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The aquatic living caterpillars (Lepidoptera: Pyraloidea: Crambidae) of Central Europe. A key to the larvae and autecology

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With 23 Figures and 6 Tables

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An identification key has been worked out for the 7 species of Lepidoptera, family Crambidae, with aquatic living caterpillars, known from Central Europe. In this key new characters are used, in comparison with other keys, for better identifying the species. In addition autecological and biological information is given about the species treated.

1 Introduction

Some butterflies have aquatic living caterpillars. From Central Europe there are eight species known, and they all belong to the family of Pyralidae. The species *Elophila rivulalis* (Duponchel) occurs in southern Europe, West Poland and East Austria; the larva is unknown and therefore not included in our key. Whereas the almost semi-aquatic living species *Donacaula forficella*, *Nymphula nitidulata* and *Schoenobius gigantella* are included. The caterpillars of the given species can only be found at sites where the plants they feed on are present. Because of the dependence of water plants it will hardly be possible to use caterpillars as indicators of water quality. Most of the species from this key are common, when looking to the faunistics of the butterflies. However the caterpillars of some species are not easy to find and therefore the faunistics of these is very incomplete. Only *Cataclysta lemnata* and *Elophila nymphaeata* are very common. In general caterpillars can easily be found when the eating pattern in the leaves and when the cases, where they live in, are known. The caterpillar of *Donacaula forficella* was only once found by H. J. Vallenduuk and the caterpillar of *Nymphula nitidulata* is only known from literature (Buckler 1902).

In the present key we used new features, in comparison with other keys, which allow a more reliable identification of the larvae. Information from literature made it possible to give an overview of the biology of the caterpillars.

We used material from a lot of institutes to have many specimens for making reliable ranges. From many institutes in The Netherlands we received material for studying characters and making measurements.

2 The Central European species

Among the butterflies, especially Pyralidae, there are species with aquatic living caterpillars. These caterpillars adapted theirselves to a special way of living under water. This adaptation can consist of having abdominal gills or building cases like Trichoptera larvae do. Caterpillars which are living under water but only mining in plant stems without leaving these are not seen as aquatic living larvae. As far as we know there are eight species of butterflies with aquatic living caterpillars (Tab. 1).

Tab. 1: Central European Crambidae species with aquatic living larvae. Nomenclature and taxonomy follow Speidel (2002) and Karsholt & Razowski (1996)

species name	synonym	specimens studied	specimens measured	length (mm)
Acentria ephemerella (Denis & Schiffermueller)	*Acentropus niveus*	21	12	3,5-9
Cataclysta lemnata (Linnaeus)		148	12	3-16
Donacaula forficella (Thunberg)	*Schoenobius forficellus* *Schoenobious forficella*	1	1	12
Elophila nymphaeata (Linnaeus)	*Nymphula nymphaeata* *Nausinoe nymphaeata*	67	12	2-23
Nymphula nitidulata (Hufnagel)	*Parapoynx stagnata* *Nymphula stagnata*	0		
Parapoynx stratiotata (Linnaeus)	*Paraponyx stratiotata*	15		
Schoenobius gigantella (Denis & Schiffermueller)	*Schoenobius gigantellus*	32	14	5-20

3 Recognizing and collecting caterpillars

Caterpillars distinguish themselves from other insect larvae by having abdominal prolegs which are furnished with hooks. There is some congruence with the larvae of sawflies (Hymenoptera: Symphyta). However, the head of a sawfly-larva is more round and projecting ventrally and the abdomen has more than four pairs of prolegs. Moreover the eye of a sawfly-larva consists of one ocellus where a caterpillar has six ocelli (Tab. 2; Fig. 1, 2).

Tab. 2: Distinguishing characters between caterpillars and sawflies

	Caterpillar	Sawfly
number of prolegs	4	5 or more
claspers	with hook row	without hook row
head	some ocelli two long antennal segments antenna in front of the eye	one ocel antenna short, conical antenna under the eye

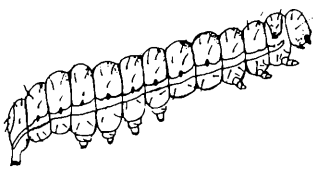

Fig. 1: Caterpillar (after Carter & Hargreaves 1986)

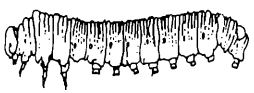

Fig. 2: Tenthredinidae-larva (after Seifert 1975)

Separating aquatic living caterpillars from terrestrial living species is more difficult. Aquatic living species use self-build cases, which are built from parts of plants where they feed on and eat submerse parts of these plants.

