

LJUBLJANA, DECEMBER 2000

Vol. 8, No. 2: 147-189

SIPHONAPTERA OF SQUIRRELS AND DORMICE (RODENTIA: SCIURIDAE, GLIRIDAE) FROM THE WESTERN AND CENTRAL BALKANS

Savo BRELIH and Tomi TRILAR

Slovenian Museum of Natural History, Prešernova 20, P.O.Box 290,
SI-1001 Ljubljana, Slovenia, e-mail: ttrilar@pms-lj.si

Abstract - We present data on 22 species and 6 subspecies of Siphonaptera of *Sciurus vulgaris*, *Spermophilus citellus*, *Glis glis*, *Dryomys nitedula*, *Eliomys quercinus*, and *Muscardinus avellanarius* from the Western and Central Balkans. A new subspecies is described: *Ctenophthalmus orientalis jakupicae* ssp. n. The distribution of 1 species and 8 subspecies of fleas typical for the mentioned hosts is shown on 6 maps. A survey of hosts is presented as well as the Siphonaptera on them. Postglacial migrations of *S. citellus* are suggested on the basis of their variability as well as the distribution of the Siphonaptera.

KEY WORDS: Siphonaptera, *Sciurus vulgaris*, *Spermophilus citellus*, *Glis glis*, *Dryomys nitedula*, *Eliomys quercinus*, *Muscardinus avellanarius*, Balkans

Izvešček - BOLHE VEVERIC IN POLHOV (RODENTIA: SCIURIDAE, GLIRIDAE) ZAHODNEGA IN OSREDNJEGA BALKANSKEGA POLOTOKA

Navedenih je 22 vrst in 6 podvrst bolh z veverice (*Sciurus vulgaris*), tekunice (*Spermophilus citellus*), navadnega polha (*Glis glis*), drevesnega polha (*Dryomys nitedula*), vrtnega polha (*Eliomys quercinus*) in podleska (*Muscardinus avellanarius*) iz zahodnega in osrednjega Balkanskega polotoka. Opisana je nova podvrsta, *Ctenophthalmus orientalis jakupicae* ssp. n. Razširjenost ene vrste in 8 podvrst bolh značilnih za navedene gostitelje je prikazana na 6 geografskih kartah. Podan je tudi pregled gostiteljev in na njih ugotovljenih bolh. Na osnovi razširjenosti bolh in variabilnosti tekunic je predlagana shema postglacialnih selitev tekunice.

KLJUČNE BESEDE: bolhe, veverica, tekunica, navadni polh, drevesni polh, vrtni polh, podlesek, Balkanski polotok

Introduction

This contribution continues the series »Ectoparasitical entomofauna of Yugoslav mammals« (Brelj & Petrov, 1987; Brelj, 1986; Brelj & Trilar, 2000). The changes in former Yugoslavia in the last few years resulted in the establishment of five new countries and thus the title of the series is now inappropriate (Fig. 1). We will call this area as the Western and Central Balkans.

The present paper provides the data on siphonapterofauna of squirrels (Sciuridae) and dormice (Gliridae) from this territory.

Wagner (1928-1929, 1934, 1936, 1939), Rosický & Cernelutti (1959), Rosický & Todorović (1964), Hopkins & Rothschild (1962, 1966, 1971), Brelj (1986) and Trilar (1995, 1997) published data on fleas of squirrels (Sciuridae) and dormice (Gliridae) from the territory of the Western and Central Balkans.

Data concerning hosts are summarized from Đulić & Mirić (1967), Ružić (1978), Petrov (1992), Kryštufek (1991, 1993, 1996), Kryštufek & Hrabě (1996) and Tvrtković et al. (1995). We used the mammalian nomenclature according to Mitchell-Jones et al. (1999).

Material and methods

Most of the material was collected in the last 30 years along with the mammalian field collecting. There were no field trips purely for ectoparasite collection. The only exception was the systematic study of *Glis glis* nests in nestboxes at the Mt. Snežnik and Mt. Goteniška Gora (Trilar, 1995, 1997). Dormice were mainly collected in micro-mammalian faunistic studies, where between 100 and 200 snap-traps were placed per night. Dead animals were removed from the traps early in the morning as numerous ectoparasites later leave them. Each single species of host was stored into a separate linen or plastic bag until the examination attended to immediately after collection. Ectoparasites were stored in 70% alcohol, separately with respect to host, survey site, altitude, and date. In most cases ecological examinations were not performed. Unfortunately, we very rarely possessed information on the number of host specimens examined. European sousliks (*Spermophilus citellus*) were collected in all distribution areas, but in limited numbers. Red squirrels (*Sciurus vulgaris*) were mainly collected by shooting and also recovered as traffic casualties. We examined material provided by hunters, where animals had been dead for a longer time and some fleas had already left them. A small number of *S. vulgaris* were inspected from Slovenia, but only single specimens from all other areas. Until today we have not examined a single specimen of the Alpine marmot (*Marmota marmota*). Collected flea specimens were used to prepare microscopic slides in Canada balsam, with the exception of some large samples of *Ceratophyllus sciurorum sciurorum* from nests of *Glis glis*, which were preserved in 70% alcohol. All the material without a literature citation is kept in the Slovenian Museum of Natural History (coll. S. Brelj, coll. T. Trilar). Species identification was according to Hopkins & Rothschild (1953, 1956, 1962, 1966, 1971) and Rosický (1957). Some of the more recent contributions of authors (Cyprich, 1989) were also utilized.

List of the hosts: *Parus major* Linnaeus, 1758; *Talpa europaea* Linnaeus, 1758; *Homo sapiens* Linnaeus, 1758; *Sciurus vulgaris* Linnaeus, 1758; *Marmota marmota* (Linnaeus, 1758); *Spermophilus citellus* (Linnaeus, 1766); *Spermophilus suslicus* (Güldenstaedt, 1770); *Spermophilus pygmaeus* (Pallas, 1779); *Cricetus cricetus* (Linnaeus, 1758); *Clethrionomys glareolus* (Schreber, 1780); *Dinaromys bogdanovi* (Martino, 1922); *Microtus arvalis* (Pallas, 1778); *Nannospalax leucodon* (Nordmann, 1840); *Micromys minutus* (Pallas, 1771); *Apodemus flavicollis* (Melchior, 1834); *Apodemus mystacinus epimelas* (Nehring, 1902); *Apodemus sylvaticus* (Linnaeus, 1758); *Rattus rattus* (Linnaeus, 1758); *Mus musculus* s. lat. Linnaeus, 1758; *Glis glis* (Linnaeus, 1766); *Muscardinus avellanarius* (Linnaeus, 1758); *Eliomys quercinus* (Linnaeus, 1766); *Dryomys nitedula* (Pallas, 1778); *Vulpes vulpes* (Linnaeus, 1758); *Martes foina* (Erxleben, 1777); *Martes martes* (Linnaeus, 1758); *Meles meles* (Linnaeus, 1758); *Felis silvestris* Schreber, 1775.

