

Two recent immigrants into Czech aquatic habitats: *Daphnia ambigua* and *D. parvula* (Crustacea: Cladocera)

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Abstract. Available data on the distribution of *Daphnia ambigua* Scourfield, 1947 and *D. parvula* Fordyce, 1901 in Czechia were summarized. We compare interspecific differences in the size distributions among these two invasive and a common native species *D. galeata* G. O. Sars, 1863 as well as locality-specific (6 Czech and 1 North American) body-size differences for each of the exotic species. Both invaders are able to attain maximal body size about 1.3 mm, a substantial overlap with the native *D. galeata*. In one reservoir, *D. galeata* population dropped the mean body size down to similar values as are common in *D. ambigua*. Size differences among localities are not significant due to the wide local range of values. Size distribution frequencies in a locality are mostly symmetric suggesting that input of young stages into the population in the sampling dates studied was already diminishing. The populations of invader species differ in the timing of sexual reproduction; gamogenetic populations of *D. parvula* occur from September to November, while those of *D. ambigua* were found only in May.

Biological invasions, zooplankton, *Daphnia ambigua*, *Daphnia parvula*, *Daphnia galeata*, size distribution, gamogenetic populations, Czech Republic, Palaearctic region

INTRODUCTION

Two species of the genus *Daphnia* Müller, 1785 widely distributed in North America, has been recently reported spreading across Europe invading various kinds of water bodies: *Daphnia ambigua*, originally described from a Kew Garden reservoir in London, and *D. parvula*, from a fish pond about 5 km south of Arapahoe, Nebraska. Starting from 1970, the former species was occasionally reported from water bodies in continental Europe: Amoros (1972) mentioned a short occurrence of *D. ambigua* in one fishpond in S.-E. of France, unfortunately without any further details or drawings. Well-documented records from Belgium were published by Dumont (1974), followed by Flössner & Kraus (1976), and Margaritora (1985). *Daphnia parvula* seems to be less frequently recorded. The species appears in recent review of Spanish cladoceran fauna (Alonso 1996), and one of the figures of postabdominal claw of *D. ambigua* in Margaritora (1985) may belong to *D. parvula*. Schrimpf & Steinberg (1982) reported the species from waters in neighbourhood of Mannheim, Germany, and Petkowski (1990) found *D. parvula* in Macedonia. Hudec (1990, 1991) published data on the distribution of both the species in Slovakia. Weiler (poster communication, symposium in Plön, Germany, 1999) found both species in lakes in neighbourhood of Bonn (Germany). *D. ambigua* was found recently in a system of interconnected ponds in Belgium (Michels et al. 2001.) German localities of both the species are summarised in Flössner (2000). In

This contribution is dedicated to Doc. RNDr. Jaroslav Hrbáček DrSc., upon the occasion of the 80th anniversary of his birthday (12th May 1921)

Czechia, the second author found *D. parvula* in late seventies (1977) in a drinking water reservoir, and *D. ambigua* has been regularly recorded only from 1994 (I. Příkryl, samples and personal communication 1998).

The centre of geographic distribution of both the species is on American continent (Brooks 1957), and European localities are supposed to be secondary as result of recent invasion of both the species. Careful re-examination of samples from various waters in Czechia revealed relatively frequent occurrence of both the species in habitats like reservoirs, fishponds and pools. Such situation is interesting from the ecological point of view. Newly arrived species has to found a vacant niche and be successful in inter-specific competition with native species with similar environmental requirements.

The aim of the present study is to give an overview of populations living in our region. The data will be used for the further study of their phylogeography and competitive abilities.

MATERIAL AND METHODS

Beside re-examination of some of the preserved material offered by our colleagues, we have sampled prospective habitats as well as those from which one of the species has been already reported. North American material was obtained due to the kind assistance of colleagues from Canada, USA, Mexico and Cuba. Most of the material was collected with the 100- μ m-mesh size plankton net and preserved with 4% formalin solution. The following table lists all the populations, which were at our disposal for the study. We omitted habitats where the species occurred only sporadically and in low numbers.

