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Shore habitats of larval *Stilpon graminum* (Fallén, 1815) in Northwestern Russia (Diptera Hybotidae)

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Abstract

Adults of *Stilpon graminum*, a dance-fly species with poorly known bionomics, were reared from different shore habitats in six localities within NW Russia. These habitats include the water margin zone of lakes and the supralittoral zone of the White Sea. The published data on the bionomics of *Stilpon* are reviewed, with special attention to larval habitats. The features of known larval habitats of *S. graminum* are discussed. *S. graminum* is recorded for the first time from Leningrad, Pskov and Novgorod provinces, and from northern Karelia.

Keywords: Diptera, Hybotidae, *Stilpon*, habitats, shore, rearings

Introduction

Dance flies of the genus *Stilpon* LOEW, 1859 are among the smallest predatory dipterans, with a body length of 1.0-1.5 mm. A total of 12 species are known from the Palaearctic Region (SHAMSHEV & GROOTAERT, 2005). The data on bionomics of this genus are scattered and not very numerous. Consequently, they are briefly reviewed below, with a special attention to larval habitats. For the types of wetland habitats we mainly follow ZOLTAI (1987) and KEIPER *et al.* (2002).

Adult habitats are only sufficiently known for three species of *Stilpon* in Central Europe.

Stilpon lunatus (WALKER, 1851) inhabits contrasting habitats: *Sphagnum* bogs (LINDNER, 1944; MEYER & HEYDEMANN, 1990), inland freshwater marshes (BÄHRMANN, 1987a, 1994), inland meadows (BÄHRMANN, 1987b), inland salt marshes (ROZKOŠNÝ & VAŇHARA, 1995; CHVÁLA, 1998), and sandy sites on sea coasts (CHANDLER, 1978). The species was abundant only on a raised *Sphagnum* bog and therefore was classified as xerophilous (MEYER & HEYDEMANN, 1990).

Stilpon nubilus COLLIN, 1926 is abundant on sea coasts, mainly on salt marshes (CHANDLER, 1978; ALLEN, 1980; MEYER & HEYDEMANN, 1990; MEYER *et al.*, 2000) and classified as halophilous (MEYER & HEYDEMANN, 1990). However, it was found in a wide range of inland habitats: on a *Sphagnum* bog (LINDNER, 1944), on a freshwater marsh (BÄHRMANN, 1987a, 1994), on a meadow near eutrophic lake (SANDER *et al.*, 1985), in a garden (ALLEN, 1980), and also was common in greenhouses (MACLEAN, 1978; KÜHNE *et al.*, 1994). In addition, *S. nubilis* was abundantly recorded inland from a mesoxerophytic meadow (Mesobrometum) (BÄHRMANN, 1984, 1987b) and from very specific grassland habitats, *Elytrigia repens* (L.) NEVSKI and *Puccinellia distans* (JACQ.) PARL. monocoenoses on alkaline soils strongly influenced by a fertilizer factory and characterized by the presence of other halophilous dipterans (BÄHRMANN, 1988, 2000).

Stilpon graminum (FALLÉN, 1815) is the most common and widespread species of *Stilpon* in Europe, including European Russia (CHVÁLA & KOVALEV, 1989; CHVÁLA, 2004), and has been recently recorded from the extreme eastern border of the Palaearctic Region (south of the Russian Far East) and from East Siberia (Yakutia) (SHAMSHEV & GROOTAERT, 2005). Adults of this species are common or abundant in various wet inland habitats, especially on shorelines. Among those habitats are fens (REMM, 1959), inland freshwater marshes (CHANDLER & ISMAY, 1978; BÄHRMANN, 1987a,

1994), bogs (JOOST, 1991; BARTÁK & ROHÁČEK, 2000; BEREZHNOVA, 2005), wet floodplain forests (VAŇHARA, 1981, 1986; BARTÁK, 2000), meadows (BÄHRMANN, 1987b), wet and marshy shores of different types of standing or slowly running freshwaters (LUNDBECK, 1910; MEYER & HEYDEMANN, 1990; CHALAYA, 1994; BARTÁK, 1995, 2000; PRZHIBORO, unpublished data). The species is clearly hygrophilous; many of the sampling sites were strongly influenced by nearby water bodies, e.g. periodically flooded. In one case, the species was abundant only so long as the habitat, a floodplain forest, was periodically flooded (VAŇHARA, 1981, 1986).