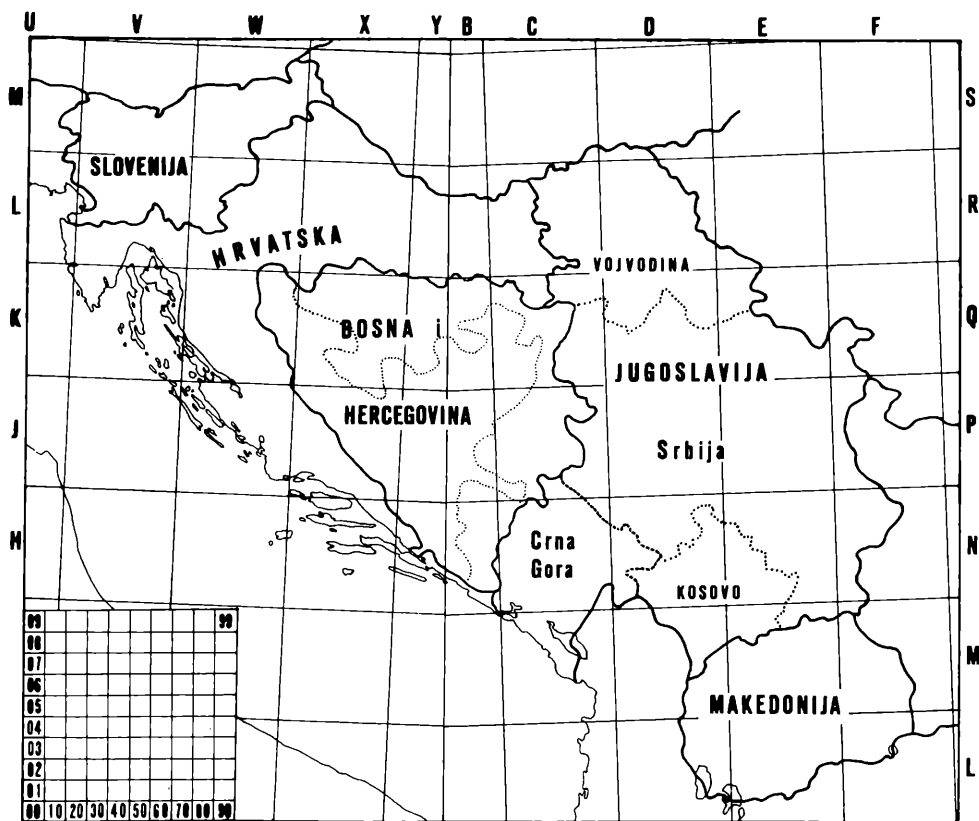


Fig. 1: Western and Central Balkans with indicated states, borders, and UTM (100 x 100 km grid).

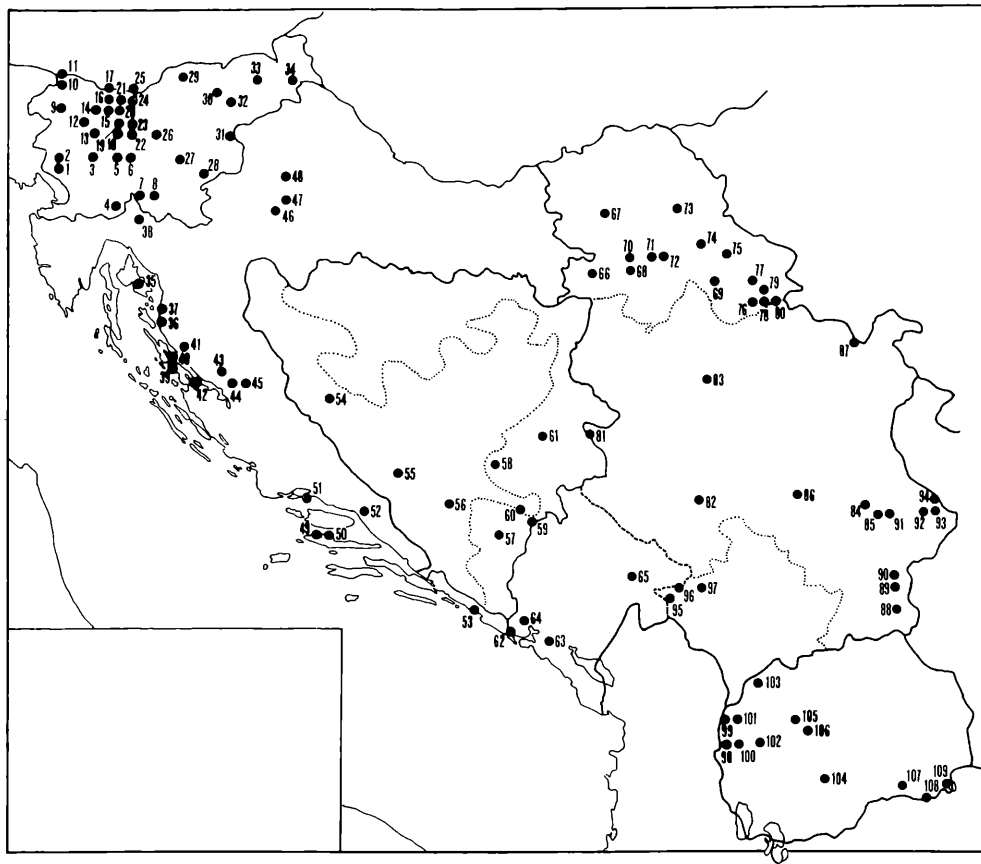


Fig. 2: Map of the Western and Central Balkans. Numbers indicate survey sites (localities).

SLOVENIJA (SLOVENIA):

1. VL07 Komen, Kobjeglava
2. VL08 Trnovski gozd: Čaven
3. VL38 Hotedršica, Novi Svet; Hotedršica, Ravnik
4. VL54 Snežnik; Snežnik: Sviščaki
5. VL58 Borovnica, Pako
6. VL68 Turjak
7. VL75 Goteniška gora: Draga
8. VL85 Kočevje, environs
9. VM02 Bohinj: Ukanc
10. VM04 Trenta: Julijana
11. VM05 Rateče, Zelenci
12. VM21 Cerkno
13. VM30 Poljanska dolina
14. VM32 Jelovica: Goška ravan; Rudno; Rudno, Hujška

15. VM42 Kranj, Sveti Jošt
16. VM43 Tržič
17. VM44 Podljubelj, Čizovnik
18. VM50 Ljubljana: Vrhovci
19. VM51 Medvode; Sorško polje: Žabnica
20. VM52 Cerklje, Štefanja gora; Kranj; Kranj, Milje; Šenčur, Voglje
21. VM53 Lom, Grahovše, Gaberčev rovt
22. VM60 Črnuče; Ljubljana and environs; Gameljne
23. VM61 Kamnik, environs
24. VM63 Kamniška Bistrica
25. VM64 Zgornje Jezersko
26. VM80 Litija
27. WL08 Mirna na Dolenjskem
28. WL27 Kostanjevica, Šentjernej