Daphnia ambigua Scourfield, 1947

MATERIAL EXAMINED. Závist Pond, Skaličany, Blatná, Sep. 22. 1999; Padrt' Pond, Drásov, Příbram, Sep., 23. 1999; Novokestřanský Pond, Strakonice, Sep. 22. 1999; Nový Pond, W. of Čekanice, Blatná, Sep. 22. 1999; (all M. Žofková legit). Zlivský Pond, Hluboká, České Budějovice, June 12. 1996; Zámecký Pond, Lednice, May 22. Aug. 22. 1996; Režabinec, Písek, Aug. 17. 1998; Domin Pond, Vrbno at České Budějovice, June 12. 1996; Věžický Pond, W. of Rovensko, June 8. Aug. 14. 1995; Skalský Pond, Protivín, Aug. 13. 1996; Jordánek Pond, Hrnčiče, Sep. 10. 1996; Komorní Pond, Turnov, Sep. 22. 1998; Žabokor Pond, Mnichovo Hradiště, Sep. 1. 1994; Žehuňský Pond, Poděbrady, July 10. 1996. (all I. Příkryl legit). Sand pit "Bagr" in park, České Budějovice, Sep. 2. 1997. (J. Sed'a legit), Jul. 31. Aug. 15. Sep. 2. 1997, Jul. 2. 1998, (H. Lukčíková legit.); Orlik reservoir, Zvíkov, May 12. 1999 (L. Růžička legit). Rímov reservoir, České Budějovice, May 24. 2001, (J. Macháček J. legit); village pond, Divišovice at Sedlec-Prčice, Jun. 29. 2001 (V. Kořínek legit). Channel, Pohansko, Břeclav, S. Moravia, Jun. 21. 1999 (M. Omesová legit). Backwater, river Morava, Vysoká, Slovakia, May 27. 1994. (O. Štěrba legit).

Comparative material from North and Central America

MATERIAL EXAMINED. Grenadier Pond, Ont., Canada, June 6. 1966 (H. Harvey legit); Upper Bass lake, Ont., Canada, June 1. 1965 (F. Rigler's collection Univ. Toronto); Kashe lake, Muskoka Co., Ont., Canada, July 31. 1978 (M.J. Dadswell legit); Johnson lake, Florida, USA, Jan. 19. 1994 (W.M. Lewis junior legit), Jan. 28. 1987 (D.G. Frey legit); Feb. 23. 1988 (G. Deevey legit); fish pond #6, Apr. 9., Apr. 28. 1968; fishpond #15, Apr. 9. 1968, Auburn, Alabama, USA, (all J. Hrbáček legit); Laguna #1, El Dique, Cuba, March 5. 1968 (N. Martinez legit); Laguna Eduardo, prov. Habana, Cuba, June 17. 1990 (J. Fott legit); Presa los Canos, Mexico, June 17. 1990 (M. Briano legit).

Daphnia parvula Fordyce, 1901

MATERIAL EXAMINED. Ruda Pond, Třeboň, May 23. 1996 (I. Příkryl legit); Sep. 28. 1999 (M. Žofková legit); Dušákovský Pond, Třeboň, May 23. 1996 (I. Příkryl legit); Sep. 28. 1999 (M. Žofková legit); Velký Tisý Pond, Třeboň, June 26. July 17. 1996; Nový Spálený Pond, Třeboň, May 23. 1996; Žehuňský Pond, Poděbrady, July 10. 1996; Přesličkový Pond, Nové Hradky, Sep. 11. 1996; Sousedský Pond, Chlum at Třeboň, Aug. 14. 1996; Kotvice Pond, Odra river, Nový Jičín, Aug. 29. 1995, N. Moravia (all I. Příkryl legit); Božkov Pond, Mnichovice, Prague, July 23. 1987, Oct. 29. 1989 (M. Pražáková legit); Dvorský Pond, Zbiroh, Sep. 19. 1994, Nov. 27. 1994, Oct. 29. 1997; fish pond in Zbiroh, Sep. 18. 1994 (all J. Vávra legit); Žabokor Pond, Mnichovo Hradiště, Sep. 23. 1998; Novokestřanský Pond, Strakonice, Aug. 20. 31. 1998; small pond near Pařezská Lhota, Jičín, Sep. 23. 1998; fishpond S. of Branná, Třeboň, Oct. 1. 1997; Buzický Pond, Blatná, Sep. 14. 1997; Nový Pond near

