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DISTRIBUTIONAL PATTERNS, HOST SPECIFICITY AND DENSITY OF AN EPOICTIC MIDGE, EPOICOCLADIUS FLAVENS (DIPTERA, CHIRONOMIDAE) IN CZECHOSLOVAKIA

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Abstract. Larvae of *Epoicocladius flavens* (Malloch) were found at 268 localities evenly spread in all faunistic districts in Czechoslovakia. Larvae occur currently on larvae of *Ephemera danica* (59.3 % of known host localities) and *E. vulgata* (49.2 %) preferring brooks and small rivers at altitudes of 250–500 m to lakes, ponds and large lowland rivers and biotopes of higher altitudes. *E. flavens* is recorded from *E. lineata* for the first time from a single South Bohemian locality-. Chironomid's densities were studied in 5 selected Bohemian localities-. Infestation rates on individual mayfly species depends on their density and quantitative presentation; occurrence on larvae of *E. lineata* is probably incidental. There are no substantial seasonal density changes although older larvae of mayflies are infested more frequently (up to 98.2 % specimens infested), especially during winter months.

INTRODUCTION

With the exception of incidental associations between chironomids and mayflies, e.g. findings of *Rheotanytarsus* sp. on *Stenonema smithae* is South Carolina (White et al., 1980), and recently described *Nanocladius* (*Plecopteracoluthus*) *bubrachiatus* on *Traverella* sp. from Honduras (Epler, 1986) larvae of the genus *Epoicocladius* represent the only epoictic (or "commensalistic" or "symphoretic") chironomids living on mayflies. *E. flavens* is widespread, frequently collected from larvae of the genus *Ephemeroptera* in a large number of European countries (see Fittkau and Reiss in Illies, 1978 and others). Although our knowledge on its development, life cycle and infestation rate is relatively extensive, its distribution and densities within individual areas remain unknown since detailed studies have been conducted only in Sweden (Svensson, 1976, 1978, 1980) and England (Tokeshi, 1986).

E. flavens is considered to be abundant in Czechoslovakia (cf. Landa, 1969; Lellák, 1970, 1980). However, except for some brief mentions, e.g. that by Šulc and Zavřel (1924) on its occurrence on *Ephemera vulgata* in Eastern Bohemia, there are no data concerning its distribution within the country. The present paper is intended to summarize distributional data and to study host-specificity and infestation rates in some selected localities.

MATERIAL AN METHODS

Material of host larvae (4 species of the genus *Ephemera*) was collected during an extensive faunistic research of mayflies carried out in 1950–1965 and 1970–1985. More than 2000 localities evenly spread on the whole Czechoslovakia's territory comprising all types of aquatic biotopes at all altitudinal zones (for details see Landa and Soldán, 1988) were studied.

Only localities with a positive occurrence of larvae of *Epoicocladius flavens* among the material of *Ephemera* larvae are listed below. The data concerning the localities are listed in the following sequence: (i) number of locality, (ii) name (in Czech) of respective aquatic biotope, (iii) name of adjacent town or village, (iv) altitude of locality, (v) coordinates of the uniform entomofaunistic

grid system and (vi) host species of *Ephemera*. Localities are arranged in order of faunistic districts as defined by Landa and Soldán (1985) which mostly correspond to natural main river watersheds. Localities of hosts occurrence (more than 500 localities) are not listed here, for their list see Landa and Soldán (1988); their distribution is presented on the maps showing positive occurrence in the uniform grid system (Figs 1–3). All the material collected is deposited in the collection of Institute of Entomology, Czechoslovak Academy of Sciences, České Budějovice.

The larvae of *E. flavens* frequently leave their hosts during fixation and at least a part of them is usually lost when the material is sorted. Moreover, the larvae of *Ephemera danica* and *E. vulgata* occurring at the same locality were mostly fixed together. Consequently, it is impossible to evaluate their densities on individual hosts in most of samples. In order to study host-specificity and infestation rate five localities were selected (see localities Nos 36, 63, 66, 118, 132). At these localities larvae of *Ephemera* were collected in all seasonal aspects, 4–6 times a year (every sample collected for 1–2 hrs) and fixed and observed individually. Sinc ethe numbers of chironomid larvae per host were studied by Svensson (1976) in detail, the level of infestation was simply expressed as a number (percentage) of infested younger and older larvae and average number of chironomids per larva of respective species (infestation quotient by Svensson 1976). "Younger larve" larvae of *Ephemera* spp. represent those during the first year of their developmental cycle (half-grown), "older larvae" are larvae ready to emerge during the same year. Larvae smaller than 10–12 mm were usually not infested; they were not sampled and analysed.

RESULTS

Distribution of host species

Larvae of *Epoicocladius flavens* were found on three of four species of the genus *Ephemera* living in Czechoslovakia. The most distributed species is *E. danica* (Müll.). *E. danica* is widely distributed European species occurring all over the Europe and representing an arboreal faunistic elements of Mediterranean origin. Throughout Czechoslovakia, its area is quite continuous in both Hercynian and Carpathian systems (Fig. 1). It is a very common species (grade 6 according to Friederichs, 1941) of mass occurrence at most localities. It was found altogether at 401 localities in all faunistics districts. It is distributed mostly at altitudes of 250–500 m but its large ecological range helps to colonize even biotopes above 750–1000 m. Larvae prefers small and mid-sized streams and small rivers often occurring also in very small and shallow brooks and ponds outflows. Larger rivers and ponds or lakes are colonized only occassionally.

Ephemera vulgata L. represents a faunistic element of large distributional area, widespread throughout the whole Westpalaearctic region. Its area in Czechoslovakia is quite continuous but it has not been collected yet only in the faunistic district XV. It is a species of moderate occurrence (grades 3–4 according to Friederichs, 1941) so far found at 71 localities (Fig. 2). Larvae prefer especially brooks and smaller rivers at altitudes to 300–500 m very frequently colonizing oligotrophic ponds and lakes as well as large lowland rivers. It occurs also in mountain lakes at higher altitudes.