29. WM05 Slovenj Gradec
30. WM34 Pohorje: Lobnica
31. WM40 Kozje, Lesično, Gruska jama
32. WM43 Poljčane, Studenice, Jama v kamnolomu
33. WM65 Dvorjane, Vurberg, Grmada
34. WM95 Srednja Bistrica
- HRVATSKA (CROATIA):**
35. VK78 Krk Island: Veli vrh
36. VK95 Velebit: Mirevo
37. VK96 Velebit: Zavižan; Zavižan, Modrića dolac (Botanički vrt); Vučjak
38. VL73 Gorski Kotar: Risnjak
39. WK01 Pag Island: Pag, environs
40. WK02 Pag Island: Metajna
41. WK13 Velebit: Baške Oštarije; Papratnjak
42. WK20 Ražanac, Vrankovići
43. WK41 Velebit: Bunjevci
44. WK50 Velebit: Tulove grede
45. WK60 Velebit: Predžid
46. WL84 Vukomeričke gorice: Prkovec
47. WL95 Turapolje: Peščenica, near the river Odra
48. WL97 Zagreb, Dugo Selo
49. XH28 Hvar Island: Brusje
50. XH38 Brač Island: Dol
51. XJ11 Split
52. XJ60 Biokovo: Sveti Jura
53. BN62 Dubrovnik
- BOSNA I HERCEGOVINA (BOSNIA AND HERZEGOVINA):**
54. XJ29 Šator planina: Šatorsko jezero; Babina greda
55. XJ93 Svinjača, Blidinje jezero
56. YJ31 Velež, Rujište
57. BN88 Bjelašnica (Gacko)
58. BP84 Igman
59. CN19 Maglić
60. CP00 Zelengora: Orlovačko jezero
61. CP26 Gazivoda
- JUGOSLAVIJA: CRNA GORA (YUGOSLAVIA: MONTENEGRO):**
62. BN90 Hercegnovi
63. CM29 Cetinje, environs
64. CN02 Orjen
65. CN94 Bjelasica: planina Jelovica; Zekova Glava
- JUGOSLAVIJA: SRBIJA: VOJVODINA (YUGOSLAVIA: SERBIA: VOJVODINA):**
66. CQ79 Srem: Erdevik
67. CR84 Bačka: Savino Selo
68. DQ09 Srem: Fruška Gora: Irig; Jazak
69. DQ78 Pančevo, Crepaja
70. DR00 Srem: Fruška Gora: Zmajevac
71. DR20 Srem: Fruška Gora: Čortanovci
72. DR30 Bačka: Titel, Lok
73. DR44 Banat: Melenci
74. DR61 Banat: Zrenjanin, Orlovat, reka Tamiš
75. DR80 Deliblatska Peščara: Samoš
76. EQ06 Deliblatska Peščara: Deliblato; Dolina
77. EQ08 Deliblatska Peščara: Čoka
78. EQ16 Deliblatska Peščara: Šumarak
79. EQ17 Deliblatska Peščara: Kremenjak; Šušara
80. EQ26 Banat: Banatska Palanka
- JUGOSLAVIJA: SRBIJA (YUGOSLAVIA: SERBIA):**
81. CP66 Tara Planina: Kremiči; Predov Krst
82. DP50 Golija: Biser Voda
83. DQ60 Arandelovac
84. EN89 Niš: Sičevo
85. EN98 Suva Planina
86. EP30 Veliki Jastrebac, Ravnište
87. EQ82 Donji Milanovac
88. FN00 Besna Kobila
89. FN02 Vlasinska Tresava
90. FN03 Vlasina
91. FN08 Suva Planina: Tri lokve
92. FN38 Vidlič: Basara: Planinica
93. FN48 Stara Planina: Dojkinci; Dojkinci, Bašta; Ponor
94. FN49 Stara Planina; Stara Planina: Kopren
- JUGOSLAVIJA: SRBIJA: KOSOVO (YUGOSLAVIA: SERBIA: KOSOVO):**
95. DN22 Rugovo, Bjeluha; Kućište
96. DN33 Žljeb: Kula
97. DN53 Istok
- MAKEDONIJA (MACEDONIA):**
98. DM60 Šar Planina: Lukovo Pole
99. DM62 Korab: Guri Velpnis
100. DM70 Bistra
101. DM72 Ničpurska Planina: Ničpur
102. DM90 Kičevo, Dolenci
103. DM95 Šar Planina: Jelak
104. EL47 Prilep
105. EM22 Karadžica
106. EM31 Jakupica: Gorno Begovo, Begovo Pole; Solunsko Pole
107. FL06 Kožuf
108. FL25 Gevgelija
109. FL46 Dojransko jezero, Ačikot

The UTM coordinates are followed by the major localities (province, mountain, etc.), then the exact survey site. If separated by a comma, the exact locality is situated close to the major one (e.g. Kičevo, Dolenci). If separated by a colon, the survey site is situated at the major locality or represents its component (e.g. Šar Planina: Jelak).

List of the species and subspecies

PULICIDAE

1. *Echidnophaga murina* (Tiraboschi, 1903)

Hrvatska:

2♀ Hvar Island: Brusje, 340 m, 4. 10. 1975, from *Eliomys quercinus*, leg. N. Tvrtković

The major host of *E. murina* are rats, especially *R. rattus*. Only rarely is found to infect other species of small ground rodents. This uncommon flea species (Hopkins & Rothschild, 1953) is distributed in the Mediterranean area (Italy, Greece, Egypt, Maroco, Turkey, Asia Minor) but was also found in Gruzia (=Georgia) and eastern Asia (Hong Kong, Japan). The island of Hvar is the only known survey site for this area. *Eliomys quercinus* is the first known dormice host of this species.

2. *Pulex irritans* Linnaeus, 1758

Slovenija:

1♀ Hotedršica, Ravnik, 550 m, 9. 9. 1966, from *Glis glis*, leg. S. Brelih & R. Jelinčič

The passage of the human flea to *G. glis* is presumably a coincidental. Wagner (1939) also found *P. irritans* on *G. glis*, but the exact locality was not given.

HYSTRICHOPSYLLIDAE

3. *Hystrichopsylla (Hystrichopsylla) orientalis orientalis* Smit, 1956

Bosna i Hercegovina:

1♂ Gazivoda, 26. 10. 1988, from *Glis glis*, leg. B. Kryštufek

Hystrichopsylla o. orientalis occurs in the fur and in the nests of small terrestrial mammals (Talpidae, Soricidae, Arvicolidae and Muridae). The passage to *G. glis* is probably very rare.