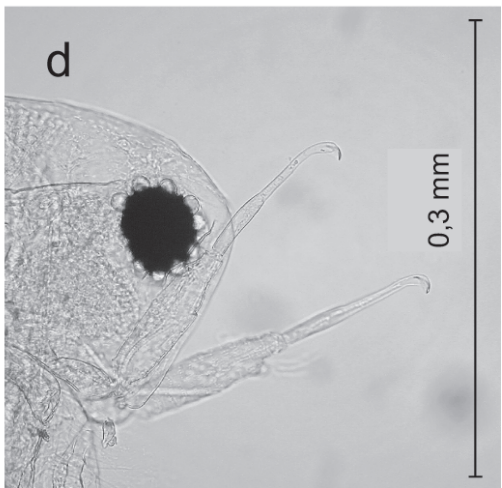
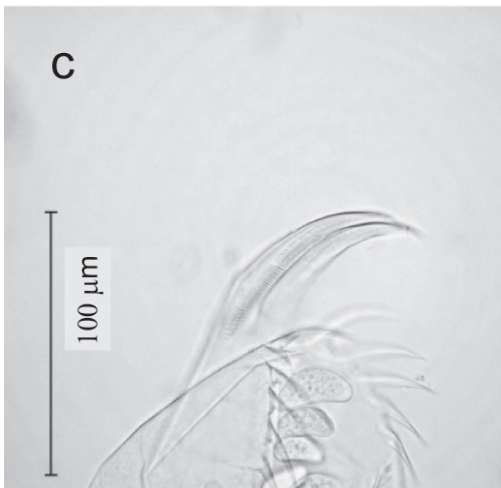
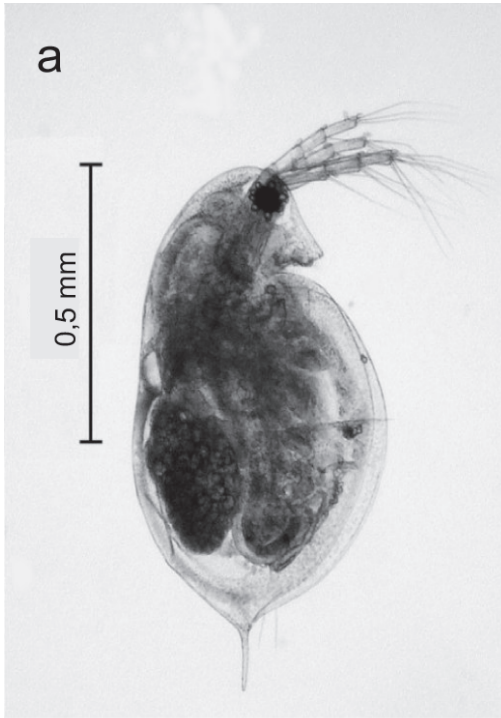


Fig. 1. *Daphnia ambigua* Scourfield: a – adult female, b – adult male, c – postabdominal claw of female, d – adult male – antennule.

