in all stages, that it is easily recognizable also in the field.

### Aedes (Aedes)

The subgenus has one holarctic species (*A. cinereus* Meigen) and six palaeartic species, of which four are known from Europe. However, the specific status given to *cinereus*, *esoensis* Yam. and *rossicus* D.G.M. by Stone et al. (1959) is not accepted by all who work on the group. Peus (1972) evaluates *cinereus* and *esoensis rossicus* as two different species, whereas Ljov (1956) and Gutsevich et al. (1970) do not accept the differences between these forms as specific. Recently Peus (1970) described another species, *A. (A.) geminus* mainly on hypopygial differences, which is very close to *cinereus*. Thus until the distribution and status of all the forms involved in the species complex is clarified, the older records of *cinereus* or those recent ones, where only larvae or females were found, should be treated as *cinereus* s.l. sensu Peus. In Fennoscandian material, the situation is further complicated by the presence of a very dark female form, which was described by Zetterstedt (1850) as *nigritulus*. This dark form is the dominating one in Lapland and found both in the northern *cinereus* material of the Stockholm collection, as well as in the Zetterstedt collection where it is represented by a female bearing the label *nigritulus* and three other females from Lapland. I have also caught this form recently in Lule Lapmark, but still only in the female form (Dahl 1974 b). In Scania hitherto only the light type is found and to judge from museum material, this occurs at least as far north as Upland.

Recently Tanaka et al. (1975) have described a species *A. (A.) sasai* Tanaka, Mizusawa, Saugstad 1975, which has a dark

female, belongs to the *cinereus*-complex and seems to be near *nigritulus* (Zetterstedt 1850). It occurs in Japan in temporary pools in May, June, often associated with *A. (O.) communis* and *punctor*.

In the following the males of *cinereus* and *geminus* are treated under their respective names, whereas the females and larvae found on Öland are listed under the name *cinereus* s.l. as the material is too scanty for separating the two species in these stages.

The following synonymy could be established:

**A. (A.) cinereus** Meigen 1818  
s.str. sensu Peus

Syn.: *cinereus* Natvig 1948

### Culiseta (Culiseta)

**C. (C.) annulata** (Schrank) 1776

Syn.: *C. annulatus* Zetterstedt 1938, cf. Natvig (1948); *Theobaldia annulata* Edwards 1921 b.

### Culiseta (Culicella)

**C. (C.) morsitans** (Theobald) 1901

Syn.: *Th. morsitans* Wahlgren 1915; *Th. morsitans* Edwards 1921 b, cf. Natvig (1948).

### Culex (Culex)

**Culex (C.) pipiens pipiens** Linnaeus

Syn.: according to Natvig (1948) and Stone et al. (1959).

This cosmopolitan species with at present two subspecies and some hybrid and biological forms seems in Fennoscandia to be represented by the nominate form. This is not feeding on man, but most probably on birds.

## 4. Distribution and Biology

The present list is the result of rather restricted collections in both time and number of localities. It leaves thus the summer species of mainly *Culiseta* and *Culex*, as well as those



not attracted by man unattended. Locally culicids may be real nuisance both at the seashore and in or near forests. Thus further knowledge of the species occurring on the island will help in more accurately delimiting local populations.

**Anopheles claviger** (Meig.) s.l.

In Fennoscandia the distribution and biology of the species are very little known. It occurs from the Mediterranean, the Balkans, Turkistan, Afghanistan, throughout the western and central parts of Europe to the Leningrad district, and in South Fennoscandia.

From the southeastern shores of the Baltic Sea Remm (1957) reports two peaks of adults in the summer, a smaller one in June—July and an often larger one at the beginning of September. This is in agreement with the findings of adults in England (Service 1973) and in South Germany (Kühlhorn 1963) as well as in northwestern Germany (Zielke 1970). The larval stages are found throughout the year (Service 1973, Trpiš 1962). The species may be a vector of malaria in some southeastern districts of Europe and is said to be a transmitter of tularemia.

On Öland the females were found in early July and August.

New to Öland.

Högsum, St. Rör, källbäck 4.7.49, 1 ♀ (Tjeder); Södra Bäck loc. 121 8.8.71 1801, 2 ♀.

**Anopheles maculipennis** Meigen s.l.

The only recent record of a species of the complex based on identification of eggs from Fennoscandia is that of *A. m. messeae* Fall. from Finland (Ulmanen and Brummer-Korvenkontio 1971). This species is also reported from the USSR (Gutsevich et al. 1970). It is a widespread, mainly inland species in Europe (Mohrig 1969).

The females hibernate, which also was found in Lule Lapmark (Dahl 1974 b). Thus the present larvae from August must belong to the one generation, which is hatched from

the eggs laid by hibernating females in late spring and developing during summer.