4. *Neopsylla setosa spinea* Rothschild, 1915

Jugoslavija: Srbija: Vojvodina:

2♂ 4♀ Srem: Fruška Gora: Jazak, 180 m, 12. 4. 1989, from *Spermophilus citellus*, leg. B. Kryštufek & T. Trilar

1♂ Čertanovci, Srem (correct Srem: Fruška Gora: Čortanovci), from *Citellus citellus* (= *Spermophilus citellus*), leg. J. Wagner (»*Neopsylla setosa*«) (Wagner, 1939)

1♀ Deliblatska Peščara: Deliblato, 100 m, 7. 5. 1947, from *Spermophilus citellus*, leg. A. Ružić

1♂ 3♀ idem, 5. 4. 1949, leg. B. Petrov

1♀ Deliblatska peščara: Čoka, 7. 5. 1947, from *Citellus citellus* (= *Spermophilus citellus*), leg. A. Ružić (»*Neopsylla setosa*«) (Rosický & Todorović, 1964)

Neopsylla setosa mainly lives in the nests of *Spermophilus* (Hopkins & Rothschild, 1962). While we examined only the fur of collected sousliks and not the nests, the findings in the Central Balkans were quite rare. The species is probably more common than thought and probably occurs throughout the range of the host.

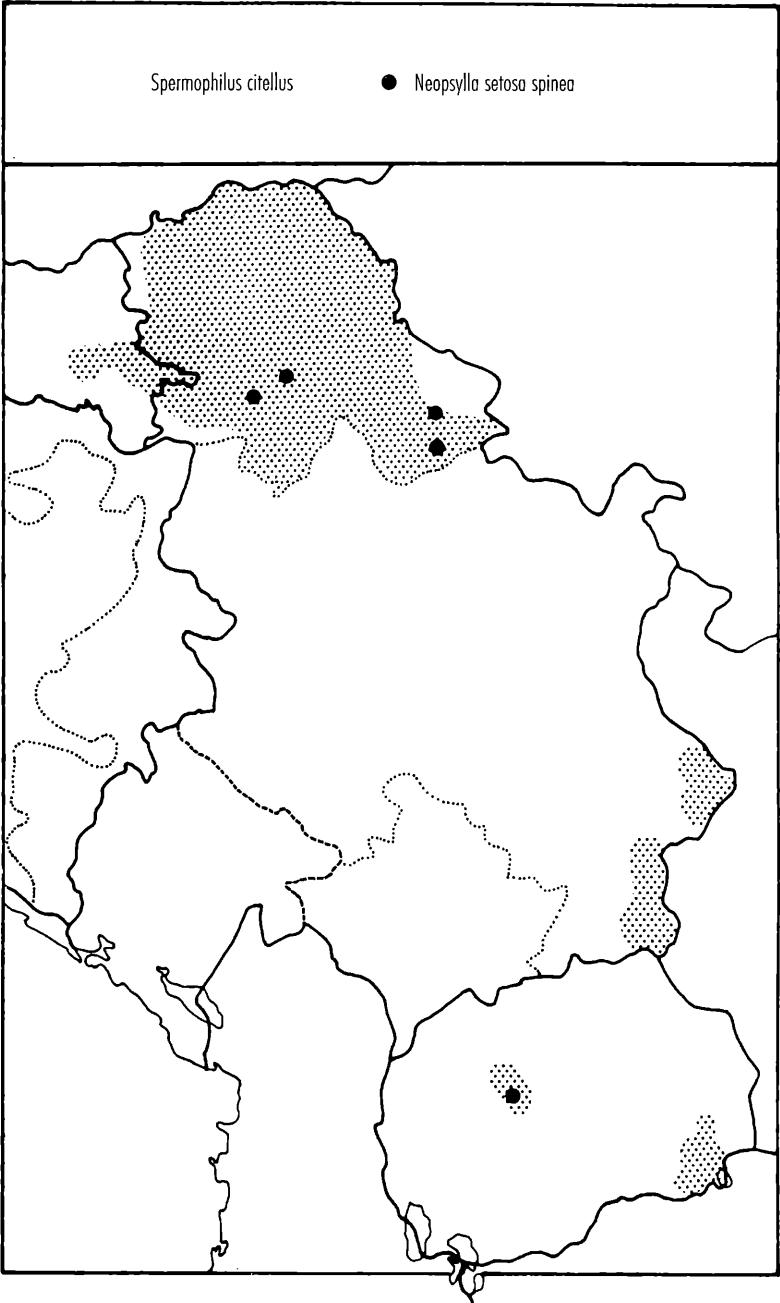


Fig. 3: Distribution of *Spermophilus citellus* (Linnaeus) (adapted from Petrov, 1992), and survey sites of *Neopsylla setosa spinea* Rothschild.

5. *Doratopsylla dasyncnema dasyncnema* (Rothschild, 1897)

»All over the territory of the Western and Central Balkans«, from *Sorex* and *Talpa*, and also from *Sylvaemus flavicollis* (= *Apodemus flavicollis*) and *Glis glis* (»*Doratopsylla dasyncnemus*«) (Wagner, 1939)

6. *Ctenophthalmus (Spalacotenus) monticola* (Kohaut, 1904)

Jugoslavija: Srbija:

1♀ Tara Planina: Kremiči, 950 m, 20. 6. 1949, from *Glis glis*, leg. B. Petrov

1♂ Stara Planina, October 1947, from *Glis glis*, leg. B. Petrov & A. Ružić

The passages of fleas, typical for *N. leucodon* (Hopkins & Rothschild, 1962), to *G. glis* are presumably very rare.

7. *Ctenophthalmus (Ctenophthalmus) agyrtes wagnerianus* Peus, 1950

Slovenija:

1♀ Hotedršica (=Hotedršica, Novi svet), 700 m, 26. 8. 1956, from *Glis glis*, leg. R. & N. Jelinčič (»*Ctenophthalmus agyrtes carnicus*«) (Rosický & Cernelutti, 1959)

1♀ Hotedršica, Ravnik, 580 m, 13. 9. 1971, from *Glis glis*, leg. R. Jelinčič

5♂ 2♀ Snežnik, Sviščaki, 1250 m, 4. 7. 1995, from 5 nests of *Glis glis*, leg. T. Trilar

1♂ ibidem, 22. 7. 1997, from 1 nest of *Glis glis*

1♀ ibidem, 3. 9. 1999, from 1 nest of *Glis glis*

1♀ Trenta: Julijana, 720 m, 13. 9. 1968, from *Glis glis*, leg. S. Brelih & J. Dovič

8. *Ctenophthalmus (Ctenophthalmus) agyrtes graecus* Jordan, 1926

Makedonija:

1♀ Prilep, 700 m, 21. 4. 1969, from *Dryomys nitedula*, leg. B. Petrov

1♂ Jakupica: Gorno Begovo, Begovo Pole, 1950-2000 m, 11. 5. 1989, from *Spermophilus citellus*, leg. B. Kryštufek

9. *Ctenophthalmus (Ctenophthalmus) agyrtes ohridanus* Wagner, 1939 ⇔ *dinarus*

Rostigayev, 1959

Hrvatska:

4♂ 6♀ Brač Island: Dol, 600 m, 4. 9. 1975, from *Glis glis*, leg. N. Tvrtković

Ctenophthalmus agyrtes is one of the most common flea species on small terrestrial mammals (Talpidae, Soricidae, Arvicolinae, and Muridae). The passage to dormice is common; to sousliks is quite rare.