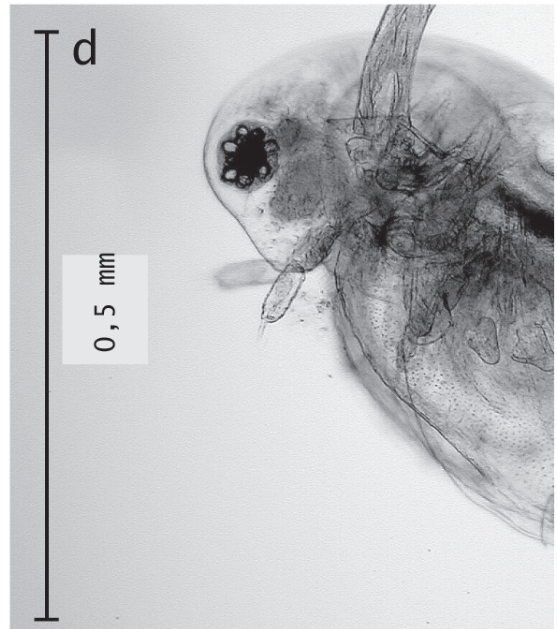
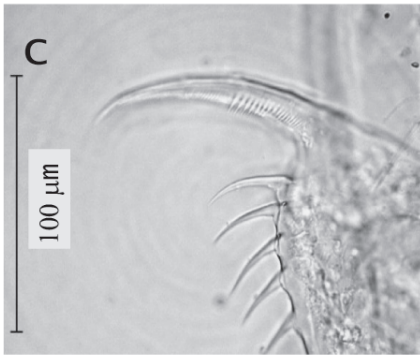


Fig. 2. *Daphnia parvula* Fordyce: a – adult female, b – adult male, c – postabdominal claw of a female, d – immature male – antennule.

Čekanice, Strakonice, Aug. 30. 1998; Řežabinec Pond, Písek, Aug. 30. 1998; forest pond, Libínské sedlo, Prachatic, July 17. 1997; Rokytnický Pond, Hrubá Skála, Sep. 23. 1998; Pýcha Pond, Skaličany, Blatná, Oct. 4. 1998; fishpond in Podkost, Sobotka, Sep. 23. 1998, (all V. Kořínek legit); Skalka Pond, Drásov, Příbram, Oct. 31. 1997 (K. Urbanová legit); Hostivař reservoir, Prague, July 8. 1980 (J. Fott legit), Aug. 14., Sep. 18., Oct. 2. 1981 (all E. Hrušková legit); Vrchlice reservoir, Kutná Hora, June 21. 1977, (V. Gottwaldová legit); backwater Dlouhá, Upper Lužnice river, N. Ves, Suchdol, Sep. 2. 1992 (J. Hrbáček legit); Římov reservoir, Oct. 8. 1997 (J. Sedá legit); Pond Biřička, Hradec Králové, Aug. 31. 1998 (M. Dewetter legit). Village pond in Sedlce, České Budějovice, Oct. 15. 2000 (L. Stará legit). Pond Jejkal Dolní, Vranov nad Dyjí, Jun. 8. 2001; pond Jejkal Horní, Jun. 8. 2001; Červený pond, W of Znojmo, Jun. 7. 2001; fish pond NW of Ješetice, Votice, Jul. 2. 2001, (all V. Kořínek legit). Pastvisko pond, Břeclav, Jun. 3. 1993; Ostrícová pool, Jul. 8. 1993; Panenská pool, Jul. 8. 1993, Krivé jezero reserve, S. Moravia (all O. Skácelová legit); backwater at Devinská Nová Ves, Slovakia, May 27. 1994 (O. Štěrba legit).

Comparative material from North and Central America

MATERIAL EXAMINED. Lake Max, Turtle Park, Manitoba, Canada, Aug. 7. 1969; Lake Winnipeg, Manitoba, Canada, July 9. 1969, (K. Patalas legit); Heart Lake, Ontario, Canada, May 28., Aug. 6., Nov. 5. 1965, (all F. Rigler's collection, Univ. Toronto); Teapot Pond, Ont., Canada, May 28. 1961; Toussaint Lake, Ont. Canada, June 2. 1965, (C.H. Harvey legit); Lake #302, Erickson, Manit., Canada, Oct. 13. 1971, (V. Kořínek legit); Lynx Lake, B.C., Canada, July 15. 1969; Shell Lake, B.C., Canada, July 3. 1960, (all T. Northcote collection, Univ. B.C.); Acueducto Holguin, Cuba, Apr. 23. 1966. (M. Legner legit).