Ephemera lineata (Eaton) is a Palaearctic species and an arboreal faunistic element with probably polycentric area of Mediterranean origin. Its area in Czechoslovakia seems to be disjunct (Fig. 3), restricted to the faunistic district II–VII, IX, XI–XIII, XV and XVII. It was found at 27 localities, occurrence in the district III is probably historical; a species of scarce occurrence (grade 2 according to Friederichs), larvae found solely in large or medium sized rivers and canals with swift current. Fourth Czechoslovakia's species, *Ephemera glaucops* Pictets represents only a potential host for larvae of *E. flavens*. It is a very rare (grade 1 according to Friederichs, 1941) South-central European species and Mediterranean faunistic element, so far known from the faunistic districts XIV and XVII (altogether 6 localities).

Larvae were found solely in large lowland rivers in Czechoslovakia although they live in oligotrophic lakes as well (German Democratic Republic).

As to area changes during the past 20—30 year, only the areas of *E. lineata* and *E. glaucops* were apparently restricted probably because of cummulative pollution of larger lowland rivers. On the contrary, the area of *E. danica* slightly expanded because of the relatively higher vagility of this pecies. The area of *E. vulgata* did not substantially changed (for details see Landa and Soldán, 1985).

Distribution of *Epoicocladius flavens*

Larvae of *E. flavens* were found at the following localities on the following species ("v" — *E. vulgata*; "dv" — *E. danica* and *E. vulgata*; „dl" — *E. danica* and *E. lineata*; if not stated, the finding refers to *E. danica* as a host species):

I (the upper Elbe basin): 1. Loučná, Týniště, 200 m a. s. l., coordinates of the uniform grid system 5962; 2. Cidlina, Paměťník, 210, 5858 (v); 3. brook, Nehvizdy, 210, 5854 (v); 4. brook, Nouzov, 215, 5757; 5. Bohumilečský brook, Bukovina, 230, 5861; 6. Doubrava, Žleby, 240, 6159 (v); 7. Podolský brook, Barchov, 245, 5960; 8. brook, Mlékovice, 250, 5956; 9. Brodec, Zdelov, 260, 5862; 10. Loučná, Vysoké Mýto, 287, 6062; 11. Vavřinec, Hryzely, 308, 6056; 12. Struha, Licomělice, 319, 6059; 13. brook, Lukavice, 320, 6161; 14. brook, Lhota, 325, 5562; Šembera, Doubravčice, 330, 5955; 16. Dlouhá, Solnice, 330, 5473; 17. Černíkovský pond, Černíkovice, 341, 5863; 18. Lokotský brook, Solnice, 341, 5763; 19. Novohradka, Doly, 350, 6162; 20. brook, Hranice, 386, 6260; 21. Olešenka, Pekło, 390, 5663; 22. brook, Skuhrov, 395, 5763; 23. Končínský brook, Pazucha, 401, 6164; 24. Chrudimka, Mezisvětí, 410, 6160; 25. Tichá Orlice, Jablonné, 430, 5965; 26. brook, Seč, 443, 6159; 27. Stěnava, Hynčice, 450, 5363; 28. reservoir Seč, Seč, 495, 6159, (v); 29. Tichá Orlice, Lichkov, 527, 5960.

II (the lower Elbe basin): 30. Pšovka, Lhota, 185, 5653; 31. Liběchovka, Tupadly, 190, 5552; 32. Opárenský brook, Opárno, 200, 5450; 33. Liběchovka, Liběchov, 211, 5552; 34. Valtéřický brook, Valtéřice, 230, 5352; 35. Žehrovka, Žabikory, 231, 5456; 36. Pšovka, Kokořín, 250, 5553, (dv); 37. Mlýnský brook, Jestřebí, 255, 5453; 38. Bobří brook, Borek, 265, 5353, (v); 39. Řasnice, Řasnice, 280, 5057; 40. Ploučnice, Mimoň, 285, 5354; 41. Bobří brook, Kravaře, 285, 5352; 42. Mohelka, Třtí, 305, 5356; 43. Desná, Tanvald, 310, 5257 (v); 44. Svitavka, Drnovec,

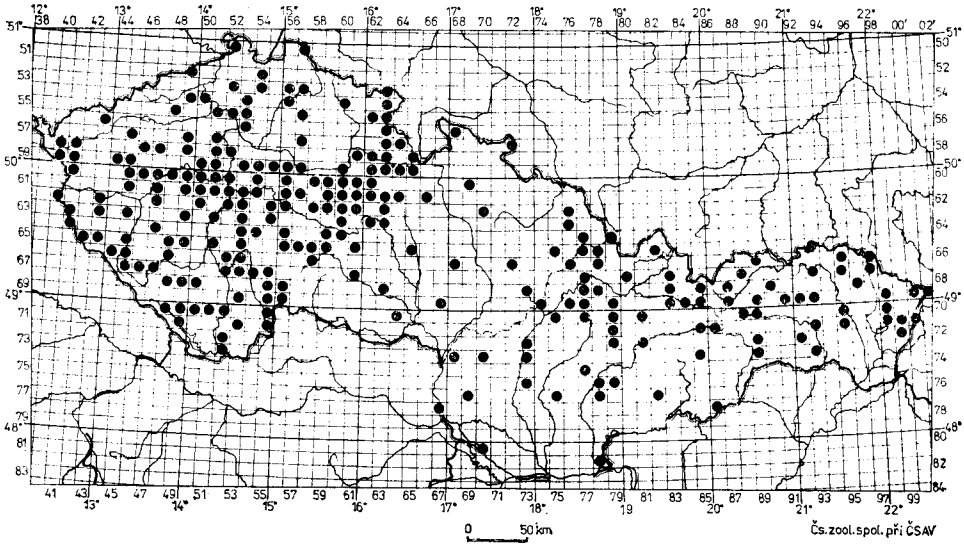


Fig. 1. Dot mapping of the area of *Ephemera danica* in Czechoslovakia; 401 localities grouped according to the uniform grid system.

