EMERGENCE OF *ABLABESMYIA MONILIS* (DIPTERA: CHIRONOMIDAE) FROM FINDLEY LAKE DURING WARM AND COLD YEARS

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With 3 figures

ABSTRACT. There was considerable yearly variation in the maximum surface temperature at Findley Lake and the depth to which the warm surface water mixed during the summer. *Ablabesmyia monilis* emerged where the water temperature was more than 16º C. The maximum emergence was from the organic detritus from the surrounding forest at a depth of 1.8 metres in years when the water was warm enough at that depth.

RESUMO. Encontramos uma variação consideravel na temperature máxima na superficie do Lago Findley bem como na profundidade da circulação da água quente nos meses vernais. A eclosão de *Ablabesmyia monilis* occoreu quando a temperatura da água excedeu 16º centígrados. Eclosão máxima ocorreu nos detritos orgânicos derivados da floresta circundante numa profundidade de 1,8 metros quando a água naquela profundidade atingiu uma temperatura suficientmente quente.

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INTRODUCTION

Species of Chironomidae emerging from Findley Lake in the warm year of 1973 emerged from depths between 0 m and 19.3 m, or 0.5 m and 19.3 m, except *Ablabesmyia monilis* (LINNAEUS, 1758), which was restricted to the shallow littoral (0 m to 5.6 m depth) (SHERK & RAU, 1992; 1996), indicating a higher temperature threshold compared to other species. Temperature threshold for for *A. monilis* emergence in the Pyrenees was estimated at 16° C to 17° C (LAVILLE, 1971). Annual maximum surface temperature at Findley Lake varies due to the variation in snowfall and therefore onset of the thaw (HENDREY & WELCH, 1974; SHERK & RAU, 1996). In some years maximum surface temperature exceeded 16° C, but in other years it was less than 16° C.

Earlier papers (SHERK & RAU, 1992; 1996) have only explored emergence of *A. monilis* in 1973 from Findley Lake when maximum surface temperature reached 19.25° C. In this paper we study yearly variation in *A. monilis* emergence during years when the maximum surface temperature was above or below the emergence threshold of 16° C.

Study area

Findley Lake (1128 m asl) in the Cascade Mountains of Washington, USA is surrounded by coniferous forest, talus slopes and wet meadows (Fig. 1). The glacial lake, carved in volcanic rock (andesite), has a maximum depth of 27.5 m, a mean depth of 7.8 m and an area of 11.4 ha. The lake is oligotrophic (HENDREY & WELCH, 1974). Most phytoplankton production is between the depths of 5 to 15 m, with the maximum production at 15 m. Detritus from the forest enters the lake near the shore (RAU, 1976), especially near the temporary melt-water tributaries.

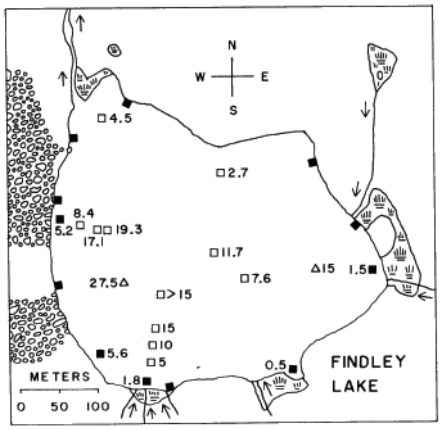

Fig. 1. Map of Findley Lake with depths in metres. Locations of traps where *Ablabesmyia monilis* emerged (solid squares). Locations of traps where *A. monilis* did not emerge (hollow squares). Maximum depths of the east and west basins (triangles).

MATERIALS & METHODS

Insects were collected in 1.0 m^2 floating emergence traps covered by 1.0 mm mesh fiberglass screening (SHERK *et al*., 2003). Similar traps were placed with one side onshore. Ten floating and seven shore traps were used in 1972. Fewer traps were used in other years. Collections were made at one to five day intervals during ice-free periods.

RESULTS

There was considerable yearly variation in maximum surface temperature and the depth to which the warm surface water mixed during the summer (Fig. 2). *A. monilis* started to emerge from most depths when temperature reached a threshold of 16° C. Maximum emergence was from organic detritus derived from the surrounding forest at a depth of 1.8 m in years when the water was warm enough at that depth.

In 1972 (lake thaw 7 July), maximum surface temperature reached 21.0° C, but cold temperatures remained below the surface (Fig. 2). *A. monilis* only emerged within one metre of shore (Fig. 3) when the surface temperature reached 16° C and continued at a wet meadow when the surface temperature fell below 16° C.