RESULTS

Morphology

Daphnia ambigua. Females of Central European populations are mostly without any spine on top of head or the spine is only faintly suggested in sub-cuticle tissues. We have found only two habitats where females had remarkably pronounced apical horn on top of head. Both the habitats are fishless pools with *Chaoborus* Lichtenstein, 1800 larvae present. Ocellus is seldom pigmented. Other characters, including those of males, were found similar to North American populations. In some of the ponds, the species co-occurs with *D. parvula* and the only reliable differentiation has to be based on the difference in pectens on the postabdominal claw (Fig. 1).

Daphnia parvula. There was no difference in the morphology of females and males between populations from our region and those from North America (Fig. 2).

Habitats

Populations of *D. ambigua* dwell mostly in shallow fishponds or in pools and backwaters along rivers. Recently it was found in one reservoir (Římov). On the other hand *D. parvula* probably started to invade first such relatively young habitats as are reservoirs not more than several decades after their construction. Only in nineties we have found the species in many fishponds.

Biology

The peak of the population densities in *D. ambigua* is reached mostly in August and at the beginning of September. Nevertheless the populations start to occur already from May. Gamogenetic populations were found only in May. Occurrence of males and ephippial females seems to be rare, we have found it only in 4 habitats (a dug out flooded with water, a fish pond, one river backwater and a reservoir). Besides populations from American continent, we have checked one locality reported outside the supposed Euro-American range of the species: Japan (Ueno 1960). The population from a high mountain lake Mikuriga-ike (Toyama ken, Honshu, altitude 2405 m, Sep. 25. 1978, K. Okamoto legit) belongs certainly to the "*Daphnia longispina*" group of species and morphology of females as well as males of that population differs substantially from that of *D. ambigua* populations.

Maximal population density of *D. parvula* populations is reached mostly during the late summer: second half of August and September. Only in few cases we have found dense populations in

spring (May). Males and ephippial females occur in the period September–October. The co-occurrence with native species *D. galeata* G. O. Sars, 1863 is quite common in our samples.

Both the species are small. Body size according to Brooks (1957) is 0.7–1.0 mm for *D. parvula* and 1.0 mm for *D. ambigua*. As planktivorous fish dominate most of our habitats where the species are dwelling, we supposed that the competitive advantage of invasive species is their small body size. We compared the mean, minimal and maximal sizes of species studied with those of *D. galeata* from a reservoir (high predation pressure of fish and *Chaoborus* larvae) and a fish pond (low fish predation pressure – about 500 ind. of two years old carp) (Fig. 3). The high value of the mean body size within 4 groups of populations was found in *Daphnia parvula* – over 0.9 mm, and the low one in *Daphnia galeata* from a reservoir with presumably high predation pressure of planktivorous fish (roach) – over 0.7 mm. Comparison of means and corresponding 95% conf. intervals of body size on 13 different localities and 12 different sampling dates (including populations from two randomly selected Canadian lakes) revealed large interpopulation variability (Fig. 4). With few exceptions, the size distribution within one habitat was nearly symmetric (Fig. 5). It means that in the time of sampling the input of newly born was already decreasing. The largest individuals of both the species were found on different localities in size class 1.3–1.4 mm. However, the native *D. galeata* is able to reach the maximal body size in some fishponds to about 2.5 mm (Košinec, pers. obs.).