340, 5254; 45. Lesní brook, Šluknov, 375, 5052; 46. Luční brook, Bukovice, 410, 5449; 47. Ždírnický brook, Žandov, 530, 5249.

III (the Ohře basin): 48. Hrádecký brook, Raná, 255, 5548; 49. Blšanka, Vroutek, 302, 5846; 50. Lužní brook, Děvín, 430, 5840; 51. Liboc, Mětikalov, 500, 5745; 52. Libava, Arnoltov, 531, 5841; 53. Šitbořský brook, Žandov, 545, 5941.

IV (the Berounka basin): 54. Červený brook, Velvary, 190, 5751; 55. Unětický brook, Roztoky, 200, 5853; 56. Rokytka, Počernice, 210, 5953; 57. Švarcava, Černošice, 235, 6051; 58. Kačák, Sv. Jan, 240, 6050; 59. Kačák, Hostim, 245, 6050; 60. Loděnice, Loděnice, 250, 6050; 61. Habrový brook, N. Huť, 250, 6049; 62. brook Davle-Libřice, 250, 6152; 63. Zahořanský brook, Davle-Libřice, 250, 6152; 64. Zlatý brook, Davle-Libřice, 260, 6052; 65. Radotínský brook, Rutický mlýn, 280, 6051; 66. Radotínský brook, Cikánka, 285, 6051, (dv); 67. Zlonický brook, Žerotín, 285, 5749; 68. brook, Kosoř, 285, 6052; 69. Zbirožský brook, Skryje, 285, 6048; 70. Zlatý brook, Březová, 285, 6052; 71. Zahořanský brook, Zahořany, 300, 6052; 72. Kralovický brook, Hradiště, 300, 6047; 73. Loděnice, Nenačovice, 305, 5950; 74. Radotínský brook, Choteč, 305, 6051; 75. Chumava, Libomyšl, 305, 6150, (v); 76. Střela, Plasy, 310, 6046; 77. Švarcava, Solopysky, 325, 6051; 78. Chlumčanský brook, Dobřany, 335, 6345; 79. brook, Žerotín, 340, 5740; 80. Karlický brook, Roblín, 345, 6051; 81. Rokytka, Říčany, 350, 5954; 82. brook, Kyšice, 350, 5950; 83. canals, Roblín, 350, 6051; 84. Klíčava, Lány, 355, 5849; 85. brook, Červené Poříčí, 365, 6545; 86. Otročínský brook, Milíkov, 370, 6243; 87. Lánský brook, Lány, 385, 5849; 88. Bělá, Trnová, 385, 6145; 89. canal, Ruda, 385, 5849; 90. Habrový brook, Nový Jáchymov, 388, 6049; 91. Úpořský brook, Broumy, 390, 6049; 92. Holoubkovský brook, Borek, 390, 6247; 93. brook, Nemanice, 390, 6441; 94. Strupinský brook, Hředle, 400, 6149; 95. Rokytka, Mukařov, 400, 6054; 96. brook, Karlova Ves, 400, 6049; 97. Úhlava, Janovice, 405, 6645, (dv); 98. Padrtský brook, Hrádek, 405, 6247; 99. Poleňka, Slatina, 410, 6545; 100. Zbirožský brook, Zbiroh, 410, 6148; 101. Jelenka, Janovice, 420, 6645; 102. Strupinský brook, Žebrák, 420, 6149; 103. canals, Janovice, 425, 6645; 104. Trhanovský brook, Klenčí, 450, 6543, (v); 105. brook, Trhanov, 455, 6542; 106. Šipský brook, Křekovice, 490, 5957; 107. Zubřina, Havlovice, 495, 6543; 108. brook, Ondřejovice, 495, 6645; 109. Kateřinský stream, Kateřina, 514, 6351; 110. canal, Trstěnice, 540, 6042, (v); 111. Senný brook, Drmoul, 562, 6041, (dv); 112. brook, Háje, 75

V (the Vltava basin): 113. Bojovský brook, Měchenice, 210, 6052; 114. Sladovařský brook, Ždáň, 295, 6252; 115. Kocába, Knín, 305, 6251; 116. brook, S. Huť, 345, 6251; 117. Brzina, Dražkov, 350, 6351; 118. Židova strouha, Nuzice, 370, 6752 (dv); 119. Voznický brook, Voznice 375, 6151; 120. Smutná, Bechyně, 380, 6752, (dv); 121. Plzinský brook, Bechyně, 385, 6652,

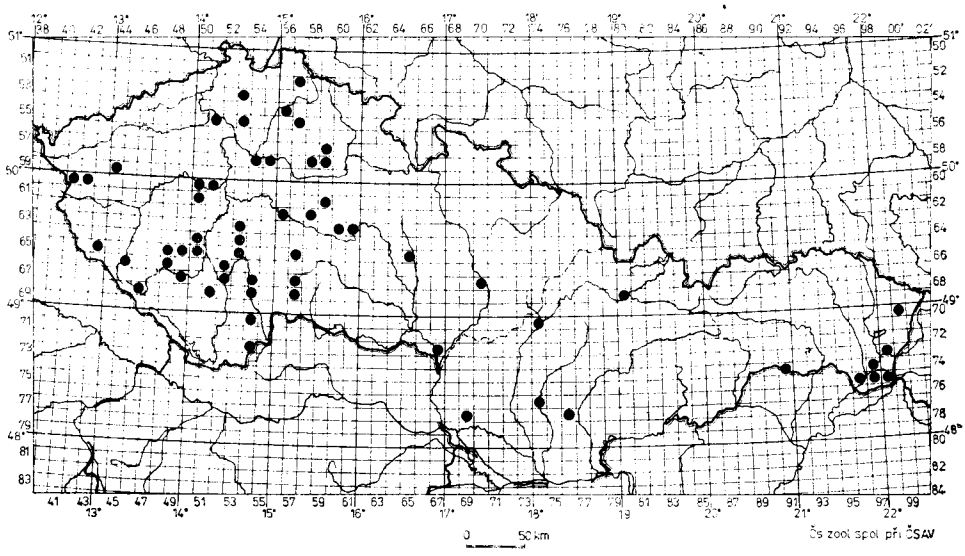


Fig. 2. Dot mapping of the area of *Ephemera vulgata* in Czechoslovakia; 71 localities grouped according to the uniform grid system.

