Duckweed fronds are multiplying nearly exponentially in clonal growth (Landolt, 1986) thus the biomass can be harvested continuously (Cheng & Stomp, 2009). Main limiting factors for growth and harvest are nutrient supply and space (Driever et al., 2005; Lasfar et al., 2007). However, the development of duckweed can be limited by algal growth (Roijackers et al., 2004). Furthermore, as in other crop production systems, diseases and pests can critically limit the performance of hydroponic or aquaponic systems (Folorunso et al., 2020) and thus jeopardize the duckweed production success. However, few pathogens are known for duckweed such as *Tracya lemnae*, *Olpidium amoebae* (syn. *Reesia amoeboides*) and *Pythium* spp., but information on pathogenicity is scarce (Brandenburger, 1985; Rejmankova et al., 1986). According to the sparse literature, *Pythium* species such as *P. aphanidermatum* and *P. myriotylum* seem most relevant for duckweed production (Rejmankova et al., 1986; Flaishman et al., 1997).

## Material & Methods

### *Source of samples*

In July 2020, rapidly growing patches of discolored, and eventually bleached fronds of *Lemna minor* L. (clone 9441; Germany) were observed (Fig. 1) in experimental hydroponic production systems for duckweed at the University of Applied Sciences Osnabrück, Germany. The first signs of the disease appeared 7 days after the start of cultivation in pools with no water movement, hence no duckweed movement (Fig. 1A). In the following six days, one specific spot (Fig. 1B) grew from 3 cm to 26 cm in diameter. In a circulatory hydroponic system, mainly in zones with very low duckweed movement, spots were observed 15 days after the start of cultivation (Fig. 1 C). In both system types water temperatures ranged between 24 to 27 °C.

In order to be able to take appropriate countermeasures, inhibit further spread and prevent repeated occurrence, the cause of this disease was investigated phytopathologically.

### *Microbiological identification*

Samples of healthy and diseased *Lemna minor* L. (clone 9441; Germany) fronds were send by mail in a water containing plastic flask to the lab of the plant protection service, Oldenburg, Lower Saxony, Germany. Fronds were transferred to glass dishes filled with tap water to a height of about 2 cm and examined visually under a binocular (Nikon SMZ800).

Without pretreatment, individual discolored or bleached duckweed fronds were laid out on half strength potato dextrose agar ($PDA_{50\%}$; 19,5 g $l^{-1}$ potato extract glucose agar [Carl Roth, Karlsruhe, Germany], 7,5 g $l^{-1}$ agar) and on carrot piece agar (CPA: 50 g $l^{-1}$ grated carrot, 15 g $l^{-1}$ agar) and incubated at room temperature. Pure isolates were produced, transferring tips of single hyphae to $PDA_{50\%}$ and CPA.

Resulting mycelium was examined microscopically (Nikon Eclipse Ni). Microscopic images and measurements of characteristic structures were made using the Nikon DS-Fi3 camera and the imaging software NIS-Elements D 5.20.01. For each relevant structure, 100 measurements were made. Measurements are reported as (minimum–)mean ± standard deviation (–maximum) and as median.

To determine growth characteristics, plugs were taken from fully grown $PDA_{50\%}$ and CPA plates of a selected isolate using a cork borer (5 mm diameter) and transferred centrally to fresh $PDA_{50\%}$ and CPA, respectively. Incubation was performed at five temperature levels (20, 25,

**Fig. 1. Patches of discolored and bleached fronds of *Lemna minor* in pools of hydroponic systems.** A: standing water, diseased (left) and healthy (right), B: standing water, single patch in detail, C: closed circulatory system, single patch in detail.