Aquatic living caterpillars dwell stagnant and slowly flowing waters. Their distribution depends on the presence of the plants they feed on (Tab. 3). In the early instars the caterpillars are mining in leafs or stems of water plants and are difficult to find. After that caterpillars live, depending of the species, in self-made cases between or on different parts of the plant. The caterpillars have eight instars and they have an annual cycle with a winterdiapauze of the caterpillar.

Aquatic living caterpillars can be obtained by collecting drifting parts of plants with a net. This material can best be put in a water tank. After some time the larva creeps out of its case. With some experience the cases can be recognized when drifting between a lot of other parts of plants. Some species betray their presence by showing a specific pattern of glutton on the leafs. Most species live during a great part of the instars under water. *Acentria ephemerella* stays the whole period under water. The larvae of *Schoenobius* and *Donacaula* use their cases for floating on the water surface to move from one plant to the other. These species can be counted to the semi-aquatic species.

Tab. 3: Microhabitat of aquatic caterpillars with the dominant plant feeding on

Nymphula nitidulata	*Schoenobius gigantella*	*Donacaula forficella*	*Cataclysta lemnata*	*Elophila nymphaeata*	*Parapoynx stratiotata*	*Acentria ephemerella*
						
Sparganium	*Phragmites*	*Glyceria*	*Lemna*	*Potamogeton*	*Ceratophyllum*	*Elodea*

4 Morphological terminology of caterpillars

The general morphology of a caterpillar of Crambidae can be seen in figure 3. Every proleg is furnished with a frame, which is formed by two rows of hooks. The ventral side of the claspers is furnished with two straight or curved rows of hooks. Laterally on the pronotum, directly ventrally from the prothoracic plate, are the stigma and two praestigmal setae situated. These bristles are not to be found at the same place in the individual species.

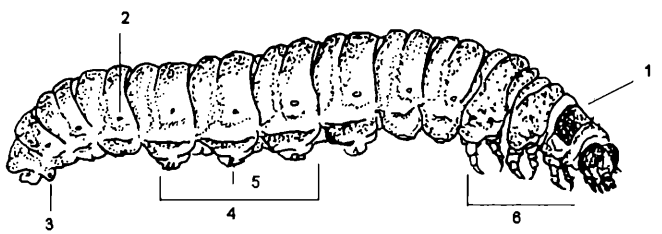

Fig. 3 *Elophila nymphaeata.* 1 pronotum with prothoracic plate, 2 segment with stigma, 3 claspers, 4 prolegs with frame, 5 frame, 6 legs (after Engelhardt 1980)

The features of the head and the thorax are shown in the figures 4, 5, and 6.

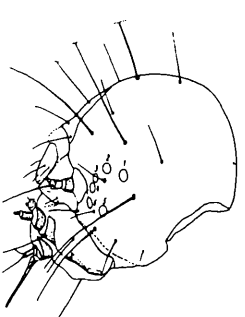

Fig. 4: *Crambus hortuellus.* Head with numbering of the ocelli (from Hasenfuss 1960)

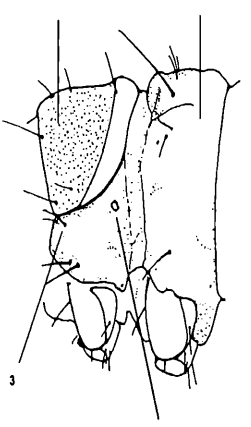

Fig. 5: *Cataclysta lemnata.* 1 pronotum, 2 mesonotum, 3 praestigmal setae, 4 stigma (from Hasenfuss 1960)

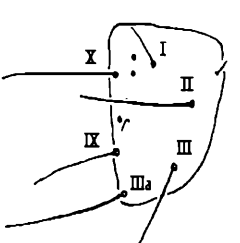

Fig. 6: *Salebria obductella.* Prothoracic plate with numbering of the bristles (from Hasenfuss 1960)

5 Key to the caterpillars

A synoptical key based on several features is given in table 4 at the end of the following dichotomous key.