(dv); 122. Bílinský brook, Dražíč, 390, 6752; 123. Smutná, Srlín, 394, 6652, (v); 124. Chválovický brook, Bojanovice, 395, 6152; 125. Svinenský brook, Pašínovice, 400, 7153; 126. Malše, Plav, 400, 7052; 127. Lipižský brook, Dobříš, 400, 6150; 128. Sedlecký brook, Sedlec-Prčice, 405, 6453, (v); 129. Borovanský brook, Dražíč, 405, 2652; 130. Kyselý brook, Úsilné, 411, 6953; 131. Bechyňský brook, Záluží, 416, 6753; 132. Nová řeka, Mláka, 430, 6955, (dl); 133. Hrejkovický brook, Květov, 430, 6551; 134. Košínský brook, Košín, 430, 6553; 135. Zlatá Stoka, Třeboň, 435, 7054, (v); 136. canal, Ženich, 435, 6955; 137. Trnovský brook, Dobříš, 450, 6250; 138. Kosínský brook, Nasavrky, 450, 6543; 139. brook, Rzavá, 450, 6553; 140. Tušť, Suchdol, 455, 7055; 141. Dírenský brook, Dírná, 460, 6754, (dv); 142. Radouňský brook, Radouňka, 475, 6855; 143. brook, Jindřichův Hradec, 480, 6855; 144. brook, Zátoň, 495, 7352; 145. Lhotecký brook, Křemže, 500, 7051; 146. Ženský brook, Studnice, 500, 6755; 147. canal, Studnice, 510 6755; 148. Koštěnický brook, Čiměř, 520, 6956; 149. brook, Borotín, 520, 6453; 150. brook Člunek, 525, 6856; 151. Brložský brook, Rojšín, 535, 7051; 152. Stropnice, H. Stropnice, 550 7254, (v); 153. pond Zvůle, Mosty, 640, 6857, (v).

VI (the Otava basin): 154. Lomnice, Mirotice, 405, 6550, (v); 155. Lomnice, Blatná, 440, 6549; 156. brook, Nišovice, 445, 6849; 157. Závišínský brook, Bezdědovice, 450, 6549, (dv); 158. Peklov, Nikošovice, 456, 6849; 159. Nadymač-pond, Vrbno, 475, 6548; 160. canal of the Krčový pond, 480, 6548; 161. Divišovský brook, Divišov, 495, 6747; 162. canals, Kadov, 505, 6648, (dv); 163. Spůtka, Bohumilice, 565, 6848; 164. Zlatý brook, Záhoří, 680, 7050; 165. Blanice, Blažejovice, 737, 7049.

VII (the Sázava basin): 166. Janovický brook, Václavice, 285, 6253; 167. Janovický brook, Vatěkov, 295, 6253; 168. Břežanský brook, Břežany, 320, 6152; 169. brook, Jílové u Prahy, 325, 6152; 170. brook, Mirošovice, 330, 6054; 171. Brejlovský brook, Netvořice, 360, 6153; 172. Blanice, Blanice, 360, 6454; 173. Brodec, Světlá, 380, 5464; 174. Tloskovský brook, 380, 6253; 175. Zdeslavský brook, Trhový Štěpánov, 380, 6255; 176. brook, Talmberk, 385, 6255; 177. canals, Vrchotovy Janovice, 390, 6353; 178. Sázavka, Miřátky, 400, 6258, (dv); 179. Losínský brook, Kácov, 400, 6156; 180. brook, Vyžlovka, 400, 6054; 181. Martinický brook, Martinice, 455, 6456; 182. Bělá, Žižkovo Pole, 465, 6360; 183. Trnávka, Hrádek, 480, 6556; 184. Borovský brook, Macourov, 480, 6360; 185. brook, Skuhrov, 480, 6259; 186. Hejlovka, Hodějovice, 495, 6557; 187. brook Lištěnec, 500, 6353; 188. brook, Přibyslav, 500, 6460; 189. Janovický brook, Jarkovice, 519, 6253; 190. canals of the Kladiny pond, 540, 6558; 191. Trnávka, Obrataň, 550, 6556; 192. Velké Dářko pond, Škrdlovice, 620, 6361, (v).

VIII (the Morava basin): 193. Olšinka, Zdounky, 240, 6770, (v); 194. Haná, Ivanovice, 220, 6663; 195. Brezovský brook, Brezová p. Bradlom, 275, 7370; 196. brook D. Bušinov, 415, 6166; 197. Dřevnice, Držková, 445, 6672; 198. Trusovický brook, Těšíkov, 500, 6270; 199. Rožnovská Bečva, Horní Bečva, 525, 6575.

IX (the Dyje basin): 200. canal, Markovice, 200, 7064; 201. brook, Obora, 350, 6565, (v); 202. brook Kotkovice, 420, 6863; 203. Býkovka, Bukovice, 435, 6565; 204. Oslava, Ostrov, 500, 6561; 205. Bílý brook, Kamenec u Poličky, 585, 6263; 206. brook, Blatiny, 705, 6362.

X (the Odra basin): 207. Osoblaha, Osoblaha, 235, 5772; 208. Lučina, Šenov, 246, 6276; 209. Lučina, Vojkovice, 325, 6376; 210. Vidnávka, Žulová, 350, 5865; 211. Morávka, Morávka, 495, 6477.

XI (the lower Váh basin): 212. Šurský brook, Jur pri Bratislave, 145, 7769, (v); 312. Čachtický brook, Čachtice, 185, 7272; 214. Trnávka, Trstín, 210, 7074, (v); 215. Pružinka, Visolaje, 285, 6976; 216. Hôrčanský brook, Hôrka, 285, 7273; 217. Modrovský brook, Modrovka, 203, 7373; 218. Bystrá, Považská Bystrica, 325, 6877; 219. Vlára, Vlachovice, 335, 6873; 220. Domanižianka, Prečín, 360, 6977.

