

Distribution, phenology and status for the larger Branchiopoda (Crustacea: Anostraca, Notostraca, Spinicaudata and Laevicaudata) in Denmark

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Abstract

Distribution, phenology and status is given for the five Danish species of larger Branchiopoda. All species are univoltine and inhabit small, temporary waterbodies. The distribution of all species is very restricted in Denmark, probably because of habitat destruction.

Introduction

There is a long tradition in studying freshwater crustaceans in Denmark, dating back to O. F. Müller in the late 18th century and P. E. Müller in the late 19th century, continuing with C. von Wesenberg-Lund in the first half of the 20th century, K. Berg in the middle of the 20th century, and U. Røen in the second half of the 20th century. It is therefore surprising that there has not been a regular survey for the larger Branchiopoda since P. E. Müller's checklist for Danish 'Phyllopoda' in 1873.

Five species of larger Branchiopoda are known from Denmark, including the two anostracans *Siphonophanes grubii* (Dybowski, 1860) and *Tanymastix stagnalis* (Linnaeus, 1758), the two notostracans *Lepidurus apus* (Linnaeus, 1758) and *Triops cancriformis* (Bosc, 1801) and the conchostracan *Lynceus brachyurus* (O. F. Müller, 1776), however, the taxonomical/phylogenetical validity of the 'Conchostraca' being uncertain (e.g. Fryer, 1987; Olesen, 1997). The notostracan *Lepidurus arcticus* is known as subfossil from late glacial deposits (Røen, 1995).

Earlier reports of the conchostracan *Limnadia lenticularis* (Linnaeus, 1761) from Denmark (Straskraba, 1965; Brtek & Thiery, 1995; Scanabissi & Tomasini, 1997) are unconfirmed and probably erroneous. However, the existence of *L. lenticularis* in

Denmark can not be ruled out as it is known from the southern parts of Fennoscandinavia and Northern Germany (Brtek & Thiery, 1995). Franzén (1996) lists *Branchipus schaefferi* from Denmark, but we have been unable to confirm this record.

This article presents the distribution, phenology and status of the five Danish species of larger Branchiopoda based on museum collections, literature, interviews, and new collections in known or potential localities. Unfortunately, the results of the surveys in 1996 and 1997 has been poor due to the extremely arid winters, which prevented the normal filling of many temporary pools during spring.

Distribution, habitat and phenology

The maps presented by Brtek & Thiery (1995) are unfortunately incomplete and often misleading with regard to the distribution of the larger Branchiopoda in Denmark: *Tanymastix stagnalis* is correctly shown from northern Jutland; *Siphonophanes grubii* is correctly shown from northern Zealand but is not shown on its more southern localities; *Lepidurus apus* is not shown from Denmark at all; *Triops cancriformis* is shown from one incorrect locality and not from the two actual localities; *Lynceus brachyurus* is correctly shown from northern Zealand but also from an additional, unconfirmed locality in southern Jutland;

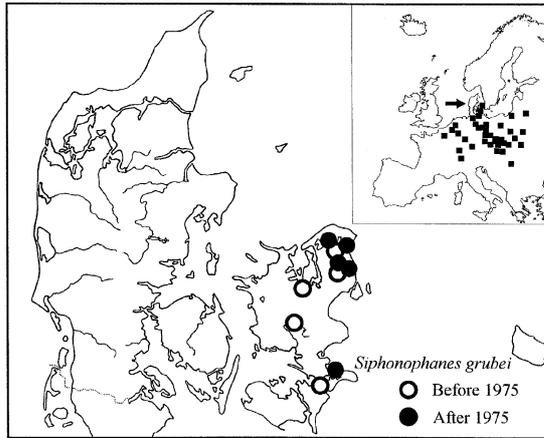


Figure 1.

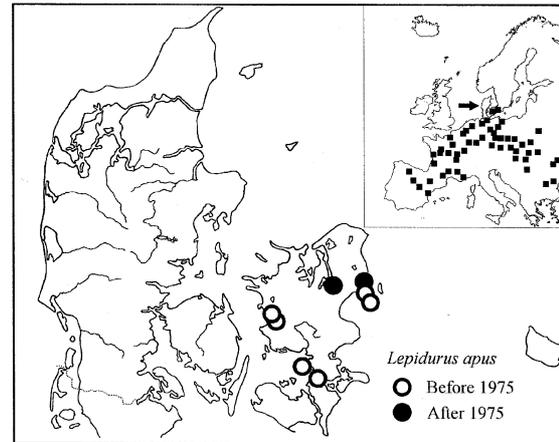


Figure 4.

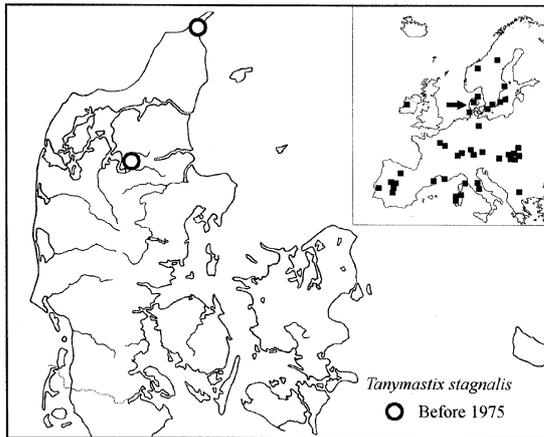


Figure 2.