As a rule, the adults of *Stilpon* in the temperate zone are confined to the ground layer (soil surface, litter, low-lying vegetation) and do not occur above it. This trait was observed for many times (COLLIN, 1961; BÄHRMANN, 1987a, 1987b; JOOST, 1991; CUMMING & COOPER, 1992; CHALAYA, 1994; KÜHNE *et al.*, 1994; SHAMSHEV & GROOTAERT, 2004; etc.) and was distinctly demonstrated for *S. graminum* by VAŇHARA (1981) and BÄHRMANN (1994), and for *S. nubilus* by BÄHRMANN (1984, 1988, 2000), using sampling in different layers of the same sites.

In addition, such microhabitats of *S. graminum* are mentioned as grass tufts, sedge tussocks, moss, leaf litter, heaps of cut sedge, and accumulations of plant remains on shorelines (LUNDBECK, 1910; CHVÁLA, 1975; CHANDLER, 1978; CHALAYA, 1996; SHAMSHEV & GROOTAERT, 2005).

In contrast to the above three species, adults of many *Stilpon* species distributed in the tropics and subtropics are known to occur not only near the ground but also in the higher layers (GROOTAERT & SHAMSHEV, 1993; SHAMSHEV& GROOTAERT, 2004).

Although the life cycle of *Stilpon* has not been studied, adults of all three species occur in central Europe during the entire warm season, since February-May till September-November, depending on the locality (VAŇHARA, 1981; BÄHRMANN, 1987a; CHALAYA, 1994, 1996; BARTÁK, 2000; BARTÁK & ROHÁČEK, 2000; MEYER *et al.*, 2000; PLANT, 2003). At least in *S. graminum* some adults hibernate and are found during the entire winter (COLLIN, 1961; VAŇHARA, 1981; CHALAYA, 1996; CHVÁLA, 1998).

Almost nothing is known about trophic relationships and behaviour of *Stilpon*. KÜHNE *et al.* (1994) observed adults of *S. nubilus* feeding on larvae of Thysanoptera and Cicadinea in greenhouses, and also described behaviour of this species during copulation.

Little is known about the immature stages of *Stilpon* and their ecology. In some guides, *Stilpon* was mentioned as a genus with aquatic or semiaquatic larvae (VAILLANT, 1967, 1978; CUMMINS *et al.*, 1978; COURTNEY *et al.*, 1996), with most additional ecological information being doubtful. In particular, CUMMINS *et al.* (1978) and COURTNEY *et al.* (1996) classified larval habitat of the genus as "lotic-erosional", life habit of larvae as "clingers", and their trophic relationships as "predators (engulfers)", referring to VAILLANT (1967, 1978) and CUMMING & COOPER (1992). Actually, the cited papers do not contain such information. VAILLANT (1967, 1978) supposed only that the larvae of *Stilpon* are aquatic or hygrophilous. However, in VAILLANT (1967) there are no references to publications on larval habitats of *Stilpon*. Of the works cited in VAILLANT (1978), only two contain information on larval habitats of *Stilpon*, VAILLANT (1956) and TREHEN (1971). In the first work, "*Stilpon demnatensis* Vail." is mentioned as inhabiting the hygropetric zone on rocks ("zone limimadicole", i.e. (micro)habitats with a friable substrate) in a locality in Morocco (VAILLANT, 1956: pp. 44, 244). Probably, an adult was reared from a larva. However, the species *Stilpon demnatensis* has never been described, and the name is considered a nomen nudum (CHVÁLA & KOVALEV, 1989).