XII (the upper Váh and Poprad basin) 221. Čierňanka, Svrčinovec, 435, 6578; 222, Vadičovský brook, Lopušné, 450, 6678; 223. Čierňanka, Skalité, 475, 6479; 224. brook Kralovany, 500, 6880, (v); 225. brook, Jablunkov, 500, 6578; 226. Predmieranka, Klokočov, 545, 6577; 227. Zazrivka, Zázrivá, 635, 6780; 228. Kvačianka, Kvačany, 635, 6883; 229. Žarnovice, H. Štubňa, 635, 7179; 230. Rieka, Lendak, 705, 6788; 231. Belá, Pribylina, 795, 6885; 232. brook Kastánie. 800, 6578.

XIII (the Nitra basin): 233. brook, Vieska, 165, 7776, (v); 234. Hlavínka, M. Ripňany, 175, 7573; 235. Črešňový brook, H. Slažany, 195, 7575; 236. brook, Nitra, 245, 7674, (v); 237. Dubnička, Dubnička, 250, 7674.

XIV (the Hron basin): 238. brook Chľaba, 245, 8178; 239. Štampoch, Bohunice, 305, 7678; 240. Kľak, Hámre, 305, 7477; 241. Driekyňa, Slovenská Ľupča, 390, 7281; 242. Halčianský brook, Banská Štiavnica, 500, 7579; 243. Kremnický brook, Kremnica, 610, 7279.

XV (the Ipeland Slaná basin): 244. Tisovecká Rimavica, Tisovec, 295, 7385; 245. Madačka, Šuľa, 350, 7682; 246. Pača, Krásnohorske Podhradie, 335, 7389; 247. Čremošná, Drnava, 445, 7389.

XVI (the Hornád basin): 248. Blatný brook, Zádielské Dvorníky, 190, 7491, (v); 249. Balky, Šarišské Bohdanovce, 300, 7193; 250. Malá Svinka, Svinia, 350, 6992; 251. Veľký brook, Šarišské Sokolovce, 410, 6993; 252. Veľká Bielá voda, Píla, 500, 7088; 253. Veľká Svinka, Fričovce, 545, 6991.

XVII (the Tisza basin): 254. canals, Somotor, 98, 7596, (v); 255. Čierna voda, Stretava 100, 7398, (v); 256. Okna, Jasenov, 130, 7299; 257. Porubský brook, Poruba, 145, 7198; 258. Kusín, Jovsa, 180, 7198; 259. Čertež, Brusnica, 200, 6896; 260. Ondava, Svidník, 230, 6695; 261. Pichoňka, Snina, 245, 6998; 262. Žiarovnica, Hliviština, 265, 7199; 263. Kovný brook, Ruský Hrabovec, 265, 71100. 265. Okna, Remetské Hámre, 380, 7199; 266. Veľký rybný brook, Lukov, 430, 6793; 267. Kamenec, Becherov, 445, 6593; 268. Morské lake. Remetské Hámre, 610, 7099, (v).

Larvae of *Epoicocladius flavens* were found altogether at 268 localities in all 17 faunistic district of Czechoslovakia. It occurs at 35 (49.2% localities of total host occurrence) localities on larvae of *Ephemera vulgata* and at 238 localities (59.3%) on *E. danica*. Infestation of both these species simultaneously was observed at 10 localities only. Although the localities of a chironomid occurrence evenly cover the whole Czechoslovak territory (Fig. 4) its distribution shows certain preferency of habitats and/or altitudes.

Larvae prefer host localities of unpolluted brooks approximately up to 5 m across with well aerated but relatively warmer water. There is probably no habitat or microhabitat preferrency, they occur on mayfly larvae evenly within host habitat range. Larger rivers, although frequently inhabited by *Ephemera* larvae, are usually free of *Epoicocladius*, with the exception of localities Nos. 1, 24, 76, 126, 154 and 155. Eutrophic ponds, although sometimes colonized by *Ephemera* species (mostly *E. vulgata*), are inhabited only exceptionaly also by *Epoicocladius* (e.g. locality No. 159). The cases of occurrence in oligotrophic ponds at higher altitudes (Nos. 153, 192), larger reservoirs (No. 28) or submontane lakes (No. 268) are more frequent. On the other hand, some artificial biotopes are inhabited frequently if the conditions resemble those occurring in natural brook and streams. *Epoicocladius* larvae are often found especially in carp ponds in- and outflows or in larger canals (e.g. localities Nos. 3, 83, 89, 110, 160, 190, 236 and others).

As to vertical zonation of localities, lowland localities up to 200 m a.s.l. are relatively rare, except some cases where abiotic factors resemble those is highland and submontane brooks (e.g. Nos. 30, 31, 55, 213, 235). Most localities of *E. flavens* occurrence are situated at altitudes of 250—500 m in highlands. Submontane localities above 400—500 m are represented mostly by smaller rivers with respective abiotic factors (relatively high water temperature), e.g. Nos. 24, 25, 29, 107, 126, 152, 186, 211 and others. Submontane and montane localities are rare as well, the occurrence of *E. flavens* on hosts living at the localities above 700 m is exceptional (Nos. 112, 165, 206, 230—232).

Most localities are concentrated to the Elbe basin, faunistic districts of the South-Bohemian highland and the Berounka highland show the highest number of localities (IV, V); chironomids are frequent also in the district VII (the Sázava river basin). *E. flavens* seems to be sparse in the Odra, Morava and Dyje basins (VIII, X and IX) in Moravia and in Central Slovakia (see Fig. 4). In general, this species can be evaluated as a species of an abundant or of considerable occurrence (grades 5 and 4 of Friederichs, 1941) in Czechoslovakia. No substantial changes were observed while comparing its distribution in 1950—1965 and in 1970—1985, at most localities it occurs during both phases of faunistic research of the Ephemeroptera species.