The localities where the larvae were found are: a) (loc. 118) a manmade water hole with *Typha* and only a small open water surface 1 m beneath the ground level of a dry meadow, b) (loc. 119) a nearby meandering stream with a luxuriant *Carex* marsh along its shallow banks. Both habitats contained larvae only in August.

New to Öland.

Köping, Kolstad VIII. 1959 1, ♀ (K. Ander); Södra Bäck, loc. 118 15.8.71 1452, 5 I—II inst. L; loc. 119 15.8.71, 3 I—II inst. L.

**Aedes rusticus** (Rossi)

The species is found from Scotland, South Fennoscandia to the Leningrad district in the North, throughout Europe with a distributional centre in the Mediterranean and in the Balkans. Its eastern distributional limits were recently altered by the records from Poland (Skierska 1971), the ČSSR (Trpiš 1962) and the Carpathian mountains (Gutsevich et al. 1970). Kirchberg and Petri (1955) summarizing previous records and their own observations, tentatively related the distributional eastern limitation to the  $-1^{\circ}$  January isotherm. On this they predicted a possible occurrence of the species in South Sweden. But the species on the whole seems to be able to adjust to rather variable conditions, e.g. to colder climate in the eastern range. In Central Europe and England, the hibernating larvae, though susceptible to freezing, may hatch irregularly during the cold period (Kirchberg and Petri 1955; Marshall 1938.). But from the Danube districts Trpiš (1962) reports only one larval generation in April, May. At the southern limits of the species Gutsevich et al. (1970) report hibernation of females, if the larval biotopes are dried up. The species is mainly found in temporary pools, ditches or marshy areas with deciduous trees, both in exposed and, mostly, in shaded localities.

On Öland the larval locality seems to be of temporary character, probably damp but not

wet during normal summers. In the centre of the place there is a string of slow-running water. At the end of May 1973 the ground was covered with at most 10 cm water, standing over a rich layer of detritus on limestone ground which was mostly covered by a rich *Cladium mariscus* vegetation. The habitat is entirely sheltered, which may contribute to a favourable microclimate in winter for larval survival. At the end of May all larva were hatched, only some pupae were present, and the adults, especially males, rested on the ground vegetation around the marsh. This brings the time of eclosion to a month later than observed in the Berlin region (Kirchberg and Petri 1955).

New to Öland.

Buserum, loc. 132 25.5.73 1730, 1 ♂; Köping, loc. 135 28.5.73 1630, 1 ♂; Nabbelund, Grankullaviken loc. 134 28.5.73, 50 ♂, 60 ♀; Byxelkrok, loc. 133 25.5.73 1340, 1 ♂.

#### **Aedes refiki** Medschid 1928

A very rare species, scarce throughout Germany, also near the Baltic coast (Mohrig 1969), in western Europe, the ČSSR, Hungary, Yugoslavia, Crimea and Asia Minor. The species usually has one generation in Central Europe. From the Crimea an apparent summer generation by overdue spring eggs, as well as facultative larval hibernation were recorded (Gutsevich et al. 1970). The larvae seem to prefer pools in marshy deciduous forest, but may also occur in open meadow pools. The Öland specimens were all swept by previous collectors and no larvae were found.

New to Fennoscandia.

Högsrum, St. Rör 8.7.49, 1 ♂ (B. Tjeder); Resmo alvaret 28.6.52, 1 ♂ (P. Ardö); Ismantorp 27.6.62, 1 ♀ (K. Ander).

#### **Aedes intrudens** Dyar

The species is a pronounced forest species and has its main abundance in the northern coniferous forest belt. It seems to be rare in western Europe, but well established on the southeast shores of the Baltic (Remm 1957,

Spuris 1965); it is found in Poland (Skierska 1971) and has its northern limit in USSR in the forested tundra of Kamtchatka and its southern limit on the steppe in the Ukraine (Gutsevich et al. 1970). In Fennoscandia the species seems to have its main abundance in central and northern parts of Finland (Brummer-Korvenkontio et al. 1971, Frey, Storå 1941). In Sweden neither distribution nor biology of the species is well studied. Besides earlier finds from Dalarna and Värmland (Natvig 1948), the species has been found in Småland and in Lapland (Dahl 1974 b). The species seems to have the same biology on Öland as recorded for Central Europe (Mohrig 1969), viz. an early spring species. Larvae (III—IV instars) as well as males were found in May—June, indicating a univoltine development. However, larvae have been occasionally reported from August (South Finland) and July (higher elevations from Norway).

New to Öland.