Apparently, the first reliable data on larval habitats of European *Stilpon* were obtained by TREHEN (1971) who used field emergence traps installed on the ground. He reported on solitary adults of *S. graminum* that emerged in traps at four moist meadow sites at two localities in northwestern France. The sites were diverse in vegetation, soil composition and humidity; one of them was submerged by water in winter. In addition, one adult of *S. nubilus* was found in an emergence trap at another site with drier, mesophytic conditions. After TREHEN, larval habitats of *Stilpon* were reported from northern Germany by MEYER & HEYDEMANN (1990), RIEF (1996), and MEYER *et al.* (1997). In research by RIEF, an adult of *S. graminum* was found in a field emergence trap on a moist meadow. MEYER & HEYDEMANN (1990) used both field emergence traps and rearing from the material of soil samples in a laboratory. They

provided data on larval habitats of three *Stilpon* species: *S. graminum* was found to develop in moist shores of a lake and of a stream with well-developed semiaquatic vegetation; in both habitats the species was among the predominant Hybotidae. *S. nubilus* was mostly found to develop on salt meadows in the sea supralittoral zone (four sites; the species was common or numerous, in one case predominant among Hybotidae), but also found in emergence traps in inland mesophytic meadow habitats (three sites: a brackish non-tidal polder meadow, a roadside meadow, and a field border). Finally, *S. lunatus* was shown to develop in a *Sphagnum* bog. MEYER *et al.* (1997) studied a number of coastal salt meadows using field emergence traps, and found *S. nubilus* to be common at sites different in soil composition (clay to silt but not sand); the species was more numerous in the upper zone (Festucetum) but found also in the lower zone (Puccinellietum) regularly submerged by the tide.

In addition, the adults of a recently described species, *Stilpon corsicanus* GROOTAERT & SHAMSHEV, 1993, were collected using field emergence traps installed on the ground in an alder forest in Corsica (GROOTAERT & SHAMSHEV, 1993).

Apparently, in all the above cases the larvae inhabited the layer of soil and litter.

Recently, another habitat type has been discovered for larvae of the poorly known species *Stilpon machadoi* SMITH, 1965. Adults of this species were reared from a fruit body of the polypore *Phaeolus schweinitzii* (FRIES) PATOUILLARD collected in a mixed forest in France (STARK & COCQUEMPOT, 1996).

In addition to this, CHANDLER (1978) mentioned that larvae of *Stilpon* developed in compost, but he gave no further information or references.

Methods

All material in this study was collected by A. PRZHIBORO by rearing adults from the shore habitats of two types: the supralittoral zone of the White Sea and the water margin zone of freshwater lakes.

The supralittoral zone extends from the average high tide level of the spring tide (ca. 2.1 m in height) to that of the highest high tide level of the spring tide (ca. 2.4 m). It borders the upper intertidal zone from below and the forest edge from above. The water margin zone is considered within the borders: from 5 cm below the water level to 10 cm above it. In general, it borders the littoral zone from below and various terrestrial habitats from above.

Three rearing techniques were used: laboratory rearings from separate immatures, laboratory rearings from substrata collected in the field, and field emergence traps.

Separate larvae were obtained from shore samples, which were washed in sieves (the smallest 0.25 mm mesh), then the macro-invertebrates were extracted by flotation in a strong solution of NaCl combined with hand-sorting of the coarse fraction. The larvae were put into vials filled with substratum from the sampling site.

The shore substrata were sampled to a depth of 5-10 cm from the surface and placed into plastic containers (surface area from 10×15 to 30×30 cm) covered with a tight lid. For ventilation, the lid was supplied with a fine-meshed window. After sampling, the litter layer of the substratum in each container was examined, for adult dipterans as well as larger predatory arthropods taken with the substratum.