1 Abdominal segments with simple or branched gills (Fig. 7, 8)
Parapoynx stratiotata
Larvae usually in a cocoon on stalks or leafs. Body length maximum 20 mm
Abdominal segments without gills 2

2 A knob-formed swelling in front of at least two pairs of the thoracic legs (Fig. 9). Last segment (segment X) dorsally with two brown pigmented, longitudinal chitin plates (Fig. 10) (the two plates are seldom merged to one plate) or not pigmented 3
No swellings in front of the thoracic legs. Last segment (segment X) with one plate (Fig. 11), small and separated particles (Fig. 21) or without plate 4

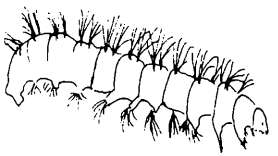

Fig. 7: *Parapoynx stratiotata.* Habitus caterpillar (after Jacobs & Renner 1974)

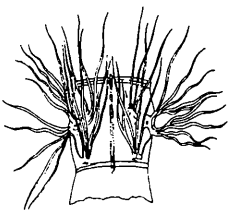

Fig. 8: *Parapoynx stratiotata.* Segment with gills (from Bertrand 1954)

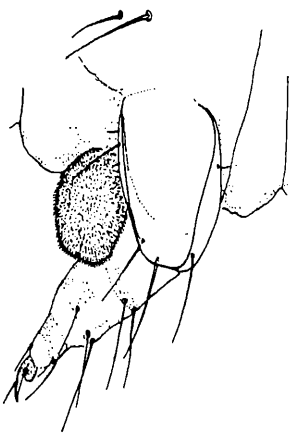

Fig. 9: *Donacaula forficella.* Knob-formed swelling in front of a leg (from Hasenfuss 1960)

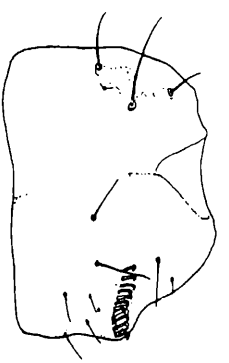

Fig. 10: *Donacaula forficella.* Lateral view of segment X with chitin frame dorsally (from Hasenfuss 1960)

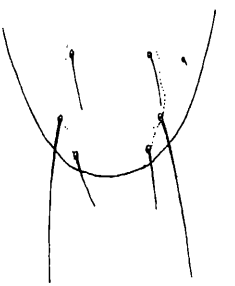

Fig. 11: *Cataclysta lemnata.* Chitin plate on segment X (from Hasenfuss 1960)

3 Praestigmal setae situated higher than the stigma (Fig. 12). (Probably also a good character: Knob-formed swelling in front of first and second thoracic pair of legs. In front of third legs more or less flat.) According to Hasenfuss (1960): Head and pronotal plate light, brownish yellow
Schoenobius gigantella
On *Phragmites* and in pieces of reed stems. Body length maximum 35 mm.
Praestigmal setae situated at about the same level as the stigma (Fig. 13). (Probably also a good character: Knob-formed swelling in front of second and third thoracic pair of legs. In front of first pair of legs more or less flat.) According to Hasenfuss (1960): Head and pronotal plate darkbrown or black *Donacaula forficella*
In *Glyceria maxima*, *G. fluitans* and *Carex* spec. or between ellipse pieces of leafs of both plants. Body length maximum 25 mm.

4 Each frame on the abdominal prolegs is furnished with unequally sized hooks in the anterior and posterior hook-row (Fig. 14, 17). Prothoracic plate with seta III placed beside IIIa (Fig. 16) 5
Hooks of the anterior row of nearly equal size and smaller than in the posterior row (Fig. 20). Prothoracic plate with seta III (on frontal edge) placed above seta IIIa (Fig. 19) 6

5 Frames on the prolegs are obviously wide. The width is 1/5 to 1/4 of the segmental width (only in early instars with less width). Both hook-rows equally sized (Fig. 14). Hook-row of claspers (segment X) straight or weakly curved (Fig. 15) *Elophila nymphaeata*
On plants with floating leafs. Case consists of two oval pieces of leafs, kept together with cobweb. Body length maximum 22 cm
See page 10

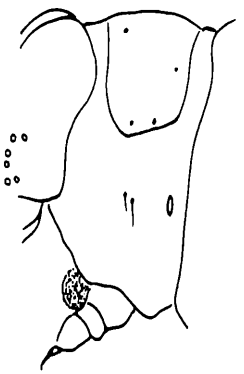

Fig. 12: *Schoenobius gigantella.* Pronotum with prothoracic plate and location of stigma and praestigmal setae
(from Hasenfuss 1960)

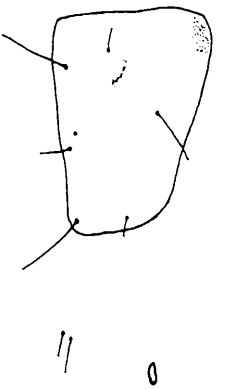

Fig. 13: *Donacaula forficella.* Prothoracic plate and location of stigma and praestigmal setae
(from Hasenfuss 1960)