Ekerum, loc. 114 6.—18.5.65, III—IV inst. L; 6.5.66, 2 ♂; Buserum, loc. 136 8.6.72. 1 ♀; assoc. larval, pupal skin.

#### **Aedes dorsalis** (Meig.)

Both *caspius* and *dorsalis* are found from the Balkans to Denmark, Poland (Skierska 1971), the Estonian (Remm 1957) and other parts of the USSR with its northern limit in South Siberia (Gutsevich et al. 1970). In Fennoscandia both species are recorded from South Finland (Natvig 1948, Brummer-Korvenkontio et al. 1971), but only *dorsalis* from South Sweden (Zetterstedt 1850, Natvig 1948, Ardö 1951) and Norway (Natvig 1948).

Both species are coastal, halophilous, but while *dorsalis* in Europe never occurs in pure freshwater localities, *caspius* may occasionally (Mohrig 1969) do so. From Denmark Wesenberg-Lund (1920) reported two generations for *caspius*, which he stated to be the more common one along the Danish coasts. *A. dorsalis* has previously been recorded from Öland by Natvig (1948).

Vickleby, dike 2.7.49, 1 ♂ (B. Tjeder).

**Aedes communis** (DeG.) s.l.

This is one of the most common if not the most common culicid species complex in the Holarctic. It is only absent from the subarctic zone in the North and the subtropical in the South.

*A. communis* s. l. is the most well-studied species complex in both Denmark and Fennoscandia in regard to the occurrence in varying biotopes, its phenology, diel periodicity of eclosion (Brummer-Korvenkontio et al. 1971, Iversen 1971, Dahl 1973), as well as the biting habits (Syrjämäki 1960, Arevad et al. 1973, Dahl unpubl.).

The species is univoltine, early, and the females are most persistent biters. Occasionally larvae may be found (Mohrig 1969) later in summer. On Öland the species is not the first to appear. It seems to be confined to more shaded localities and is a forest species. Biting females were found at the beginning of August in deciduous forest near marshy clearings.

New to Öland.

Buserum, loc. 132 27.5.73 1730, 1 ♀; Stora Rör, loc. 113 4.8.71 1628, 1 ♀, 8.6.72, 2 ♀ reared; Ekerum, loc. 114 18.5.66, 1 ♂, IV inst. L.; 7.6.72, 3 ♀ reared; Ismantorp, loc. 117 8.6.72 1805, 5 ♀; Borge hage, loc. 116 5.8.71 1104, 2 ♀; Kolstad, Köping 8.57, 1 ♀ (K. Ander); Nabbelund Grankullaviken, loc. 134 28.5.73, 3 ♀.

**Aedes punctor** (Kirby)

The distribution of *A. (O.) punctor* (Kirby) is rather well known. It is holarctic, most abundant in the coniferous forest zone and in deciduous forests restricted to habitats with low pH. In Scania and Lapland I have never found more than one larval generation, but Mohrig (1969) reports from the German coast of the Baltic occasional second larval broods. The adults (males and females) are found from early spring on Öland as well as in other parts of Sweden. On Öland females were also present in early August.

New to Öland.

Bårby mosse, loc. 131. 27.5.73 1600, 1 ♂; Dröstorps mosse, loc. 111 8.6.72 1112, IV inst. L; Buserum, loc. 136 9.6.72, IV inst. L; loc. 132 27.5.73 1730, 1 ♀; Ismantorp, loc. 117 8.6.72 1805, IV inst. L., 1 ♀; Ekerum, loc. 114 18.5.66, 3 ♂; 4.8.71 1717, 1 ♀; Borgholm 21.6.62, 3 ♀ (K. Ander); Kolstad, Köping 8.57, 2 ♀ (K. Ander).

**Aedes leucomelas** (Meig.)

*A. leucomelas* is a palearctic species. In Fennoscandia it was only found in the southernmost parts of Norway, Finland and Sweden by Natvig (1948), but Ardö (1951) added reports from Halland, Småland and Gästrikland. In Dalarna, Härjedalen and Lule Lappmark I have not found the species either in boreal forest or in the mountains. It seems to be a Central European species (Mohrig 1969) with extension in the USSR along the Baltic coast, e.g. Latvia (Spuris 1965). But its eastern distribution is also insufficiently known (Gutsevich et al. 1970). It is an univoltine species, which appears early in spring. The larvae are found in open pools in meadows or in sparse deciduous forests and in inundation zones of large rivers, occasionally also in saline waters.

On Öland the species was present at the end of May. No larval finds are at hand, but males were caught near possible larval habitats. In one case it was a temporary pool in deciduous forest, the bottom covered with leaves (loc. 114), in another case it was a *Cladium* marsh, a rather shaded locality (loc. 134).