The containers and vials were kept in the laboratory from May to early October at room temperature (18-25°C) and natural light regime at the corresponding latitude (after that, the substrata and separate immatures were placed in 5-10°C and darkness for 3 months, for a reactivation of hibernating dipterans). The emerging imagines were collected with an aspirator once ever 2-6 days.

In addition, field emergence traps were used at some sites. A construction similar to those proposed by SUBLETTE & DENDY (1959) and LAMMERS (1977) (both cited by DAVIES, 1984) was used; each trap was supplied with a sample beaker containing alcohol 50-70% with additions of glycerol and formalin.

Results

The adults of *Stilpon* were reared from six localities in Northwestern Russia listed and described below. In total, 11 specimens were reared, all being full-winged. All specimens belong to *S. graminum*. The material is deposited at the Zoological Institute, St.Petersburg.

1. KARELIA, Loukhi Distr., 66°20'N 33°38'E, Chupa Bay of the White Sea, Seldyanaya Inlet, sea shore, site 3, supralittoral zone: 1♂ and 2♀♀ reared 23.VII.2000 from substratum collected

28.VI.2000; 1♀, 24.VI.2002, in emergence trap installed 9.VI.2002.

Habitat: The site is situated close to the end of the narrow Seldyanaya Inlet. The supralittoral zone at the site is about 10 m wide, occupied by a salt meadow on muddy soil (*Juncus gerardii* LOISEL., *Carex salina* WAHL., *Agrostis stolonifera* L., and *Sonchus arvensis* L. predominate; total cover 60-90% per m^2; dense peaty turf has developed). The points in which the substrata were collected and emergence traps installed were subject to inundation by seawater several times per season (May-October), for 0.5-1 hour.

2. LENINGRAD PROV., Vyborg Distr., 60°37'N 29°20'E, Lake Okhotnich'e, site 1, water margin zone: 1♀ reared 20.VII.2001 from substratum collected 5.VII.2001.

Habitat: The water margin zone is a marsh floating shore gradually turning into a *Sphagnum* bog. The floating shore is about 100 m wide, thick; a peaty turf of medium density has developed. The points in which the substrata were collected are characterized by predominating *Sphagnum obtusum* WARNST., *Carex rostrata* STOKES, *Eriophorum angustifolium* HONCK., and *Comarum palustre* L. (total cover 40-90% per m^2).

3. LENINGRAD PROV., Gatchina Distr., 59° 23'N 29°47'E, a lakelet (limnocrene) 2 km E of vill. Glumitsy, water margin zone: 1♂ reared 7.VIII.2001 from larva collected 19.VII.2001.

Habitat: The nameless shallow lakelet is a head of the Oredezh River. It is ground-fed, characterized by a stable water level and water temperature not exceeding 12°C in summer. The water margin zone is narrow (less than 0.5 m wide), occupied by a meadow on muddy soil (*Festuca arundunacea* SCHREB., *Poa trivialis* L., *Deschampsia caespitosa* (L.) BEAUV., *Carex rostrata*, and *C. nigra* (L.) REICHARD predominate; total cover about 70%). In the ground layer the mosses *Brachythecium rivulare* SCHIMP., *Cratoneuron filicinum* (HEDW.) SPRUCE and *Plagiomnium elatum* (BRUCH. et SCHIMP.) T. KOP. are abundant. A dense turf has developed.

4. LENINGRAD PROV., Lomonosov, 59°54'N 29°46'E, Lake Verkhnii Prud, water margin zone: 1♀ reared 15.IX.2006 from substratum collected 20.VII.2006.

Habitat: The water margin zone is narrow (less than 0.5 m wide), occupied by a meadow on muddy to sandy soil (*Carex rostrata*, *Phragmites australis* (CAV.) TRIN. ex STEUD. and other Poaceae predominate; total cover about 60-90%). A turf of medium density has developed.