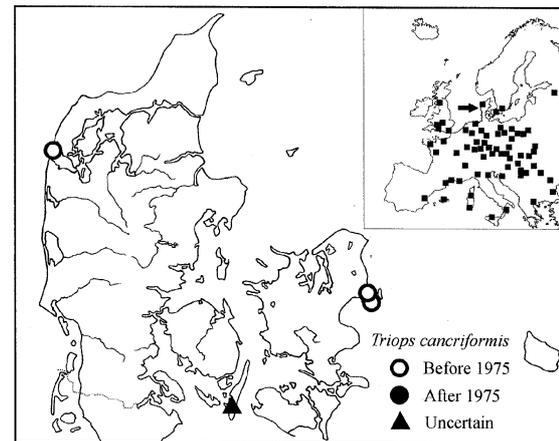


Figure 5.

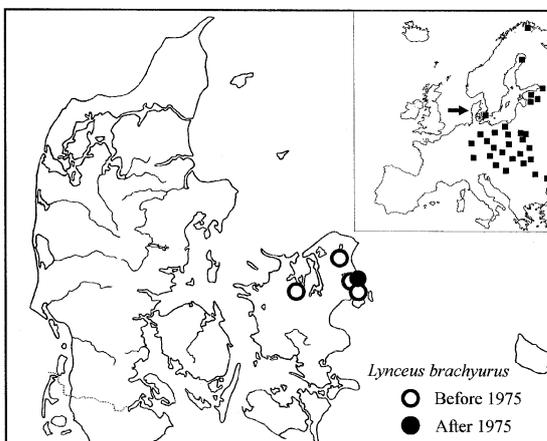


Figure 3.

Limnadia lenticularis is shown from northern Jutland, although it is not yet documented from Denmark (see introduction). In the maps (Figures 1–5) we have updated the present knowledge on the distribution of the Danish species and also shown their European distribution based on the maps presented by Brtek & Thiery (1995). We have further included records of *L. brachyurus* from Northern Europe shown by Kaisila et al. (1963) but not included by Brtek & Thiery (1995).

The knowledge of larger branchiopods in Denmark is still incomplete as there is only little tradition for surveying the fauna of temporary ponds on a broader scale. The distribution of a species may therefore be underestimated and biased towards areas close to scientific institutions. A list of all records of larger Branchiopoda in Denmark with status of the species

and localities is in preparation (Damgaard & Olesen, in prep.).

S. grubii, *L. apus* and *L. brachyurus* are quite widespread in the eastern parts of Denmark. The few localities where we found the animals during the 1996–1997 survey were all semipermanent ponds with a maximum depth of less than one meter, and often less than 25 m² in total area. A single pond in Ulvshale Skov on the island Møn was estimated to be about 300 m² and was inhabited by a large population of *S. grubii*. Most known localities for the three species are situated in light-open, deciduous forests or grassland with a scattered vegetation of old oaks and beeches. Exceptions from these are records of *L. apus* from waterfilled claypits near Sundby-Øster on the island Amager near Copenhagen (Müller, 1873), an unpublished record from the millpond at Nygård Mølle near Vordingborg (S.VI.1916, Hannes Johnsen leg., coll. Zoological Museum of Copenhagen), and three specimens from an artificial semipermanent pond near Roskilde (30.IV.1995, Claus Helweg Ovesen, pers. comm.).

Only in the deer park, Jægersborg Dyrehave, north of Copenhagen, all three species are found together, but only occasionally in the same ponds.

Measurements on water chemistry for localities inhabited by one or more of the three species have shown pH-values between 5.4 and 7.2 and conductivities between 148 and 286 μ S (data from localities in Jægersborg Dyrehave, Geel Skov, and Hareskoven (Wiberg-Larsen, unpublished)).

T. stagnalis was first recorded from Denmark in 1898 in shallow pools in sandy areas left behind by the migrating dune, Råbjerg Mile, in northern Jutland (Ussing, 1909). The dune was formed several hundred years ago near the shore and is migrating inland to the West at a rate of 8–10 m a year. The species has only been found in one other site, namely at Troelstrup south of Ålestrup in the northern part of mid-Jutland (E. Thamdrup leg., coll. Natural History Museum, Århus), where large populations were found during April/May 1966 in meadows flooded by the river Simested Å. Recently, *T. stagnalis* has been found in the tidal area near the River Elben in northern Germany and on the island Sylt (Spitzenberger, 1980), and it seems probable that the species also will be found in the Danish parts of the Wadden Sea.

T. cancriformis is known from a few old and widely separated localities. These are Agger in northwestern Jutland, the island Amager near Copenhagen, and perhaps also from the island of Langeland (Røen, 1995), although this record is without further documentation.