New to Öland.

Buserum, loc. 132 27.5.73 1730, 2 ♀; Ekerum, loc. 114 17.5.66, 1 ♂; Köping 3.6.51, 3 ♀ (B.-O. Landin); Nabbelund, Grankullaviken loc. 134 28.5.73 1500, 1 ♂, 1 ♀.

**Aedes cataphylla** Dyar 1916

*A. (O.) cataphylla* is a holarctic, northern species, which in the Nearctic is found from

Alaska through Canada to the northern States of USA (Carpenter and LaCasse 1955). Its distribution in Central Europe is discussed by Mohrig (1969). In the USSR it is found along the Baltic in Latvia (Spuris 1965) and from the Ukraine to the tundra, where its northern limits are not exactly known (Gutsevich et al. 1970). From Fennoscandia it is recorded from South and Central Finland as not too rare (Hirvenoja 1962, Brummer-Korvenkontio et al. 1971), from Norway up to the Trondhjem area and from Sweden up to Lule Lapmark (Dahl 1974 b). The species is reported to be one of the earliest spring species. It can be locally very abundant and occurs in larval biotopes from temporary melting water pools to weakly acid pools in forested areas.

On Öland *cataphylla* is together with *A. (O.) cantans* (Meig.) the earliest and most common spring species. Numerous larvae were found in the same biotope, viz. temporary pools without vegetation, only dead leaves on bottom and situated in semishaded localities as described by many authors (Hirvenoja 1962). All males were caught in May or June, indicating the same univoltine pattern as recorded from elsewhere (Mohrig 1969). Females were caught at attempts to bite mainly in June in both open (loc. 132) and forested localities (loc. 136, 117). But also in August fierce biting of *cataphylla* was observed (loc. 115, 113). One female was caught on *Tanacetum vulgare*, obviously feeding on nectar (coll. Bo Tjeder).

New to Öland.

Vickleby, loc. 127 5.5.65, IV inst. L., 1 ♂; Buserum, loc. 136 26.5.73, 3 ♀; loc. 132 27.5.73 1730, 6 ♀; Ismantorp, loc. 117 8.6.72 1805, 1 ♂, 5 ♀; Glömminge, Ispeudde 14.6.49, 1 ♂ (B. Tjeder); Högsrum, Stora Rör 22.6.49, 1 ♀, feeding on *Tanacetum vulgare* (B. Tjeder); 4.7.49, 4 ♀ (B. Tjeder); Stora Rör, loc. 113 4.8.71 1628, 2 ♀; Ekerum, loc. 114 6.5.65, II—IV inst. L., P.; 18.5.66, 1 ♂; Råplinge, Borge hage 29.6.49, 1 ♀ (B. Tjeder); Borge hage, loc. 115 5.8.71 1018, 1 ♀; Nabbelund, Grankullaviken, loc. 134 28.5.73, 1 ♀.

### *Aedes annulipes* (Meig.)

The species is not very common but widely distributed in western (Marshall 1938) and Central Europe (Dix 1972), in the Balkans, along the Baltic coast in the Latvian (Spuris 1965) and Estonian (Remm 1957) parts of the USSR. From other parts of the USSR it is by male finds with certainty only recorded from the Ukraine (Gutsevich et al. 1970). From Denmark Wesenberg-Lund (1920), as well as Arevad et al. (1973) reported the species as rather common in certain localities. This can also be the case in Central Europe (Ockert 1970). From Fennoscandia it has been recorded from Scania (Natvig 1948) on one male in coll. Zetterstedt, which I have been able to confirm. Ardö (1951, 1952, 1958) records finds of females and larvae from Scania, as well as of males from Halland.

The larval habitats and the biology of the species in South Sweden are not very well known. Arevad et al. (1973) report the species in Denmark to appear later than *communis* and *punctor*, and the find of the Öland male in the beginning of July does not contradict this opinion.

New to Öland.

Halltorp 1.7.47, 1 ♂ (B. Tjeder).

### *Aedes cantans* (Meig.)

This palearctic species is reported from southern Europe, the Balkans (Mihályi 1959), Central Europe along the southern and eastern shores of the Baltic (Spuris 1965, Remm 1957, under the name of *maculatus*), and in the USSR up to the taiga and probably also in the forested tundra zone (Gutsevich et al. 1970). The species is common in Denmark (Wesenberg-Lund 1920, Arevad et al. 1973). In Fennoscandia *cantans* is common in South and Central Finland (Brummer-Korvenkontio et al. 1971), in South Norway (Natvig 1948) and recorded from Scania to Upland (Natvig 1948) and from Lule Lapmark (Dahl 1974 b). It is one of the

most characteristic spring species and is found in Central Europe in a wide range of biotopes (Mohrig 1969). In Scania it is the dominating species in marshy areas in semi-shaded and shaded localities.