10. *Ctenophthalmus (Mediostenophthalmus) nifetodes brelihi* Rosický & Cernelutti, 1959

Slovenija:

3♂ 3♀ Hotedršica (=Hotedršica, Novi svet), 700 m (not 1264 m), 26. 8. 1956, from *Glis glis*, leg. R. & N. Jelinčič (Holotype and 5 paratypes) (Rosický & Cernelutti, 1959) (included 1♂ and 1♀ paratype from Rothschild collection in the British Museum (Hopkins & Rothschild, 1966))

1♀ ibidem, 4. 8. 1967, from *Glis glis*, leg. S. Brelih & R. Jelinčič (Brelih, 1986)

The single known host of this flea subspecies is *G. glis*. The flea type locality is Novi

Svet near Hotedršica in Slovenia and, according to current knowledge, is the only known site. In Slovenia there are no known recent survey sites of *D. bogdanovi*, which is the major host of the remaining subspecies of *Ct. nifetodes*. Pleistocene fragments (*D. cf. bogdanovi*) are encountered in the environs of Ilirska Bistrica and the fossil *Dinaromys dalmatinus* has been found near Trieste in Italy (Bartolomei, 1970). *D. bogdanovi* is most probably extinct in Slovenia and its specific fleas presumably passed from the primary host to the new one, which is *G. glis*.

11. *Ctenophthalmus (Medioctenophthalmus) nifetodes tvrtkovici* Brelih, 1986

Hrvatska:

1♀ Velebit: Zavižan, Modrića dolac, 1460 m, 8. 9. 1979, from *Glis glis*, leg. N. Tvrtković (Brelj, 1986)

12. *Ctenophthalmus (Medioctenophthalmus) nifetodes nifetodes* Wagner, 1933

Bosna i Hercegovina:

2♀ Bjelašnica (Gacko), 1600 m, 4. 8. 1970, from *Glis glis*, leg. B. Petrov (Brelj, 1986)

Jugoslavija: Crna Gora:

1♀ Cetinje, environs, from *Glis glis*, leg. V. Martino (»*Ctenophthalmus nivalis nifetodes*« - holotype) (Wagner, 1928-29, 1933)

As many *G. glis* nest in rocky cracks and cavities (Polak, 1997), they come in contact with *D. bogdanovi*. Fleas are quite commonly pass from one host to another.

13. *Ctenophthalmus (Euctenophthalmus) congener congener* Rothschild, 1907

Slovenija:

1♂ Trnovski gozd: Čaven, 1240 m, 23. 9. 1971, from *Glis glis*, leg. S. Brelih & R. Jelinčič

14. *Ctenophthalmus (Euctenophthalmus) congener troilus* Peus, 1954

Makedonija:

1♂ Gevgelija, 75 m, 26. 4. 1971, from *Dryomys nitedula*, leg. B. Petrov

Both subspecies of *Ct. congener* live on many species of small terrestrial mammals and periodically infect dormice.

15. *Ctenophthalmus (Euctenophthalmus) orientalis orientalis* (Wagner, 1898)

Jugoslavija: Srbija: Vojvodina:

1♂ Torža, Bačka (correct Bačka: Savino Selo), from *Crocidura* sp., leg. J. Wagner (»*Ctenophthalmus orientalis*«) (Wagner, 1939)

Irig, Srem (Srem: Fruška Gora: Irig), from *Citellus citellus* (= *Spermophilus citellus*), leg. V. Martino (»*Ctenophthalmus orientalis*«) (Wagner, 1928-29)

1♀ Trig, Banat (correct Srem: Fruška Gora: Irig), 27. 8. 1933, from *Citellus c. citellus* (= *Spermophilus citellus*), leg. T. Kasapski (Hopkins & Rothschild, 1966)

3♂ 3♀ Srem: Fruška Gora: Jazak, 180 m, 12. 4. 1989, from *Spermophilus citellus*, leg. B. Kryštufek & T. Trilar

1♂ Crepaja, Banat (=Pančevo, Crepaja), 80 m, 17. 4. 1928, from *Citellus citellus*

- (=*Spermophilus citellus*), leg. V Martino (Hopkins & Rothschild, 1966)
- 3♂ 5♀ Banat: Banatska Palanka, 85 m, 29. 6. 1988, from *Spermophilus citellus*, leg. B. Kryštufek
- 3♂ 3♀ idem, 30. 6. 1988
- 2♂ Banat: Zrenjanin, Orlovat, reka Tamiš, 81 m, 13. 4. 1989, from *Spermophilus citellus*, leg. B. Kryštufek & T. Trilar
- 2♀ Bačka: Titel, Lok, 80 m, 14. 5. 1989, from *Spermophilus citellus*, leg. B. Kryštufek
- Milenci, Bačka (correct Banat: Melenci), from *Citellus citellus* (=*Spermophilus citellus*), leg. V Martino (»*Ctenophthalmus orientalis*«) (Wagner, 1928-29)
- 1♂ 2♀ Deliblatska Peščara: Samoš, 100 m, 14. 5. 1989, from *Spermophilus citellus*, leg. B. Kryštufek
- 2♂ 1♀ Deliblatska Peščara, 9. 12. 1981, from *Talpa europaea*, leg. A. Ružić
- 1♀ Deliblatska Peščara: Deliblato, 100 m, 7. 5. 1947, from *Spermophilus citellus*, leg. A. Ružić
- 2♀ idem, 20. 4. 1949
- 1♂ 1♀ idem, 21. 4. 1949
- 1♂ Deliblatska Peščara: Dolina, 130 m, 14. 3. 1948, from *Talpa europaea*, leg. B. Petrov
- 1♂ 2♀ Deliblatska peščara: Čoka, 7. 5. 1947, from *Citellus citellus* (=*Spermophilus citellus*), leg. A. Ružić (»*Ctenophthalmus orientalis*«) (Rosický & Todorović, 1964)
- 1♀ Deliblatska Peščara: Šumarak, 110 m, 7. 2. 1983, from *Nannospalax leucodon*, leg. A. Ružić
- 2♀ idem, 29. 4. 1983
- 1♀ Deliblatska Peščara: Šušara, 170 m, 7. 4. 1964, from *Apodemus sylvaticus*, leg. Đ. & N. Heneberg
- Jugoslavija: Srbija:
- 1♂ Vlasinska Tresava, 1200 m, 18. 5. 1948, from *Spermophilus citellus*, leg. B. Petrov
- 2♂ 8♀ Vlasina, 1250 m, August 1947, from *Citellus citellus* (=*Spermophilus citellus*), leg. A. Ružić (»*Ctenophthalmus orientalis*«) (Rosický & Todorović, 1964)
- 2♂ 8♀ ibidem, 18. 8. 1947, from *Talpa europaea*, leg. A. Ružić (»*Ctenophthalmus orientalis*«) (Rosický & Todorović, 1964)
- 6♂ 3♀ ibidem, 25. 7. 1977, from *Spermophilus citellus*, leg. B. Petrov
- 1♂ 8♀ Stara Planina: Ponor, 17. 6. 1947, from *Citellus citellus* (=*Spermophilus citellus*), leg. A. Ružić (»*Ctenophthalmus orientalis*«) (Rosický & Todorović, 1964)
- Ctenophthalmus o. orientalis* is a typical flea of souslik nests, but is frequently found also in the fur of collected animals. Usually occurs in spring and autumn, but in Yugoslavia was found also from June to August. In Yugoslavia and Macedonia it was found only within the range of its major host *S. citellus*. Other hosts from this area are *T. europaea*, *Crocidura* sp., *N. leucodon*, and *A. sylvaticus*.
16. *Ctenophthalmus (Euctenophthalmus) orientalis jakupicae* ssp. n.
(Figs. 4, 5, 7, 9)
- Makedonija:
- some ♀ Karadica (=Karadžica), from *Citellus citellus* (=*Spermophilus citellus*),