5. NOVGOROD PROV., Chudovo Distr., 59° 17'N 32°07'E, Lake Oskuiskoe, water margin zone: 3♂♂ reared 6.VIII.2004 from substratum collected 10.VII.2004.

Habitat: The water margin zone is a typical marsh floating shore, about 10 m wide. The turf is thin and friable, saturated with water, almost without peat. The predominant plants are *Thelypteris palustris* SCHOTT, *Comarum palustre*, *Typha latifolia* L., *Iris pseudacorus* L., *Carex rostrata*, *C. acuta* L., *C. aquatilis* WAHL., and *Sphagnum squarrosum* CROME (total cover from 10 to 100% per m^2).

6. PSKOV PROV., Sebezh Distr., 56°12'N 28°40'E, Lake Anninskoe, site 2, water margin zone: 1♂ reared 17.VII.1998 from substratum collected 4.VI.1998.

Habitat: The water margin zone is a non-floating shore marsh (4-10 m wide) abounding in mounds. It is situated within the eulittoral zone (zone between the maximum and minimum seasonal water levels; these changes were ca. 25 cm). The predominant plants are *Thelypteris palustris* and *Acorus calamus* L.; total cover is 70-100%. Bottom substratum is represented by detritus and plant remains (herbaceous vegetation, leaves of trees, wood of willow) in some places changing into turf.

Discussion

Stilpon graminum is for the first time recorded from the following regions: Leningrad Province, Novgorod Province, Pskov Province and northern Karelia. In northern and northwestern European Russia, the species was recorded from southern Karelia (CHVÁLA, 1975). The record from northern Karelia is the northernmost (66°N) for this species. However, *S. graminum* was common at sea shore meadows (upper littoral and supralittoral zones) in this locality (PRZHIBORO, unpublished data).

In 1995-2006, A. PRZHIBORO studied the emergence of dipteran adults from the shore zone of 17 different-type lakes in NW Russia. *Stilpon graminum* is the only species of non-aquatic dance flies (Empididae s.l., other than Hemerodromiinae and Clinocerinae) reared from shores of several lakes with different conditions. In contrast to this, no adults of *Stilpon* were reared from shores of any running waters (streams, rivers, springs, waterfalls; a total of 8

running waters were studied). However, no marshy shores of water currents were considered.

In addition, before our study *S. graminum* has never been recorded as an inhabitant of sea shores. We failed to find any data on this species in marine intertidal or supralittoral habitats.

All shore habitats of *S. graminum* immatures discovered in Northwestern Russia are united by the following features: these are **wet, protected from the action of wind and waves, with well-developed higher vegetation, organic-rich soil and continuous high level of substratum humidity.** The latter was diverse, depending on locality (from wet soil to floating marsh) but no desiccation of shore substratum was observed. The water margin zone in freshwaters (localities 2-6) belongs to morphological types 1 (locality 3), 1-2 (locality 4), and 3 (localities 2, 5 and 6) (according to PRZHIBORO, 2001, 2003, 2004). All habitats but one (locality 6) are not subject to prolonged inundation. In all sites, the litter layer is well developed. However, it was variable in composition: in localities 1-5 the litter included mainly the remains of herbaceous plants and mosses, whereas in locality 6 the remains of tree leaves and wood were abundant as well. Shading of the ground layer by trees and/or by the grass cover was diverse: from comparatively low (localities 1 and 2) to high (localities 3, 4 and 6). The lakes were also different in trophic status, from oligotrophic (locality 3) to low eutrophic (locality 6).

Summarizing the original data and the data from earlier publications (TREHEN, 1971; MEYER & HEYDEMANN, 1990; RIEF, 1996): *Stilpon graminum* develops in a wide range of wet terrestrial and semiaquatic habitats apparently united by several common features listed above (underlined). Thus, it is apparent that larvae of *S. graminum* are semiaquatic or hygrophilous terrestrial rather than aquatic.

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