Table 1. The monthly distribution pattern for the Larger Branchiopoda in Denmark.

	j	f	m	a	m	j	j	a	s	o	n	d
<i>S. grubii</i>	-	-	1	1	1	-	-	-	-	-	-	-
<i>T. stagnalis</i>	-	-	-	1	1	-	3	1	2	2	-	-
<i>L. apus</i>	-	-	-	1	1	1	-	-	-	-	-	-
<i>T. cancriformis</i>	-	-	-	-	-	-	-	-	1	2	1	-
<i>L. brachyurus</i>	-	-	1	1	1	1	2	-	-	-	-	-

1 Data from labels kept together with material in the Zoological Museum of Copenhagen or Natural History Museum Århus.

2 Additional data from literature (Røen, 1995).

3 Months without data, but where larvae obviously are present.

Unfortunately, the habitat of the recorded sites has not been mentioned, but Røen (1995) lists flooded areas, ditches and temporary ponds with allochthonous material covering the bottom.

It is impossible to tell whether the scattered or local distribution of the species is due to patterns of immigration or caused by restricted ecological demands. It has been suggested that the distribution of many branchiopods results from the transfer of resting eggs, either by birds, people, or cattle and sheep (Grainger, 1991). Especially the remote and isolated records of *T. stagnalis* and *T. cancriformis* may represent transfer by migrating birds. The eggs are drought resistant and may lie dormant for many years. In the collection of the Zoological Museum of Copenhagen, there is an unpublished example of an egg of *L. apus* hatching after being kept dry for 28 yr (information from label kept with material stored in the collections). Moreover, the parthenogenetic reproduction in some notostracans and conchostracans means that a single egg may start up an entirely new population.

All species occupy temporary to semipermanent ponds that are filled up with water during autumn and winter, and often dry up during summer.

The relatively widespread distribution of *S. grubii*, *L. apus* and *L. brachyurus* in Eastern Denmark may be correlated with the less sandy and more clay containing soils in these areas, favouring the formation of precipitation dependent pools. However, there seems to be no differences in the average precipitation in the different geographical regions that can be correlated with the distribution of the species.

The distribution of the records may also have historical reasons. Many areas around Copenhagen are used for recreation or are royal parks and forests, and

are therefore under little or no agricultural influence. The concentration of records in this part of the country may also be related to more intensive collecting efforts done by people from nearby scientific institutions.

It is shown in Table 1 that the 'spring forms' *S. grubii*, *L. apus* and *L. brachyurus* occur from March to June even though occasionally juveniles of *L. brachyurus* has been found as early as December, but died during icecover (Wesenberg-Lund, 1937).

The life cycle of *S. grubii* in Denmark has been described by Mossin (1986), who found that prehatching is induced by an elevation in partial pressure of carbon dioxide due to ice cover reducing gas exchange with the atmosphere.

T. stagnalis has two annual generations in Denmark, one in the spring and one in the late summer, and this situation is thereby comparable to that in Sweden, where the species occur in rockpools (Ander, 1934). However, it is not known from neither Denmark nor Sweden if both generations can be found on the same locality. The summer generation in Denmark and Sweden is in remarkable contrast to the situation in Ireland, where the species is referred to as 'a cool water species which does not flourish in temperatures greater than 20 °C (Grainger, 1991).

The Danish locality, Råbjerg Mile, was visited in late April 1995 by one of the authors (JD) and not found to be inhabited by *T. stagnalis*. We are not aware of any other surveys on this locality in springtime. In marsh areas in Northern Germany, the populations of *T. stagnalis* appears in small pools left behind after spring floods of the Elbe and disappears when the pools dry out in May (Spitzenberger, 1980). This indicates that a survey for the species in the Danish parts of the Wadden Sea should be carried out during springtime.

The Danish records of *T. cancriformis* are all from September and November and therefore according to Wesenberg-Lund (1937) an autumn-form. This is, however, surprisingly contradicted by Røen (1995), who states that the species occur in Denmark from May to mid-July.

Status in Denmark

The habitat, phenology and scarcity of all species make their status extremely difficult to evaluate. However, judged from the present knowledge the following statements can be made: Although *S. grubii*, *L. apus* and *L. brachyurus* were all fairly widespread in the eastern parts of Denmark in earlier days, they have since 1975 only been recorded from few of the former local-

ities. Thus, *S. grubii* is known from approximately 10 localities, *L. apus* from 2 localities and *L. brachyurus* from only a single locality. However, the distribution of *L. brachyurus* may be underestimated due to its small size. *T. cancriformis* has not been recorded for almost 100 yr and seems therefore to be extinct in Denmark. *T. stagnalis* is only known from two localities and has not been recorded for about 25 yr. However, the species is probably not threatened on the record site in Råbjerg Mile since the migrating dune is protected and not likely to undergo changes for many years to come. About the occurrences of *T. stagnalis* in other parts of Denmark, the situation is unknown, but the decrease in number of spring flooded meadows is likely to be critical for the species. Even though the larger Branchiopoda have a remarkable ability to colonize new areas and have drought resistant eggs that can lie dormant for decades, their kind of habitat, temporary to semipermanent ponds in forests and grassland, are rare in Denmark and often destroyed by agricultural and urban development, overgrowing, eutrophication, pollution, upfilling and drainage or establishment of permanent waterbodies.

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