On Öland most of the larvae reach the last stage in the middle of May or the beginning of June. In years after dry winters with late springs, eclosion mainly takes place around the end of May or the beginning of June. In wet and warm years with early hatching, adults may be found by the middle of May.

The species may be bivoltine in certain localities (Mohrig 1969). The presence of actively biting females in several localities in August 1971 on Öland suggests, that in this particular year (a cool and wet one) a second larval brood was produced. In Denmark 1971 was also a favourable year for this species (Arevad et al. 1973).

Previously recorded as common from Öland (Wahlgren 1915).

Vickleby, loc. 127 18.6.66, 2 ♂; Buserum, loc. 136 8.—9.6.72, 1 ♂, 4 ♀, num. IV inst. L., P.; Ismantorp, loc. 117 5.8.71, 4 ♀; 8.6.72, 1 ♂, 1 ♀; Stora Rör, loc. 113 4.8.71 1628, 5 ♀; Ekerum, loc. 114 15.5.66, num. II—IV inst. L., P., 1 ♂; 4.8.71 1717, 23 ♀; 7.6.72, num. III—IV inst. L., P.; Borgholm 18.6.62, 2 ♀ (K. Ander); Borge hage, loc. 115 5.8.71 1018, 15 ♀; loc. 116 5.8.71 1104, 25 ♀; Nabelund, Grankullaviken, loc. 134 28.5.73 1500, IV inst. L.

#### *Aedes riparius* D.K.

It is known from northern Germany (Mohrig 1969), the Latvian and Estonian parts of the USSR (Spuris 1965, Remm 1957) and South and North Finland (Hirvenoja 1962), Central Sweden and South Norway (Natvig 1948). It is a northern, circumpolar species (Carpenter and LaCasse 1955).

On Öland the species was found near or in deciduous forest and whether several generations occur in favourable years as indicated by Mohrig (1969) from Central Europe, needs further investigation.

New to Öland.

Buserum, loc. 132 27.5.73 1730, 1 ♂; Ismantorp, loc. 117 5.8.71 1308, 1 ♀; Södra Bäck, loc. 121 5.8.71 1801, 2 ♀; Stora Rör, loc. 113 4.8.71 1628, 1 ♀; Borge hage, loc. 115 15.8.71 1008, 2 ♀; loc. 116 5.8.71 1104, 2 ♀.

#### *Aedes excrucians* (Walk.)

A holarctic species, rare, however, in western Europe (Mohrig 1969); in the coniferous forest regions it is a locally significant species (Hirvenoja 1962, Dahl 1974 b), reaching the tundra in the USSR (Gutsevich et al. 1970). In Sweden, I have found the larva in permanent and exposed *Typha* pools, in *Carex* marshes and also in small rather acid pools, which were temporary. It is not an early spring species in Scania (cf. Mohrig 1969) and is almost a summer species in Lapland (Dahl 1974 b). It is reported as univoltine. On Öland, biting females were found in August. This could indicate a second generation, but the females may also appear in the later part of June and start a new biting cycle in August. Or development may be delayed in the deeper parts of permanent pools, so that an apparent "second" generation can be found. The shallow bays of the Baltic Sea may also be suitable places for *excrucians* development, as the species tolerates salinity to some extent (Mohrig 1969). That the species is univoltine is supported by the findings of males in May — June only.

New to Öland.

Buserum, loc. 136 8.6.72 1317, 2 ♂, 4 ♀; 27.5.73, 1 ♂, 3 ♀; loc. 132 27.5.73 1730, 1 ♂, 4 ♀; Ismantorp, loc. 117 5.8.71 1308, 1 ♀; 8.6.72 1805, 1 ♂; Södra Bäck, loc. 121 5.8.71 1801, 1 ♀; Solliden 28.6.52, 1 ♂ (P. Ardö); Borge hage loc. 115 5.8.71 1104, 1 ♀.

#### *Aedes flavescens* (Müll.)

This holarctic species reaches its northern limit in the USSR in Karelia (Gutsevich et

al. 1970) and is a well established species along the southern and eastern Baltic Sea shores (Spuris 1965, Remm 1957, Mohrig 1969) and in South Fennoscandia (Natvig 1948). Aside from polycyclic occurrence in Central Europe (Mohrig 1969), *flavescens* seems to be mainly monocyclic in Northwest European areas (Zielke 1970) as well as in southeastern European localities (Mihályi 1959, Trpiš 1962). One generation is also reported as normal in North America (Carpenter and LaCasse 1955, Trpiš and She-manchuk 1969). In Scania only one generation has hitherto been found (Dahl unpubl.), and the finds on Öland also indicate only one generation. The species occurs in permanent or semipermanent pools which are heavily vegetated or in temporary pools along brackish shores, or inundation zones of rivers. The finds on Öland near Bårby mosse indicate larval biotopes of the first kind. *A. (O.) flavescens* often occurs together with *exrucians* and the adults emerge later than the first spring species.