leg. J. Wagner (»*Ctenophthalmus orientalis*«) (Wagner, 1939) (We did not check Wagner's material, but it probably belongs to *Ct. o. jakupicae*)

24♂ 29♀ Jakupica: Gorno Begovo, Begovo Pole, 1950-2000 m, 11. 5. 1989, from *Spermophilus citellus*, leg. B. Kryštufek

4♀ idem, 27. 6. 1989

Holotype male (PMSL-IA-P-7495/1), allotype female (PMSL-IA-P-7485/2) from Begovo Pole in the Mt. Jakupica (Macedonia), 11. 5. 1989, *S. c. karamani* Martino & Martino, leg. B. Kryštufek, paratypes of 23 males and 28 females (data as above) and 4 females from Begovo Pole in the Mt. Jakupica (Macedonia), 27. 6. 1989, from the same host, leg. B. Kryštufek. The type material resides in the Slovenian Museum of Natural History in Ljubljana (PMSL - Prirodoslovni muzej Slovenije v Ljubljani, coll. S. Brelih).

Diagnosis: males of *Ct. o. jakupicae* differ from the nominate form in the shape of the movable process of the clasper and in the larger number of sensillae at the anterior

	No. of ♂♂	No. of sensillae	Average
ssp. <i>orientalis</i>			
Vojvodina (7 populations)	15	6 - 7 (exceptionally 8)	6.87
south Serbia (Vlasina)	7	6 - 7	6.50
ssp. <i>jakupicae</i>			
Mt. Jakupica	24	7 - 8 (exceptionally 6)	7.42

margin of this process. Females are characterized by the apical margin of sternum VII, which forms only a very shallow sinus between the median and ventral lobes.

Description: Male: For most characters *Ct. o. jakupicae* matches its nominate form. The most distinct character is the apical margin of the movable process of the clasper, which in the new subspecies is straight (Fig. 4, 5) while in the nominate subspecies it is concave (Fig. 6). Both sclerites which surround the apical margin in *ssp. orientalis* are

	No. of ♀♀	No. of small bristles	No. of large bristles	Total No. of bristles
ssp. <i>orientalis</i>				
Vojvodina (7 populations)	21	1-8 (3.90)	5 - 10 (5.24)	6 - 13 (9.14)
south Serbia (Vlasina)	2	6 (6.00)	6 - 7 (6.50)	12 - 13 (12.50)
ssp. <i>jakupicae</i>				
Mt. Jakupica	32	3 - 9 (5.78)	5 - 10 (6.78)	9 - 17 (12.66)

expressed as projections which create the concavity (Fig. 6). In *Ct. o. jakupicae* sclerites do not go beyond the level of the anterior and apical margins (Fig. 4, 5). At the transition to posterior margin is a small projection or sclerotized tooth. The number of sensillae at the anterior margin of the movable process in the new subspecies is on average more than in the nominate form:

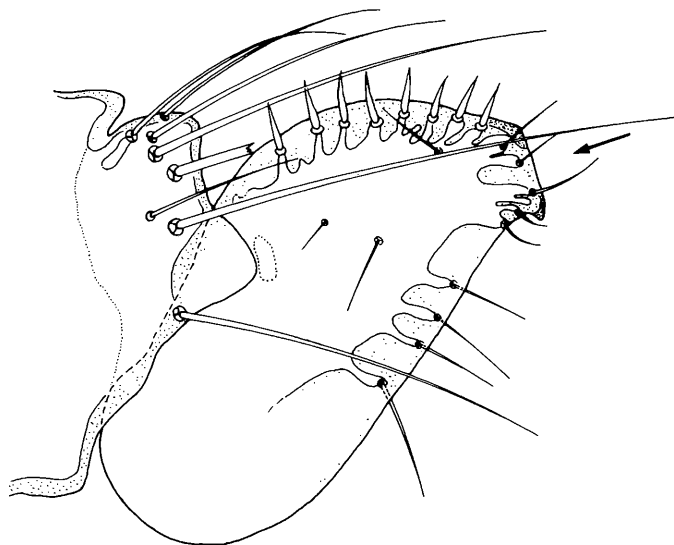


Fig. 4: *Ctenophthalmus orientalis jakupicae* ssp. n., processes of clasper of holotype male. Arrow depicts straight apical margin.

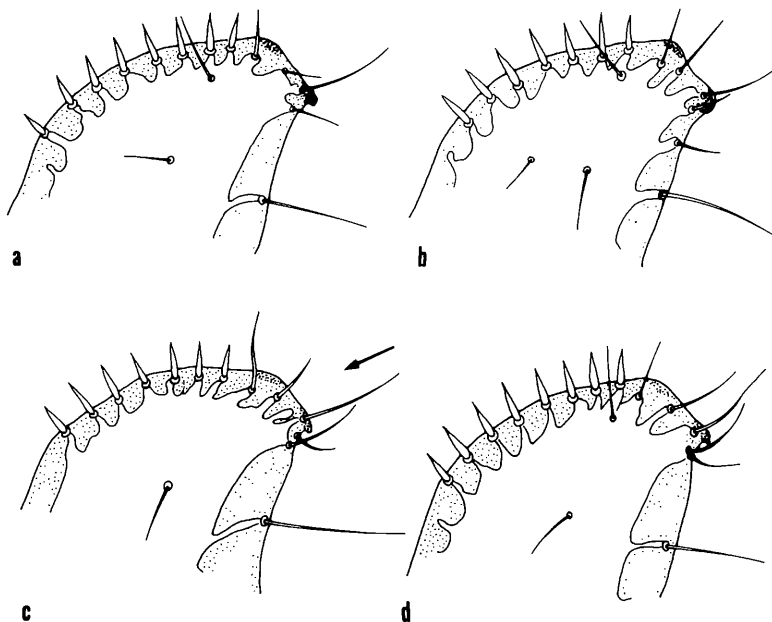


Fig. 5: *Ctenophthalmus orientalis jakupicae* ssp. n., suprafoveal portion of the movable process of four paratype males. Specimens a-d possess straight apical margin as in Fig. 4.