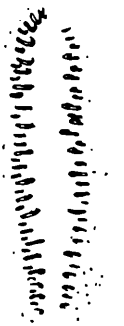

Fig. 14: *Elophila nymphaeata.* Frame on a proleg
(from Hasenfuss 1960)

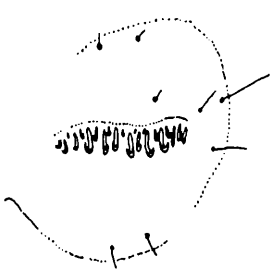

Fig. 15: *Elophila nymphaeata.* Hook-row on the claspers (segment X)
(from Hasenfuss 1960)

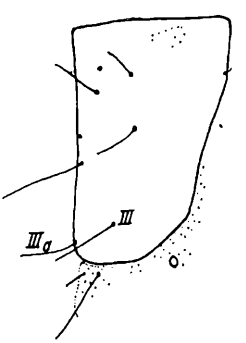

Fig. 16: *Elophila nymphaeata.* Prothoracic plate with seta III and IIIa
(from Hasenfuss 1960)

5 See page 8

Frames are very narrow. The width is 1/10 to 1/8 of segment width. Both rows not equally sized (Fig. 17). Hook-row of claspers (segment X) strongly curved at both ends (Fig. 18) *Cataclysta lemnata*

Case of leafs of duckweed, kept together with cobweb. Case sometimes of other material. Body length maximum 18 mm.

6 Seta I and II on the prothoracic plate almost placed in a vertical line (Fig. 19). Seta II as obvious as IIIa and placed somewhat in the middle of the plate. (Probably a good character too: A long seta placed at the outer side of the prolegs, about 1.5x width of row of hooks. Chitin parts on last abdominal segment (segment X) form a figure of a cross (Fig. 21)

Acentria ephemerella

On *Elodea*, *Ceratophyllum*, *Potamogeton*, *Myriophyllum* or *Chara* (seldom other water plants). Body length maximum 17 mm.

Seta I and II on the prothoracic plate almost placed in a horizontal line (Fig. 22). Seta II much smaller than IIIa and placed more posterior of the plate. Other characters unknown. Habitus probably like figure 23

Nymphula nitidulata

On and mining in *Sparganium* and *Nymphoides*. Body length maximum 20 mm.

Tab. 4: Synoptical key for the caterpillars. 1) = knob-formed swelling between the true legs, 2) = bristle at the outer side of the frame ventrally on the abdomen

	length (mm)	gills	head colour brown	pronotum colour brown	segment colour	legs with knob	prolegs[1] range	frame on proleg width (mm)	bristle[2] laterally (mm)
Parapoynx stratiotata	20	+			pale				
Donacaula forficella	25		dark	light	greyish-brown		1/10-1/8	0,20	0,1
Schoenobius gigantella	35		dark	dark	pale		1/10-1/8	0,1-0,25	0,05-0,1
Elophila nymphaeata	22		light	light– normal	pale		1/5,5-1/4	0,25-0,40	0,15
Cataclysta lemnata	18		light	normal–dark	light-dark brown		1/12-1/8	0,15-0,35	0,1
Acentria ephemerella	17		light	light	pale		1/7-1/5	0,15-0,30	0,25-0,35
Nymphula nitidulata	20								

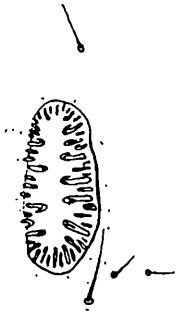

Fig. 17: *Cataclysta lemnata.* Frame on a proleg (from Hasenfuss 1960)

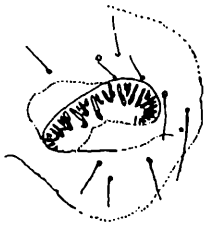

Fig. 18. *Cataclysta lemnata.* Hook-row on the claspers (segment X) (from Hasenfuss 1960)

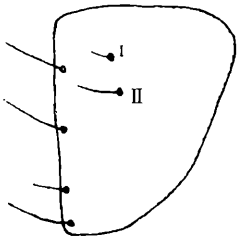

Fig. 19. *Acentria ephemerella.* Prothoracic plate with seta III and IIIa (from Hasenfuss 1960)