New to Öland.

Bårby mosse loc. 131 27.5.73 1600, 2 ♂, 2 ♀; Buserum, loc. 132 27.5.73 1730, 1 ♀.

### **Aedes cypricus** Ludl.

The species is an eastern and northern palearctic culicid, which in the USSR is known from the Ukraine, Kasachstan in the South, extending through the steppe and forest zones to Karelia and the southern taiga in the North (Gutsevich et al. 1970), in Central Europe from North Germany and along the Baltic Sea shores from Latvia (Peus 1937, Spuris 1965) and Estonia (Remm 1957). In Fennoscandia the species is found in South Sweden and South Finland (Natvig 1948, Ardö 1951), but known only in a few specimens. In Central Öland single adults have been caught during a long period of years. This indicates that the species is well established on the island. Males from two localities are known, and are found in early to late May. No larvae have been found yet,

but at least in loc. 132 eclosion must have occurred only just before my visit, because the adults had not yet left the vicinity of their larval biotope. Peus (1937) gave an account of the habitats from which the larvae were described. In both permanent and temporary pools in inundation zones he found larvae always in the middle of the pools.

On Öland the dry ditch with luxuriant vegetation of *Geum*, *Geranium* and grass, on which the males and females rested, formed together with the surrounding deciduous forest the natural limitation of a completely flooded *Carex* and grass meadow, which in the central part had a more permanent pool with *Menyanthes* and *Ranunculus aquatilis* (fig. 2). The surface limestone, covered by a about 50 cm thick layer of vegetation forming the meadow is impermeable and retains the winter and spring precipitation until it slowly evaporates. In 1973 at the end of May only small patches containing water were still present. Both these small pools and the larger, permanent one no longer contained larvae or pupae.

New to Öland.

Mörbylånga juni 1932, 1 ♀ (K. Nilsson); Buserum, loc. 136 27.5.73, 2 ♀; loc. 132 27.5.73, 3 ♂, 5 ♀; 29.5.73 1015, 1 ♀; Ekerum, loc. 114 6.—17.5.66, 3 ♂; Köping, loc. 135 28.5.73 1630, 1 ♀; Köpinge, Vipekärret 7.59, 1 ♀ (K. Ander); Löt 28.6.32, 1 ♂ (A. Kemner).

### **Aedes cinereus** Meigen s.l.

Larvae were caught in June and August. Peus (1972) reports two generations as normal also for *geminus*. Whether this applies on Öland could not be clarified, as rearing in August was not successful. That *cinereus* also breeds in rather shaded and acid habitats, I can confirm for Scania. On Öland all pools are naturally much more neutral because of the underlying limestone. According to Peus (1972) *geminus* is restricted to less acid habitats.



Fig. 2. Buserum loc. 132. The *Carex* meadow on which newly hatched ♂ and ♀ of *A. (O.) cyprius* Ludl. were found. The open pool is probably the main larval habitat. (May 1973, Ch. Dahl phot.)



Fig. 3. Buserum loc. 136. At the edge of this submerged meadow larvae of *A. (A.) cinereus* Meig. s.l. were found. To the left, the marshy ground continues with small shaded pools without vegetation. From these the adults of *A. (A.) geminus* Peus were reared. (May 1973, Ch. Dahl phot.)

#### Females and larvae:

Buserum, loc. 136 8.—14.6.72, 7 IV inst. L., 5 ♀; 25.5.73, 1 IV inst. L.; Södra Bäck, loc. 121 5.8.71 1801, 1 ♀; loc. 118 5.8.71 1458, 1 III inst. L.; Stora Rör, loc. 113 7.6.72, 1 IV inst. L.; 5 ♀; Ekerum, loc. 114 4.8.71 1717, 3 ♀; 7.6.72 1545, 3 IV inst. L.; Borge hage, loc. 116 5.8.71 1104, 2 ♀.

#### *Aedes cinereus* Meig. s.str. sensu Peus

The males were caught at or near the localities where the larvae were also found. New to Öland.

Buserum, loc. 136 9.6.72, 4 ♂ reared; Ekerum, loc. 125 7.6.72, 1 ♂; Stora Rör, loc. 113 7.6.72, 1 ♂.