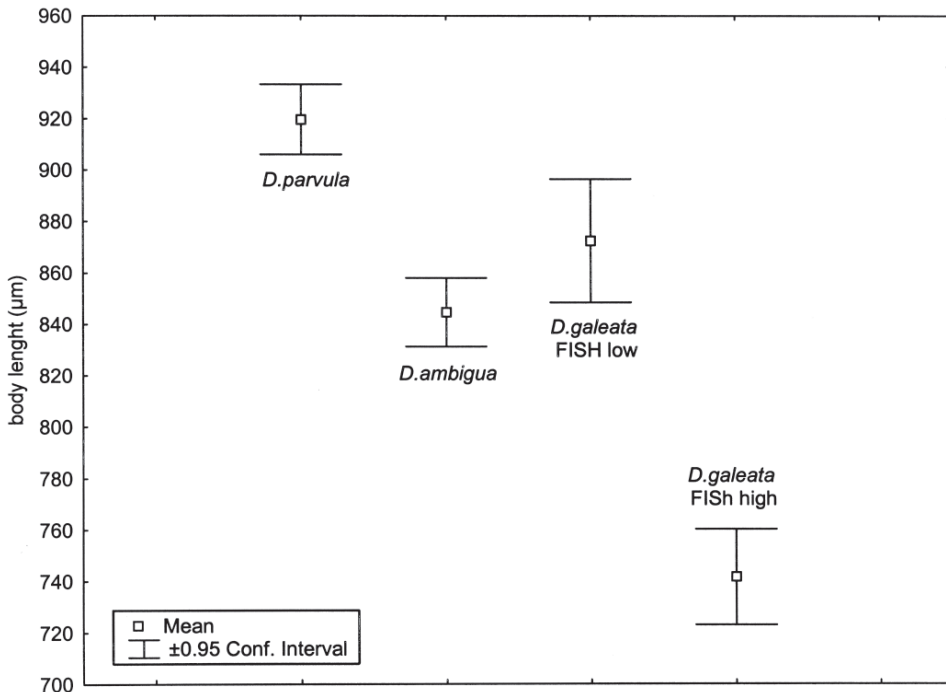


Fig. 3. Comparison of the mean body length among three species – *Daphnia parvula* Fordyce, *D. ambigua* Scourfield (respective populations treated jointly) and *D. galeata* G. O. Sars (two populations with different fish predation pressure: high from Drásov reservoir at Příbram, 1998; low from pond Smyslov at Blatná, 1968).