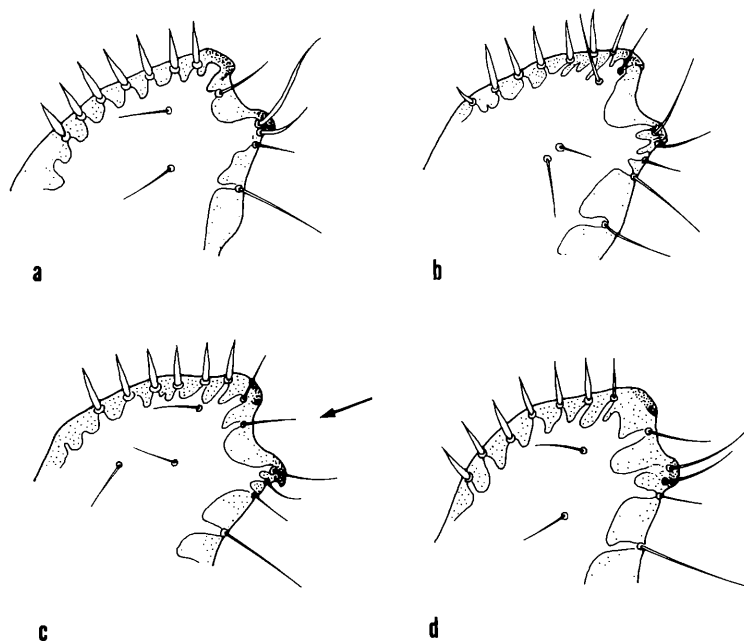


Fig. 6: *Ctenophthalmus orientalis orientalis* (Wagner), suprafoveal portion of the movable process of male: a. Orlovat, Banat, Vojvodina; b. Jazak, Fruška Gora, Srem, Vojvodina; c. Deliblatska Peščara, Banat, Vojvodina; d. Vlasina, southeastern Serbia. Arrow in 6 c depicts concave apical margin also seen in 6 a, b, d.

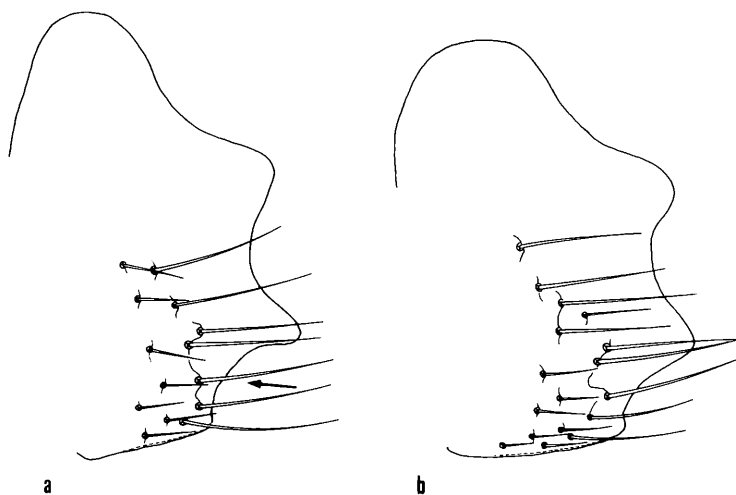


Fig. 7: *Ctenophthalmus orientalis jakupicae* ssp. n.: sternum VII of female: a. allotype; b. paratype. Arrow in 7 a depicts shallow sinus between the median and ventral lobes also seen in 7 b.

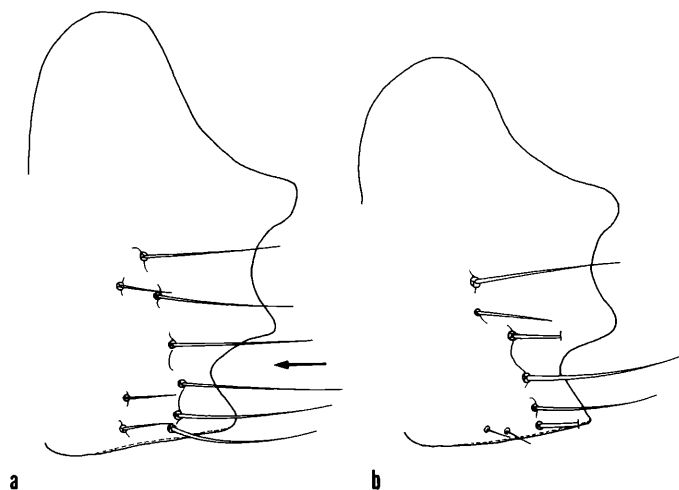


Fig. 8: *Ctenophthalmus orientalis orientalis* (Wagner): sternum VII of female: a. Lok, Titel, Bačka, Vojvodina; b. Jazak, Fruška Gora, Srem, Vojvodina. Arrow in 8 a depicts deeply rounded sinus between the median and ventral lobes also seen in 8 b.

One male from Vlasina (Fig. 6d) and one male from the Mt. Jakupica (Fig. 5b) are intermediate between the two subspecies in the movable process of the clasper.

Female: outline of apical margin of sternum VII forms a very shallow sinus between the median and ventral lobes (Fig. 7); in the nominate subspecies it forms a deeply rounded sinus (Fig. 8). The number of bristles on sternum VII in ssp. *jakupicae* is on average larger than in ssp. *orientalis* from Vojvodina, and possibly also for the population from south Serbia (N = 2 females from Vlasina):

Đulić & Mirić (1967) reported 5 subspecies of *S. citellus* from the Western and Central Balkans, but Kryštufek (1996) questioned their validity. The subspecies *S. c. karamani* Martino & Martino from the Mt. Jakupica, Macedonia, is phenetically the most distinct (Kryštufek, 1996). This marginal population lives in the mountains and is completely isolated. The population of *Ct. orientalis* collected from *S. c. karamani* is also very distinct from all other European populations and is described as a new subspecies.

LEPTOPSYLLIDAE

17. *Leptopsylla* (*Leptopsylla*) *segnis* (Schönherr, 1811)

Hrvatska:

1♂ 2♀ Brač Island: Dol, 600 m, 4. 9. 1975, from *Glis glis*, leg. N. Tvrtković

Leptopsylla segnis is a cosmopolitan and sinantropic species whose major host is *M. musculus* s. lat. Together with its host it frequently invades buildings inhabited by humans, especially in rural areas. But the flea can also be found far from human

places. From the house mouse it frequently passes to other hosts, especially insectivores and rodents, as well as to squirrels and dormice.