#### *Aedes geminus* Peus

The species has been identified from all over the German parts of Central Europe, as well as from the southern and eastern shores of the Baltic Sea in Poland and USSR (Peus 1972).

Adults were reared from two pools (loc. 113, 136) both of which are situated in deciduous forest, but of somewhat different character, see description of localities. But both pools lacked vegetation and were temporary and of either shaded or semi-shaded character. Both were visited during several years and because of variations in precipitation and air temperatures, the depth of loc. 136 varied considerably (40 cm 1972, and 20 cm 1973) and also the times of eclosion did not coincide in these two years. In 1973 loc. 136 was already at the end of May empty of larvae and pupae (water temperature 18°). Fig. 3 shows the deeper, exposed part of the flooded meadow that was connected with the small semishaded pool system in which *geminus* was found. In two of three localities wherefrom larvae were reared, both *geminus* and *cinereus* s.str. occurred.

New to Fennoscandia.

Buserum, loc. 136 9.6.72 4 ♂ reared; Stora Rör, loc. 113 7.6.72 1 ♀ reared (det. F. Peus).

**Aedes vexans** Meig.

The species is only known from the island by an old specimen (Natvig 1948). It is a typical summer species and occurs in open localities. The larvae are usually found in more permanent waters, which become quite warm in summer.

**Culiseta annulata** (Schr.)

A western palearctic species, which is common everywhere, but does not reach far north. It is known from the Estonian parts of the USSR (Remm 1957) and seems to have its northern limit in the Leningrad district (Gutsevich et al. 1970). In Fennoscandia it is known from the west coast of Norway, where it extends rather far north. In Sweden it reaches up to Central Sweden (Natvig 1948), and is known from South Finland (Brummer-Korvenkontio et al. 1971).

The females hibernate and start to bite very early in the season. The present female is probably a hibernated specimen.

New to Öland.

Stora Frö, Vickleby 13.5.66, 1 ♀ (K. Ander).

**Culiseta morsitans** (Theob.)

The species is a common holarctic one, which, however, seems to be restricted to the more southern parts of Fennoscandia. In the northern boreal forest it is replaced by *C. (C.) bergrothi* Edw., cf. Natvig (1948). In general it has thus the same distribution as *annulata*. But in *morsitans* it is the larva which hibernates. The species is univoltine.

Wahlgren (1915) recorded *morsitans* as rare from Öland. The two females caught in June and August thus cover the whole flight period of the females.

Stora Rör, loc. 113 4.8.71 1628, 1 ♀; Köping 3.6.51, 1 ♀ (B.-O. Landin).

**Culex pipiens** L.

Its northernmost distribution in Sweden is not fully known. In South Sweden it is a common summer and autumn species. The finds of larvae on Öland show that the species can breed in the most extreme habitats, e.g., a protected bay with *Phragmites* between large stones and heavily polluted brackish water, covered by red sulphur bacteria.

New to Öland.

Eriksöre, loc. 120 5.8.71 1531, III—IV inst. L., 3 ♂, 2 ♀.

## 5. Discussion

Apart from the marginal ecosystem of the alvar where only a few culicid species occur, Öland has two other interesting biotic communities. One is the reforestation of pine and spruce that are replacing the spontaneous coniferous forests of the northern parts of the island. In this biotope is found *A. (O.) rusticus* (Rossi) which exhibits unusual plasticity in regard to hibernating mechanism. The other and most significant biotope, also for culicid species on Öland, is the luxuriant deciduous forest — a mixture of *Quercus*, *Fraxinus*, *Alnus*, *Betula*, *Corylus* and *Prunus spinosa* — which is mainly preserved in the central parts of the island. In olden times cattle was kept in the forest which also was otherwise heavily influenced by man. In spite of this it represents remains of a genuine South Scandinavian forest. This is influenced on Öland by the conditions of glaciated limestone areas. It is characterized by the mosaic of marshy and dry localities and the seasonal contrast between wet and dry periods. Culicids with their special demands on aquatic habitats are much favoured by the formation of more or less temporary pools which last from autumn to spring in dry years and may remain throughout the year in wetter ones.

The species hitherto found on Öland (Tab.



Tab. 1. The present distribution of Culicinae and Anophelinae found on Öland in regard to some holarctic areas.