Fig. 20: *Acentria ephemerella.* Frame on a prolegs, anterior row with shorter hooks (from Hasenfuss(1960)

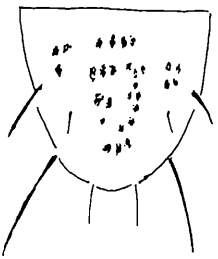

Fig. 21: *Acentria ephemerella.* Chitin particles on segment X dorsally (after Dethier 1986)

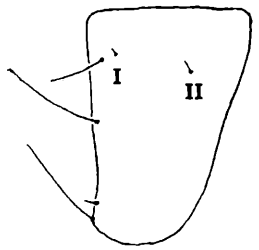

Fig. 22: *Nymphula nitidulata.* Prothoracic plate with seta I and II (from Hasenfuss 1960)

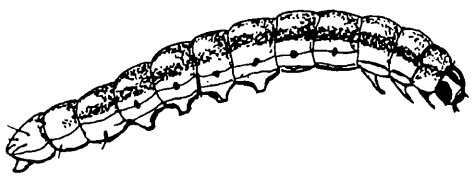

Fig. 23: *Nymphula nitidulata.* Habitus (after Buckler 1902)

6 Autecology of the species

The information about ecology and biology are taken from publications of Hasenfuss (1960), Gaevskaya (1969) and Wesenberg-Lund (1943). These authors have compiled information from a lot of publications. Most caterpillars are polyphagous. For an overview of plants they feed on, see table 5 and 6

Acentria ephemerella

Acentria ephemerella can be found from May till half of September. The caterpillar of this species is very well adapted on living under water. All instars live permanently under water and get their oxygen by respiration through the skin. The caterpillars live between the leafs at the top of the stems of *Elodea*, *Myriophyllum spicatum* or submerse growing parts of *Potamogeton*. Especially *Elodea* is a favorite plant they feed on.

In general the caterpillars live strongly hidden between fixed leafs at the top of the stem. Younger instars are mining in the stem. The winterdiapauze takes place in parts of the plant, which sank to the bottom. In spring the caterpillars start eating again. At the end of spring or in summertime the pupation takes place. The pupa is found in a cocoon filled with air under the water surface. The air probably comes from the air in the plant cells. A very special detail is that a part of the female adults do not have wings. For mating they swim to the surface and put the abdomen above the water surface.

Cataclysta lemnata

Cataclysta lemnata can be found from May till October. Only the first larval instar uses respiration through the skin. From the second instar on the caterpillar dwells in a case filled with air. The case mostly consists of leafs from *Lemna*. Rarely other material is used, even plastic from garden ponds (Van der Velde, 1991). Being in the case the caterpillars eat the leafs of *Lemna*. Pupation takes place in a cocoon camouflaged with leafs of *Lemna* just under the water surface.

Donacaula forficella

Donacaula forficella can be found from June till September. The eggs are laid on *Glyceria maxima* and *Glyceria fluitans*. The caterpillars of the early instars knaw at new shoots through which they fade. For moving to a new shoot the caterpillar builds a case from some parts of leafs. The case floats to another plant. Because of this hidden way of living the caterpillar is seldom found.

Elophila nymphaeata

Elophila nymphaeata can be found from May till October. Larvae, which hatched in the autumn, build small cases of *Lemna* or are mining in floating leafs of water plants. Elder instars live in a flat case, which consists of two parts of plants which are spinned together. The caterpillars feed on all species of the group of Nymphaeids. The glutton of the leafs is very typically. Elder instars are sometimes mining in the leafs of *Typha*, which are floating on the surface. The winterdiapauze takes place in a case under the water surface. In this period the case is filled with water and the oxygen is taken from the water by respiration through the skin. When the caterpillars get active again in spring they creep to the surface and fill their cases with air. From that moment on the caterpillar breaths through the stigmata laterally placed in the abdomen. Pupation takes place at 5-10 cm under the water surface in the last made case. This case is tied on the stem of the plant they feed on. Just before the pupation the stem gnaws a opening so that the pupa will be connected with the air filled cells in the plant.

Nymphula nitidulata

Nymphula nitidulata can be found from June till September. The larvae of the first instars are mining in the leafs of *Sparganium* and Nymphaeidae. During wintertime they stay in the stems of the plant they feed on. In spring the caterpillar builds a case, which consists of two parts of leafs. This case looks strongly like that of *Nymphula nymphaeata*. Being in the case the caterpillars eat from the plant just under the water surface. Caterpillars, who are living in *Sparganium*, stay mining during all instars. Pupation takes place in a cocoon, which is tied on water plants with floating leafs.