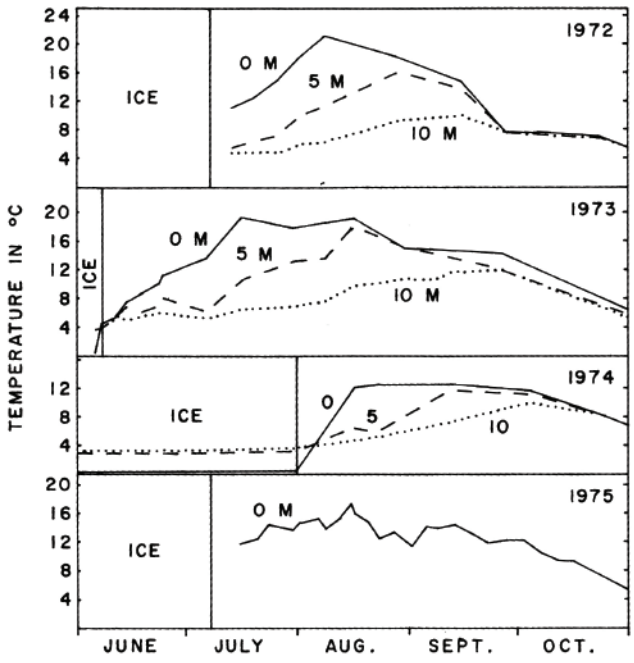

Fig. 2. Temperatures at 0 m, 5 m and 10 m depths at Findley Lake from 1972 to 1974 and at 0 m in 1975. Temperatures at the shoreline of the wet meadows were sometimes warmer than where the vertical temperature profile was measured.

In 1973 (early thaw on 7 June), maximum surface temperature reached 19.25° C, with warmer temperatures below the surface compared to other years (Fig.2), with the temperature briefly reaching 18° C at 5 m depth. *A. monilis* emerged from the 0 to 5.6 m depth (Fig. 3 and SHERK & RAU, 1996), except at the 2.7 m deep site where there was less forest detritus (RAU, 1976). Emergence started when the bottom temperature reached approximately 16° C, (excluding the two individuals that emerged early at the 1.8 and 5.6 m deep sites near the tributaries)

In 1974 (late thaw on 31 July), maximum surface temperature was only 12.5° C (Fig. 2). Only one individual emerged from the 1.8 m deep detritus near a small tributary (Fig. 3). In 1975 (thaw 7 July), maximum surface temperature was 17.4° C in mid August (Fig. 2). *A. monilis* emerged from the warm 0.5 m and 1.8 m deep sites where there was most allochthonous material (Fig. 3).