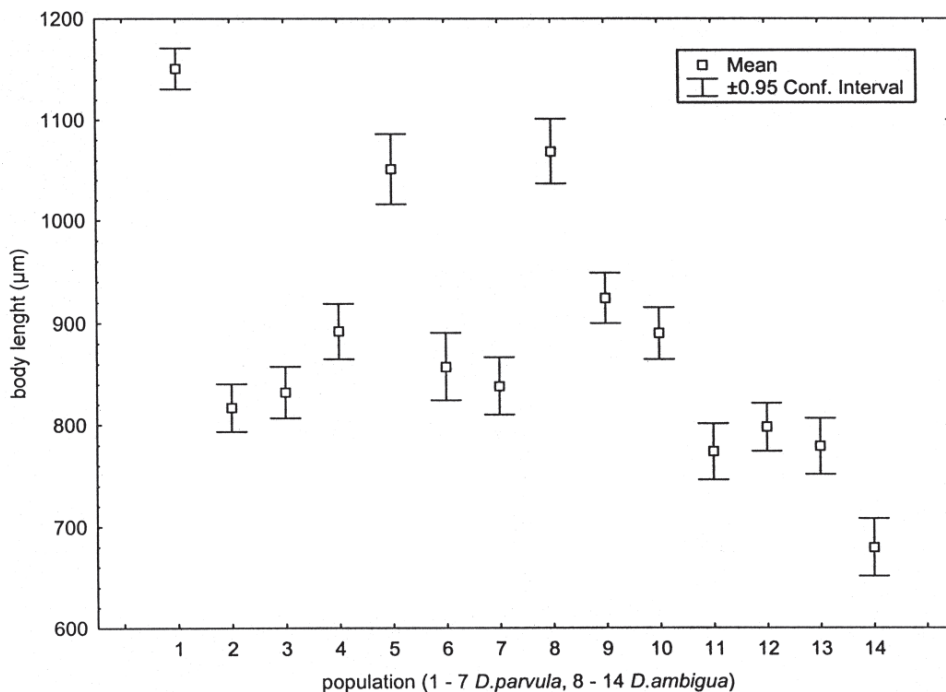
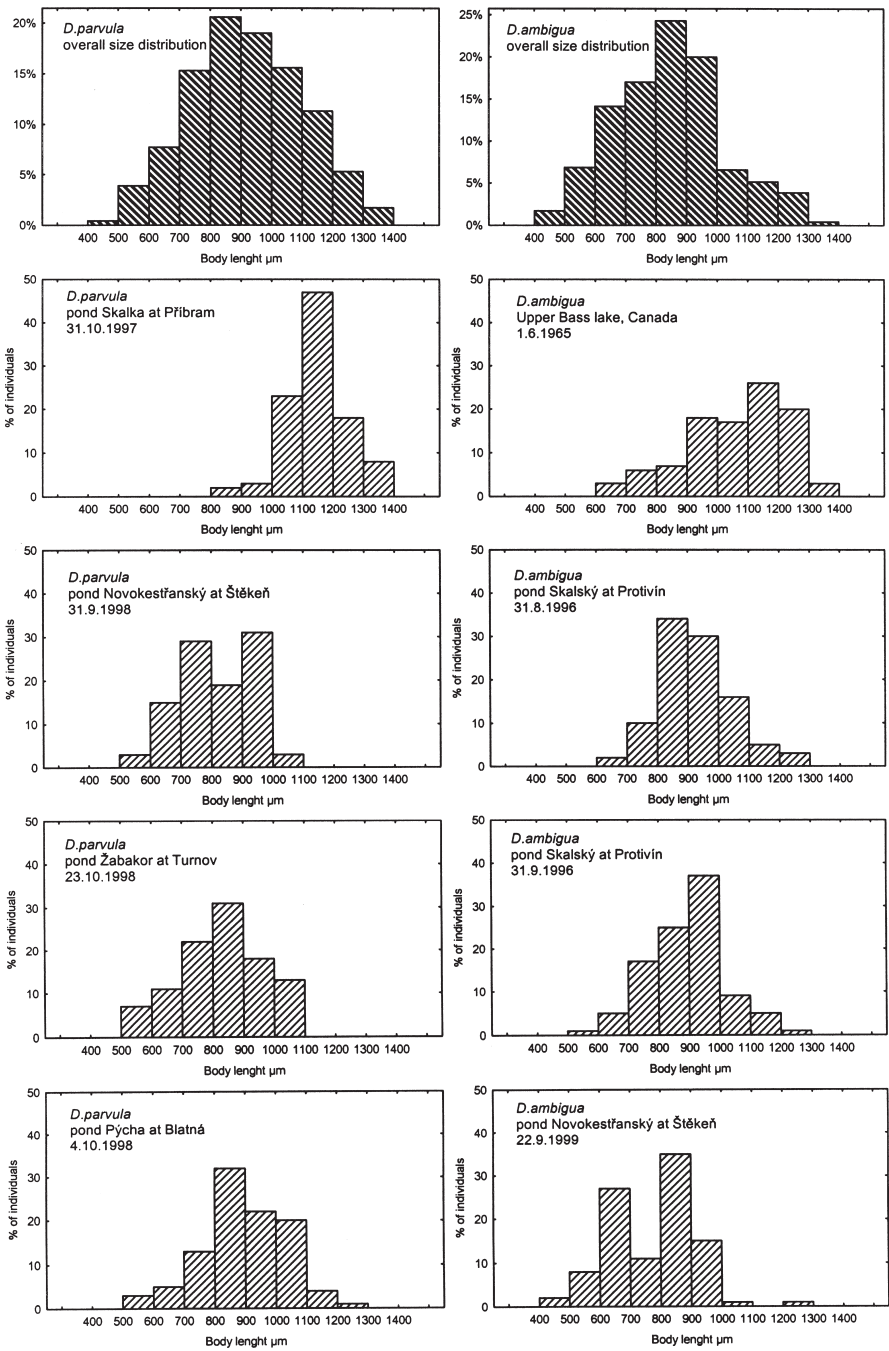


Fig. 4. Comparison of mean body length among particular populations of *Daphnia parvula* Fordyce and *D. ambigua* Scourfield. Populations are numbered as follows: *D. parvula*: 1 – Skalka, 2 – Novokestřanský, 3 – Žabakor, 4 – Pýcha, 5 – Heart lake, 6 – Ruda, 7 – Dušákovský; *D. ambigua*: 8 – Upper Bass lake, 9 – Skalský Aug. 1998, 10 – Skalský Sept. 1998, 11 – Novokestřanský, 12 – Nový, 13 – Padrť, 14 – Závist. More detailed labels are to find in Fig. 5.