Parapoynx stratiotata

Parapoynx stratiotata can be found from May till October. The female lays their eggs just under the water surface on water plants by putting the abdomen into the water. The caterpillars of this species live pure aquatic during all instars, like *Acentria ephemerella*. The gills on the abdomen are for breathing. From the second instar on the caterpillar has gills. The caterpillar prefers *Elodea*, but other submerse growing plants will be used too. Between the leafs the caterpillar builds a tube like case, which is made by spinning threads.

Schoenobius gigantella

Schoenobius gigantella can be found from June till September. The eggs are laid on new shoots of *Phragmites*. The caterpillar eats itself into the stem and creates a mine by eating in the direction of the roots. When the stem is empty the caterpillar knaws the stem underneath and above its body. This case, a part of *Phragmites*, will float on the water surface to a fresh shoot. In summertime the presence of the caterpillars can be betrayed by the moving of a reed-stem. The caterpillars pupate in the finally used stem. Before pupating the caterpillar knaws a hole just above the water surface.

Tab. 5: Caterpillars and their plants for feeding – Plants from the bank. ++ = prefered plant, + = frequently used plant, (+) = incidentally used plant. Literature cited: = 1 = Reichholf (1970), 2 = Lekic (1971), 3 = Gaevskaya (1969), 4 = Buckingham (1981), 5 = Habeck (1983), 6 = Hasenfuss (1960), 7 = Palm (1986), 8 = Goater (1986)

Caterpillar	Acentria ephemerella	Cataclysta lemnata	Elophila nymphaeata	Nymphula nitidulata	Parapoynxs tratiotata	Donacaula forficella	Schoenobius gigantella
Plant	Lit.	Lit.	Lit.	Lit.	Lit.	Lit.	Lit.
Typha sp.		+ 3,7	+ 3				
Scirpus sp.		+ 3					
Phragmites australis		+ 3				(+) 7	++ 3,6, 7
Butomus umbellatus		+ 3					
Glyceria fluitans			+ 3			+ 6	
Glyceria maxima						++ 3,6, 7	(+) 7
Sparganium erectum				++ 3			
Sparganium emersum				++ 3			
Sparganium sp.		(+) 7	(+) 3,6, 7	+ 7			
Polygonum amphibium			+ 3,6, 7				
Sagittaria sagittifolia			(+) 3				
Alisma plantago-aquat.			(+) 3		(+) 6,7		
Poa sp.						(+) 7	
Carex sp.						+ 3,7	

Tab. 6: Caterpillars and their plants for feeding - Aquatic plants. Explanations see table 5

Caterpillar / Plant	Acentria ephemerella	Lit.	Cataclysta lemnata	Lit.	Elophila nymphaeata	Lit.	Nymphula nitidulata	Lit.	Parapoynx stratiotata	Lit.	Donacaula forficella	Lit.	Schoenobius gigantella	Lit.
Potamogeton natans					++	1,3, 6	(+)	6	(+)	5				
Potamogeton lucens	+	3,4	(+)	3	(+)	3	(+)	6	+	2,3, 5				
Myriophyllum spicatum	+	3,4							++	2,5				
Myriophyllum verticillatum	+	3							+	2,5				
Elodea canadensis	++	3,4, 6			(+)	3			++	3,5, 6				
Elodea sp.	+	7							+	7				
Potamogeton sp.	+	3,4, 6,7			+	3,7			(+)	5,6, 7				
Potamogeton pectinatus	+	4												
Potamogeton crispus	+	4							(+)	3				
Potamogeton gramineus	+	4												
Stratiotes aloi-des									++	2,6, 7				
Ceratophyllum demersum	+	6,7			+	3			++	2,5, 6,7				
Trapa natans	(+)	3,4							(+)	2,6				
Lemna minor			++	3,7	+	3,7	(+)	6						
Spirodela polyrhiza			++	3	(+)	3								
Nymphaea alba					+	3,6, 7	(+)	6	(+)	6,7				
Nymphaea candida					+	3								
Nuphar lutea					+	3,6, 7	(+)	6,7						
Nymphoides peltata					+	3								
Najas sp.									(+)	5				
Zostera sp.	(+)	3,4												
Zannichellia sp.	(+)	3												
Callitriche sp.					(+)	3			(+)	3,5, 6,7				
Hydrocharis morsus-ranae					+	3,6, 7								
Chara sp.	+	6,7												

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