\*Palearctic species; ( ) brackets=rare in this area; 1 new to Fennoscandia

species	West Europe	South and Central Europe	South and east coast of Baltic Sea	South and Central Fenn.	North Fenn.	New to Öland
<i>Aedes (Ochlerotatus)</i>						
<i>rusticus</i> * (Rossi) . . . . .	×	×	×	×	—	×
<i>refiki</i> * Medsch. . . . .	×	×	(×)	—	—	× <sup>1</sup>
<i>intrudens</i> Dyar . . . . .	(×)	×	×	×	×	×
<i>dorsalis</i> (Meig.) . . . . .	×	×	×	×	—	—
<i>communis</i> (DeG.) s.l. . . . .	×	×	×	×	×	×
<i>punctor</i> (Kirby) . . . . .	×	×	×	×	×	×
<i>leucomelas</i> * (Meig.) . . . . .	×	×	×	×	—	×
<i>cataphylla</i> Dyar . . . . .	×	×	×	×	—	×
<i>annulipes</i> * (Meig.) . . . . .	×	×	×	×	—	×
<i>cantans</i> * (Meig.) . . . . .	×	×	×	×	—	—
<i>riparius</i> D. K. . . . .	—	—	×	×	×	×
<i>excrucians</i> (Walk.) . . . . .	(×)	×	×	×	×	×
<i>flavescens</i> (Müll.) . . . . .	×	×	×	×	—	×
<i>cyprius</i> * Ludl. . . . .	—	(×)	×	×	—	×
<i>Aedes (Aedes)</i>						
<i>cinereus</i> Meig. s.str. . . . .	×	×	×	×	×	×
<i>geminus</i> * Peus . . . . .	—	×	×	—	—	× <sup>1</sup>
<i>Aedes (Aedimorphus)</i>						
<i>vexans</i> Meig. . . . .	×	×	×	×	×	—
<i>Culiseta (Culiseta)</i>						
<i>annulata</i> * (Schr.) . . . . .	×	×	×	×	—	×
<i>Culiseta (Culicella)</i>						
<i>morsitans</i> (Theob.) . . . . .	×	×	×	×	—	—
<i>Culex (Culex)</i>						
<i>pipiens</i> L. . . . .	×	×	×	×	—	×
<i>Anopheles (Anopheles)</i>						
<i>claviger</i> (Meig.) s.l. . . . .	×	×	×	×	×	×
<i>maculipennis</i> Meig. s.l. . . . .	×	×	×	×	×	×

1) exhibit all three modes of hibernation found in northern culicids. *Anopheles maculipennis* s.l., *Culiseta annulata* and *Culex pipiens* hibernate in the female stage, whereas *Aedes rusticus* and *refiki* and *Culiseta morsitans* are present in the larval stage during the winter. Most species, however, hibernate in the egg stage, the larvae hatching in spring.

A number of species inhabit forests, viz. *communis*, *punctor*, *intrudens*, *cinereus* and *cantans*. They are widely distributed in coniferous forests and the larvae dominate in temporary pools without vegetation.

Some species prefer open or only partly shaded habitats with more or less dense vegetation in the larval pools, viz. *cataphylla*, *excrucians*, *flavescens*, *annulipes*, *cyprius*.

Culicids have mainly been collected on the central parts of the island (fig. 3). Therefore a discussion of the detailed distribution of single species on the island is not yet possible.

But when the species are grouped according to their present distribution in other parts of Europe (tab. 1), an indication as to the origin of the main part of the culicid fauna on Öland is found.

Culicids have a great dispersal potential

in the adult stage, but as larvae are strictly bound to special types of aquatic habitats. In general, there are three groups of species in regard to their distribution in the formerly glaciated areas in Sweden, a northern circumpolar group confined to the taiga — tundra biome, a southern one which has its northern limits roughly coinciding with the occurrence of *Quercus*, *Fraxinus* and *Corylus*, and the last group with wide distribution but which is absent from the subarctic and high mountainous regions. Except for six species (*punctator*, *communis*, *intrudens*, *excrucians*, *riparius* and *cinereus*) the Öland culicids all belong to the southern group of species. If the high percentage of palearctic species with a present rare occurrence in the central, south and southeastern parts of Europe is considered (tab. 1), it is obvious that the deciduous forests of Öland have served as a reservoir for more species than elsewhere in southern Sweden. In late glacial and early postglacial periods a tundra biome followed the regression of the ice. Tundra elements may in fact be found on the alvar (Wahlgren 1917, Brinck 1966). The successive invasion and stabilization of a deciduous forest distinguished the following amelioration of the postglacial climate. And where suitable aquatic habitats existed, a rich culicid fauna became established. The present number of species may only be part of the original sequence of species, somewhat reduced by the following deterioration of climate. But more clearly than in other parts of South Sweden with remains of deciduous forests, the rather genuine forest habitats in the "impediment" of Öland show in their culicid fauna the dominance of southern and southeastern species. A similar situation has been previously found for other invertebrates and plants on the island (Wahlgren 1917).

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