DISCUSSION AND CONCLUSIONS

– As the species composition of the zooplankton in Czech ponds and reservoirs was intensively studied for several decades (Šrámek-Hušek 1962, Hrbáček 1962, Kořínek et al. 1986, Hrbáček 1984), the probability that both the studied species had been overlooked is negligible. We suppose that *Daphnia parvula* occurred in the region not earlier than in 1975, and *D. ambigua* not before 1990. This is in good agreement with hypothesis that the species are slowly spreading from western part of Europe eastwards and southwards.

– The competitive position of both the species within the local plankton community cannot be judged from the data available. According to our results, there is an overlap with the size distribution of native species *D. galeata* in attainable maximal body size. Factors like the size of the first reproductive instar (primipara), natality and mortality within population and attained maximal size of competitors co-occurring in one habitat are to be studied to ascertain the mechanisms allowing successful establishment of invader populations.



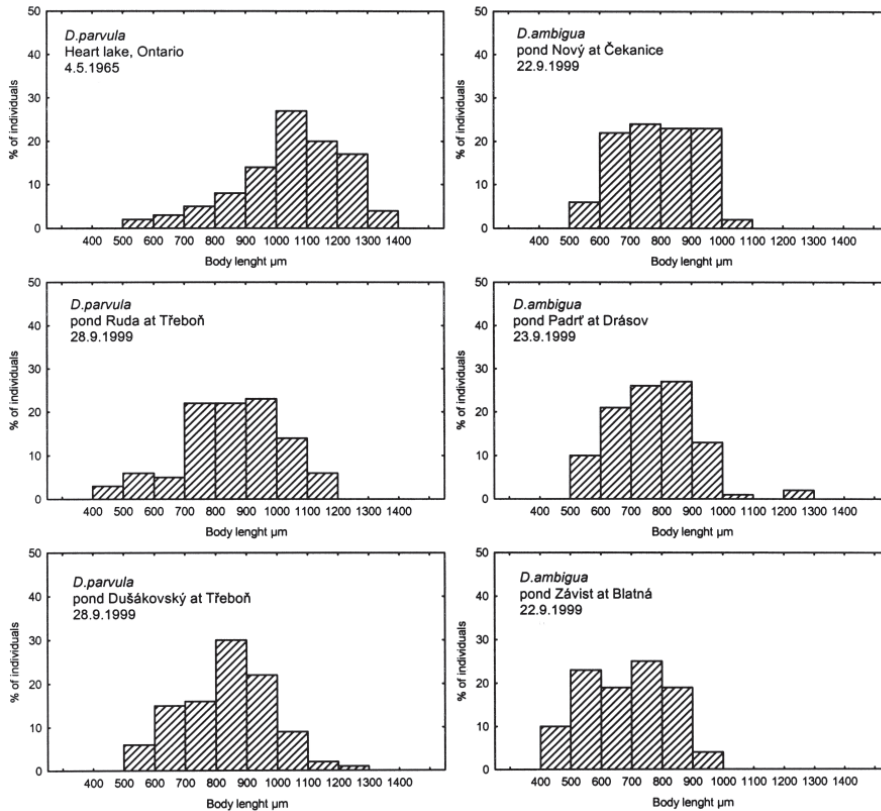


Fig. 5. Size (body length) distribution within particular populations, locality and sampling dates are given. *Daphnia parvula* Fordyce – left column, *D. ambigua* Scourfield – right column, overall mean measurements – top of the graph.

– Differentiation of both the species from other females of native *Daphnia* species is based mainly on the reduction of rostral part of head. Both species differ in the size of three pectens of spinules on postabdominal claws: in *D. ambigua* all three are small and of the same length, in *D. parvula* spinules in the middle pecten are longer than in remaining two (Kořínek 1988). Spinules are however delicate and not so robust like in the group of *D. pulex*. The presence of ocellus is not a reliable character as the pigmentation is meagre in the European populations of both the species. To differentiate the males, the tip of the antennular flagellum is the best diagnostic character.

A c k n o w l e d g e m e n t

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