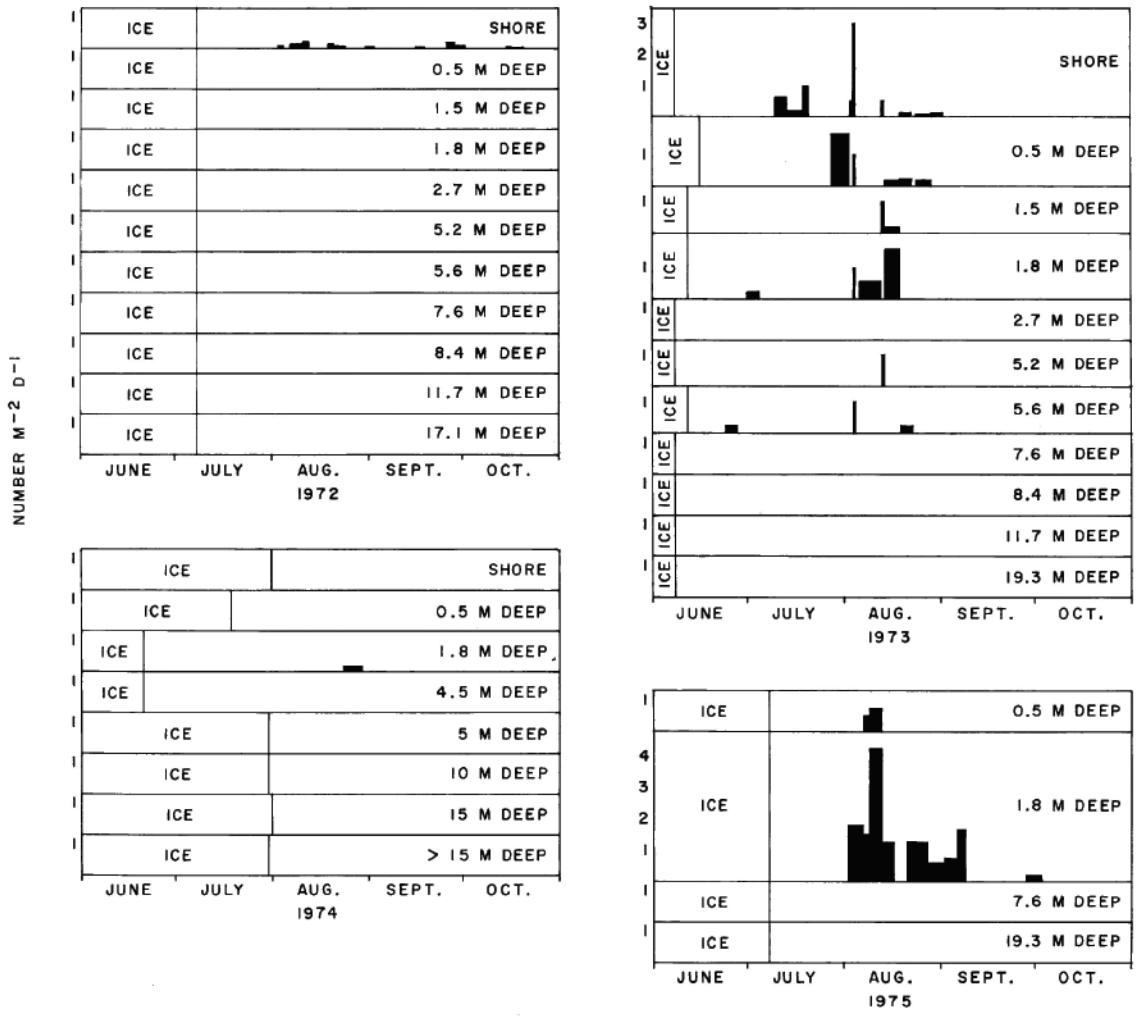

Fig. 3. Number of *Ablabesmyia monilis* that emerged per square metre per day at Findley Lake from 1972 to 1975.

Maximum emergence of *A. monilis* was in 1975 from the 1.8 m deep site with high levels of allochthonous material from the surrounding forest (RAU, 1976). Except for a few individuals from the 5.2 and 5.6 m deep sites in 1973, no *A. monilis* emerged from the 5 to 15 m depths where primary production predominated (HENDREY & WELCH, 1974).

DISCUSSION

The temperature threshold for *A. monilis* emergence in North America was the same as that in Europe (LAVILLE, 1971). The Findley Lake *A. monilis* started to emerge when the bottom temperature at most sites reached 16° C. Although most of the Findley Lake insects emerged at the surface directly above where their last instar larvae or pupae had lived, there might have been some lateral movement near the tributaries. The three individuals that emerged early at the 1.8 and 5.6 m sites near the tributaries in 1973 and 1974 (Fig. 3) might have drifted from a warmer microenvironment at the nearby wet meadow.

In the year prior to our emergence studies (1971), Findley Lake was still covered with 2 m of slushy snow on 24 July, but had completely thawed and reached a maximum surface temperature of 20° C and a maximum temperature of 16° C at 1m depth on 10 August (HENDREY & WELCH, 1974). This may have affected emergence patterns in the shallow near shore sites in 1972.

By excluding the two individuals that emerged early at the 1.8 and 5.6 m deep sites, we can observe a delay in the onset of *A. monilis* emergence with increasing depth in 1973 (Fig. 3). There was also a delay in the onset emergence with increasing depth from 1.5 to 11 m in Lake Innaren in southern Sweden (BRUNDIN, 1949), probably related to the delay in reaching temperature threshold.

A. monilis emerged later when there was a late thaw (Fig. 3), similar to the subarctic lakes of Jamtland where there was a later thaw than in the lakes of southern Sweden (BRUNDIN, 1949). In some years, the 1.8 m deep detritus at Findley Lake did not warm up sufficiently to allow full emergence and most of the 1974 emergence was probably delayed until 1975. Only a fifth as many Chironomidae emerged at Findley Lake in 1974 (late thaw and low surface temperatures) compared to 1973 (early thaw and warm surface temperatures) (SHERK & RAU, 2000). The number of *Procladius*, *Orthocladius* and *Microtendipes stygeus* TOWNES that emerged was relatively constant each year (SHERK & RAU, 1996), with onset of emergence occurring during the thaw in some years when the water was still very cold. Fewer *Stictochironomus* emerged from the intermediate depths and fewer *Chironomus* emerged from the deeper water when there was a late thaw, but the temperatures at time of emergence, following the thaw, were about the same each year. *Tanytarsus* and most other species had a high emergence from many depths in 1973 (early thaw) and a very low emergence, or no emergence, in

other years (SHERK & RAU, 1996).

In Lake Mývatn, Iceland, annual emergence numbers of *Orthocladius oblidens* (WALKER) were relatively constant, but the common *Tanytarsus gracilentus* (HOLMGREN) and several other species exhibited cyclic population fluctuations with three peaks during a 20 year period (GARDARSSON *et al*,, 1995; 2004). The number of *A. monilis* declined during the first 16 years, but recovered during the last three years. Could there have been a change in the temperature of the warm springs in the recently active volcanic watershed?

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