Host specificity of *Epoicocladius flavens*

Taking into account the distribution of *E. flavens* in Czechoslovakia it seems to be impossible to determine primary host species of this chironomid. It exhibits close

affinities solely to larvae of the genus *Ephemera* and larvae have not been found on other "burrowing" mayflies (*Ephoron*, *Palingenia*) showing a similar larval habits.

There is no clear preference between larvae of *Ephemera danica* and *Ephemera vulgata*. Judging from the number of localities where the larvae of *E. flavens* occurs the infestation of both these species is approximately the same. The relatively high number of localities with infested individual, i.e. 59.3 % in *E. danica* and 49.2 % in *E. vulgata*, supports this conclusion. Moreover, at most localities of common occurrence (e.g. localities Nos. 36, 66, 121, 162) of *E. danica* with *E.* vulg*ata*, both species are usually infested although the infestation rate is mostly different. The differences are probably caused mostly by density factors (see Densities of *E. flavens* at selected localities). However, it seems that ecological requirements of *E. flavens* are similar to those of *E. danica* as to abiotic factors, mainly oxygen content and water temperature. That is why this species is slightly preferred by *E. danica* to *E. vulgata* which lives mostly at lowland localities and often at biotopes with lower oxygenation of water (larger rivers, ponds and lakes). However, higher vagility of *E. danica*(at least in Czechoslovakia and Central Europe) and expansion of its area represent a favourable factor for dispersal of *Epoicocladius flavens*.

On the contrary, the infestation of *Ephemera lineata* is most probably only incidental, since it occurs only at a single locality (No. 132) of 27 localities studied (3.6 %). At the locality in question, which is not typical for *E. lineata* — a canal with aerated water and current speed of 20—50 cm.s^{-1}. The larvae of *E. danica* prevail and are much more infested. Larvae of *E. flavens* were found on only 8 of 85 larvae of *E. lineata*. This is the first record on occurrence of *E. flavens* on this mayfly species (cf. next paragraphs). Larvae of *E. flavens* have not been found on larvae of *Ephemera glaucops*, possible occurrence would be probably only incidental as in *E. lineata*. In Czechoslovakia, there is probably no locality of common occurrence with other *Ephemera* species.

Densities of *Epoicocladius flavens* and their seasonal changes in selected localities

As indicated above, 5 localities (Nos. 36, 63, 66, 118 and 132) were selected to study the chironomid larvae densities on their hosts. Since in all of these localities two of *Ephemera* species occur the changes in host preferences can be studied as well. The data concerning the localities Nos. 36 and 63 are summarized in Tables 1—2.

The locality No. 36 (Pšovka brook, Kokořín, North Bohemia) represents an exception since the abundance of *E. vulgata* is much higher than that of *E. danica*. The infestation rates of *Epoicocladius flavens* on *E. vulgata* are much higher as well reaching nearly 100 % while the infestation of larvae of *E. danica* exhibits a relatively very small percentage. Approximately the same proportions are apparent when evaluating the infestation quotient as defined by Svensson (1976). There is a marked decrease of infestation rates during summer months (June-October) which can be recognized especially in heavily infested *E. vulgata* (Tab. 1). A reverse situation was observed in the locality No. 63 (Zahořanský brook, Davle-Libřice, Central Bohemia) where usual quantitative presentation of individual *Ephemera* species occurred (*E. danica* much more abundant than *E. vulgata*). Infestation rates of chironomids on prevailing *E. danica* larvae are higher, contrary to the situation in the previous locality. The same decrease of infestation rates during summer months is well apparent (Tab. 2).

The locality No. 118 (Židova strouha brook, South Bohemia) was sampled during 1983. As to the quantitative presentation of individual *Ephemera* species the situation is the same as at locality No. 63. The infestation rates are also very similar. The samples containing 118 and 62 larvae of *E. danica* taken on April 8, 1959 and August 24, 1959, respectively, from the collection of the Institute of Entomology were analyzed. The infestation quotients 1.42 (April) and 0.85 (August) are fairly comparable to those obtained at respective seasonal aspects during 1983 (April 25: 1.58; September 1: 0.69). Average infestation (1983) of this locality is 65—75 % for younger larvae and-80—95 % for older larvae of *E. danica* and 35—45 % for younger larvae and 55—75 % for older larvae of *E. vulgata*. Altogether 1158 larvae of *E. danica* and 682 larvae of *E. vulg*ata were analysed.

The locality No. 66 (Radotínský brook, Cikánka, Central Bohemia) represents a habitat with approximately equal presentation of larvae of *E. danica* and *E. vulgata* although the former prefer microhabitats near the streamline and the latter sediments in pools and places with slower current speed. During 1977 (5 samples) altogether 952 larvae of *E. danica* and 869 larvae of *E. vulgata* were studied. Infestation rates are approximately the same in both younger and older larvae, slightly higher in *E. danica*, ranging from 69—98 % with quotient 0.52—1.21. Seasonal changes of infestation rates are comparable to those ascertained at localities Nos. 36 and 63, identical in both host species studied. A sample taken on May 9, 1986 (225 larvae of both species) shows nearly identical results as that from April 30, 1977 (infestation rate 92 % and 89 % in older larvae in *E. danica* and 85 % and 87 % in *E. vulgata*, infestation quotient 1.87 and 1.95 in *E. danica* and 1.77 and 1.69 in *E. vulgata*).

The locality No. 132 (Nová řeka canal, Mláka, South Bohemia) represents an exception since larvae of *E. danica* and *E. lineata* live there together. Larvae of

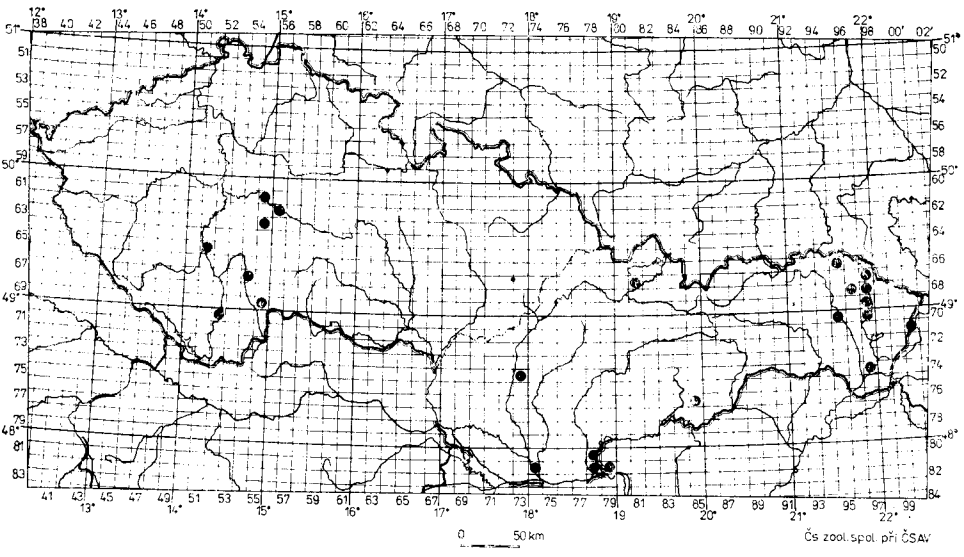
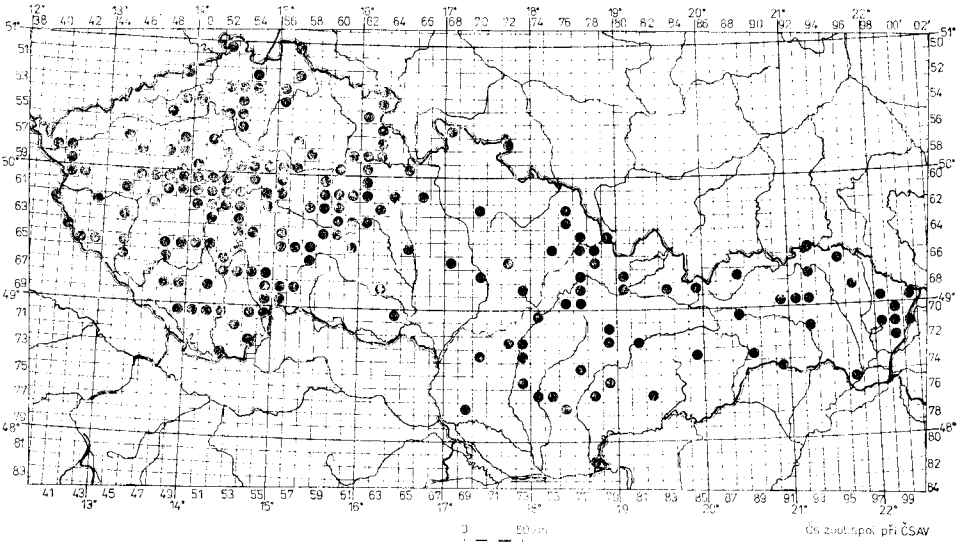


Fig. 3. Dot mapping of the area of *Ephemera lineata* in Czechoslovakia; 28 localities grouped according to the uniform grid system.

E. danica living at places with slow to moderate current speed are common but those of *E. lineata* are very rare occurring at the streamline habitats (cf. Host specificity of *Epoicocladius flavens*). The locality was sampled four times (April, June, August, October in 1974 August, October in 1973), altogether 728 larvae of *E. danica* and 85 larvae of *E. lineata* were collected. The infestation rates and infestation quotients of *E. danica* were very similar to values obtained at the localities Nos. 118 and 63. Larvae of *Epoicocladius flavens* were found on 8 larvae of samples from April and June, each larva harbored a single chironomid larva; in one case, there were 2 chironomids among the gills of the same mayfly larva. Chironomids were not found on 16 *E. lineata* larvae collected in 1979; in 1984 no larvae of *E. lineata* were found at this locality, infestation rates of *E. danica* larvae were normal.

DISCUSSION AND CONCLUSIONS

As documented by its distribution in Czechoslovakia *Epoicocladius flavens* is an abundant species and its distribution is probably correlated with that of its usual host, *Ephemera danica*. However, it has been so far recorded only from several countries, i.e. from France (Arvy and Peters, 1973), Rumania (Codreanu, 1939), Great Britain (Gillies, 1951; Henson, 1955, 1957), Sweden (Svensson, 1979, 1980), Germany (Thienemann, 1954) and Czechoslovakia (Šulc and Zavřel, 1924; Landa, 1969; Lelląk, 1970, 1980). There is no doubt that it is distributed in most European countries including the European part of the USSR although the northern and southern limits of its area are not known. Svensson (1976) found the larvae on *Ephemera vulgata* in lake Bosarpssjön, 58°58'N in Scandinavia but the extension range of the area is probably larger. I have studied the infested *Ephemera danica* larvae from Hungary, Poland, Bulgaria, Yugoslavia, France and



g Fig. 4. Dot mapping of the area of *Epoicocladius flavens* in Czechoslovakia; 263 localities rouped according to the uniform grid system.

Tab. 1. Infestation of *Ephemera* spp. larvae at the locality Pšovka, Kokořín (No. 36) and its seasonal changes in 1975

Date of sampling		*Ephemera danica*					*Ephemera vulgata*				
		Younger larvae and their infestation (%)		Older larvae and their infestation (%) and infestation quotient			Younger larvae and their infestation (%)		Older larvae, their infestation (%) and infestation quotient		
February	15	36	(36.1)	28	(46.4)	0.95	115	(75.7)	312	(95.5)	1.85
April	20	51	(56.9)	42	(47.6)	0.83	201	(79.1)	514	(98.2)	1.62
May	15	78	(57.7)	34	(17.6)	0.52	189	(91.0)	452	(92.7)	1.19
June	19	65	(69.2)	25	(36.4)	0.78	278	(50.7)	216	(69.4)	1.03
July	29	91	(35.2)	11	(18.2)	0.45	193	(38.9)	85	(71.8)	1.42
August	25	102	(27.5)	18	(27.8)	0.20	342	(46.1)	103	(67.0)	0.63
October	30	86	(33.7)	23	(21.8)	0.38	415	(53.5)	97	(82.5)	0.91
Total		509	(45.2)	181	(30.8)	0.58	1 733	(62.1)	1 779	(82.4)	1.23

Greece as well. All these specimens are morphologically identical with larvae described for *E. flavens* by Šulc and Zavřel (1924) (as *E. ephemerae*) and their relationships to *Epoicocladius gynocera* (Edwards) known only in the adult stage from the Alps and Fennoscandinavia is not clear. Svensson (1976, 1978, 1980) and Tokeshi (1986) most probably studied the same species.

Distribution in Czechoslovakia indicates that *E. flavens* is common within its area. It has been found at 268 localities. However, the percentage of localities of *Ephemera* spp. is probably higher than presented (59.3 % and 49.2 % in *E. danica* and *E. vulgata*, respectively) since in some localities only a single non-infested larva or solely adults of *Ephemera* were collected. In Sweden (Stampen) the chironomid

Tab. 2. Infestation of *Ephemera* spp. larvae at the locality Zahořanský brook, Davle Libřice (No. 63) and its seasonal changes in 1973

Date of sampling		*Ephemera danica*					*Ephemera vulgata*				
		Younger larvae and their infestation (%)		Older larvae and their infestation (%) and infestation quotient			Younger larvae and their infestation (%)		Older larvae, their infestation (%) and infestation quotient		
February	24	309	(57.9)	298	(86.9)	1.89	12	(41.7)	22	(54.6)	0.92
March	31	296	(67.7)	451	(94.2)	1.91	6	(33.3)	37	(56.8)	1.05
April	15	674	(73.6)	627	(93.6)	1.88	24	(29.2)	30	(50.0)	0.84
May	30	230	(64.4)	205	(63.4)	0.79	31	(25.8)	11	(27.3)	0.65
June	25	351	(62.4)	117	(60.7)	0.52	10	(40.4)	16	(25.0)	0.79
August	15	116	(73.3)	158	(76.5)	0.70	5	(20.0)	19	(68.7)	0.37
November	24	197	(80.7)	324	(89.5)	1.07	3	(0.0)	10	(20.0)	0.90
Total		2 173	(68.4)	2 180	(80.7)	1.25	91	(27.2)	145	(43.2)	0.78

larvae were found wherever *E. danica* was present, including stretches where the density of host larvae was even less than 5 ind.m^{-2} (Svensson, 1976). It is obvious that the relationships between chironomid and its hosts is much closer then previously thought. Since no free-living larve were found at the locality in England (Tokeshi, 1986) and host densities directly effect the chironomid's reproductive rates (Svensson, 1980) this association seems to be definitively strictly obligatory (cf. Steffan, 1967). Close correlation between the distributional patterns of hosts and *E. flavens* strongly supports this conclusion, concerning the selective background of the association. A transitory stage of this "phoresy" or "commensalism" can be documented by incidental mayfly-chironomid associations (see e.g. White et al., 1980) or symphoretic but unspecialized chironomid genus *Nanocladius* occurring not only on mayflies (Epler, 1986) but also on the Plecoptera and Megaloptera larvae (Steffan, 1965; Gotceit and Mackay, 1980)

There is probably no direct host-specificity among the species of the genus *Ephemera*, since, at least in the case of *E. danica* and *E. vulgata*, the distribution of chironomids within their areas is approximately equal. However, *E. danica* seems to be slightly more infested since its ecological requirements fit better to those of *Epoicocladius*. Chironomids apparently prefer smaller rivers and brooks of lotic erosive biotopes probably because of higher oxygen content and the temperature plays a certain role as well (absence at most of the montane biotopes). The same factors are probalby responsible for the absence of *Epoicocladius* on larvae *E. lineata* and especially *E. glaucops* which are specialized on lotic-deposital biotopes of larger rivers, at least in Czechoslovakia. However, infestation of these species is possible especially in the Mediterranean region where their larve inhabit the same biotopes as *E. danica* in Central Europe.

There is only a single record on occurrence of *Epoicocladius* sp. on other host genus than *Ephemera*. Johannsen (1937) found the larvae on *Litobrancha recurvata* (Palingeniidae; referred as *Spaniotoma* on *Hexagenia recurvata*) but this Nearctic species most probably belongs to a different species of chironomids. Larvae of *Epoicocladius* found on *Ephemera simulans* in Utah, USA, on *Ephemera* sp. in Vietnam and on *E. orientalis* in Korea markedly differs morphologically from those of *Epoicocladius flavens* from Europe representing at least 2 unnamed species (Matěna and Soldán, 1986).

Infestation rates and infestation quotient in selected localities are in full agreement with the values obtained by Svensson (1976, 1980) and Tokeshi (1986) including a decrease of infestation rates during summer months apparently connected with a flight period of the midge. Contrary to populations in England (single generation) and in Sweden (partial second generation) the Czechoslovak population of *E. flavens* seem to have two generations a year since decrease of infestation ratio caused by eggs and first instar chironomid larvae searching for host is relatively long. On the other hand, increased infestation rate of younger nymph during host's flight period probably means that some older chironomid larvae pupate next year and overwinter. Otherwise the population density is nearly constant fitting the semivoltinism of host species (cf. Tokeshi, 1986).

The conclusions that more numerous larvae of prevailing species are more infested agree also with observation by Svensson (1980) who reports that host density is the most important factor for not only a higher average infestation rate but also for a chironomid reproductive success. On the other hand, further studies of these problems are necessary to explain marked differences in average infestation rates in prevailing and the second host species at the same locality. In this respect there

is evidently no host- and habitat-preferency but equal infestation rates occur only at localities with approximately the same quantitative presentation of host species. One possible explanation represents a possibility of some differences in olfactoric stimuli after which the first instar chironomid larvae are supposed to search for host larvae (Svensson, 1976, 1978).

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