18. *Leptopsylla (Leptopsylla) sciurobia* (Wagner, 1934)

Bosna i Hercegovina:

1♂ Maglić, 1700 m, 10. 9. 1970, from *Dryomys nitedula*, leg. B. Petrov

1♀ Zelengora: Orlovačko jezero, 1500 m, 9. 9. 1984, from *Dryomys nitedula*, leg. B. Kryštufek

Jugoslavija: Crna Gora:

1♂ Bjelasica: planina Jelovica, 1500 m, 20. 9. 1981, from *Dryomys nitedula*, leg. B. Petrov & M. Milenković

Jugoslavija: Srbija: Kosovo:

2♀ Rugovo, Bjeluha, 1400 m, 24. 9. 1966, from *Apodemus flavicollis*, leg. B. Petrov

1♂ 1♀ Kućište, near Peć (=Rugovo, Kućište), 1350 m, from *Glis glis*, August 1939, E. Martino, presented by Zool. Mus. Hamburg, ex Wagner coll. (Brit. Mus. 1961. 677) (Hopkins & Rothschild, 1971)

1♀ Istok, 600 m, 6. 6. 1977, from *Apodemus mystacinus epimelas*, leg. B. Petrov

Makedonija:

1♂ Guri Vilpnis, Korab (=Korab: Guri Velpnis), [41° 45' N, 20° 40' E], from *Sylvaemus sylvaticus stankovici* (= *Apodemus sylvaticus*), July 1935, leg. E. Martino (Hopkins & Rothschild, 1971)

2♂ 4♀ Šar Planina: Lukovo Pole, 1750 m, 7. 6. 1989, from *Dryomys nitedula*, leg. B. Kryštufek

1♂ 2♀ Bistra, 25. 7. 1933, from *Sciurus vulgaris*, leg. V. Martino (»*Ctenopsyllus sciurobius*«) (Wagner, 1934, 1936, 1939)

1♂ Ničpur, Macedonia (=Ničpurska Planina: Ničpur), 13. 7. 1935, from *Apodemus mystacinus epimelas*, leg. V. Martino (Hopkins & Rothschild, 1971)

Wagner (1934) described this species on the basis of 3 specimens collected from *S. vulgaris*. According to present knowledge *L. sciurobia* is a separate species, which was not clear at the time of description. However it is not yet certain which is its major host. Apart from *S. vulgaris* it has been collected on the rodent species: *D. nitedula*, *G. glis*, *A. flavicollis*, *A. sylvaticus*, and *A. mystacinus*. It occurs on small rodents nesting on the ground (*Apodemus*), also on those in tree hollows and nestboxes (*Glis*, *Dryomys*), and in nests made of branches in tree canopies (*Sciurus*). According to Rosický (1957) there are two different ecological groups of fleas, i.e. fleas of *S. vulgaris* and dormice, and fleas of small terrestrial mammals. This is interesting, because usually a single flea species belongs only to one ecological group. At the moment there are not enough data to clearly support this conclusion.

CERATOPHYLLIDAE

19. *Dasypsyllus (Dasypsyllus) gallinulae gallinulae* (Dale, 1878)

Slovenija:

1♂ Snežnik: Sviščaki, 1250 m, 6. 10. 1994, from 1 nest of *Glis glis*, leg. T. Trilar

20. *Myoxopsylla (Myoxopsylla) laverani laverani* (Rothschild, 1911)

Hrvatska:

1♀ Krk Island: Veli vrh, 350 m, 5. 4. 1975, from *Apodemus sylvaticus*, leg. N. Tvrtković1♀ Pag Island: Metajna, 20 m, 23. 7. 1988, from *Eliomys quercinus*, leg. B. Kryštufek7♂ 6♀ Pag Island: Pag, environs, 23. 7. 1977, from *Eliomys quercinus*, leg. N. Tvrtković3♂ 7♀ Velebit: Tulove grede, 890 m, 3. 8. 1975, from *Eliomys quercinus*, leg. N.

Tvrtković

1♂ Ražanac, Vrankovići, 40 m, 6. 7. 1975, from *Eliomys quercinus*, leg. N. Tvrtković1♀ Hvar Island: Brusje, 340 m, 4. 10. 1975, from *Eliomys quercinus*, leg. N. Tvrtković7 ex. Split, from 5 ex. *Eliomys pallidus* (= *Eliomys quercinus*), leg. J. Wagner(»*Myoxopsylla laverani*«) (Wagner, 1939)

Myoxopsylla l. laverani was found only within the range of *E. quercinus*, which is most probably the major host of this flea. *Myoxopsylla l. laverani* was not found in this area on *G. glis*, and therefore is not its major host, although it is found in other geographical areas on *G. glis*.

21. *Tarsopsylla octodecimdentata octodecimdentata* (Kolenati, 1863)

Slovenija:

1♀ Turjak, 500 m, 4. 12. 1977 from *Martes foina*, leg. A. Šmuc1♂ Poljanska dolina, 17. 9. 1968, from *Sciurus vulgaris*, leg. S. Brelih & F. Leben1♀ Šenčur, Voglje, 370 m, 15. 8. 1986, from *Sciurus vulgaris*, leg. A. Kajzer1♀ Ljubljana, environs, 300 m, 15. 12. 1969, from *Sciurus vulgaris*, leg. S. Brelih2♂ 4♀ Gameljne, 320 m, winter 1954, from *Sciurus vulgaris*, leg. J. Carnelutti(»*Tarsopsylla octodecimdentata*«) (Rosický & Carnelutti, 1959)2♂ 2♀ Zgornje Jezersko, 1000 m, 12. 12. 1965, from *Martes martes*, leg. S. Brelih & A.

Šmuc

1♂ 1♀ Litija, 300 m, 1. 12. 1971, from *Martes martes*, leg. F. Leben

Hrvatska:

2♀ Dubrovnik, 1. 12. 1979, from *Martes foina*, leg. A. Lesinger

Bosna i Hercegovina:

3♀ Igman, from *Sciurus vulgaris*, leg. V. Martino (»*Tarsopsylla octodecimdentatus*«)

(Wagner, 1928-29, 1939)

Jugoslavija: Srbija:

1♂ 4♀ Tara Planina: Predov Krst, 1100 m, 29. 10. 1968, from *Sciurus vulgaris*, leg.

B. Petrov

Makedonija:

Bistra, from *Sciurus vulgaris*, leg. J. Wagner (»*Tarsopsylla octodecimdentatus*«)

(Wagner, 1939)

The major host of *T. o. octodecimdentata* is *S. vulgaris*. It is very often found on *M. martes* and *M. foina*, because *S. vulgaris* is their frequent prey and because *M. martes* often choose the nests of *S. vulgaris* as a resting place.

Tarsopsylla o. octodecimdentata was found outside of Slovenia only at two sites, because from here very few specimens of *S. vulgaris* was examined.

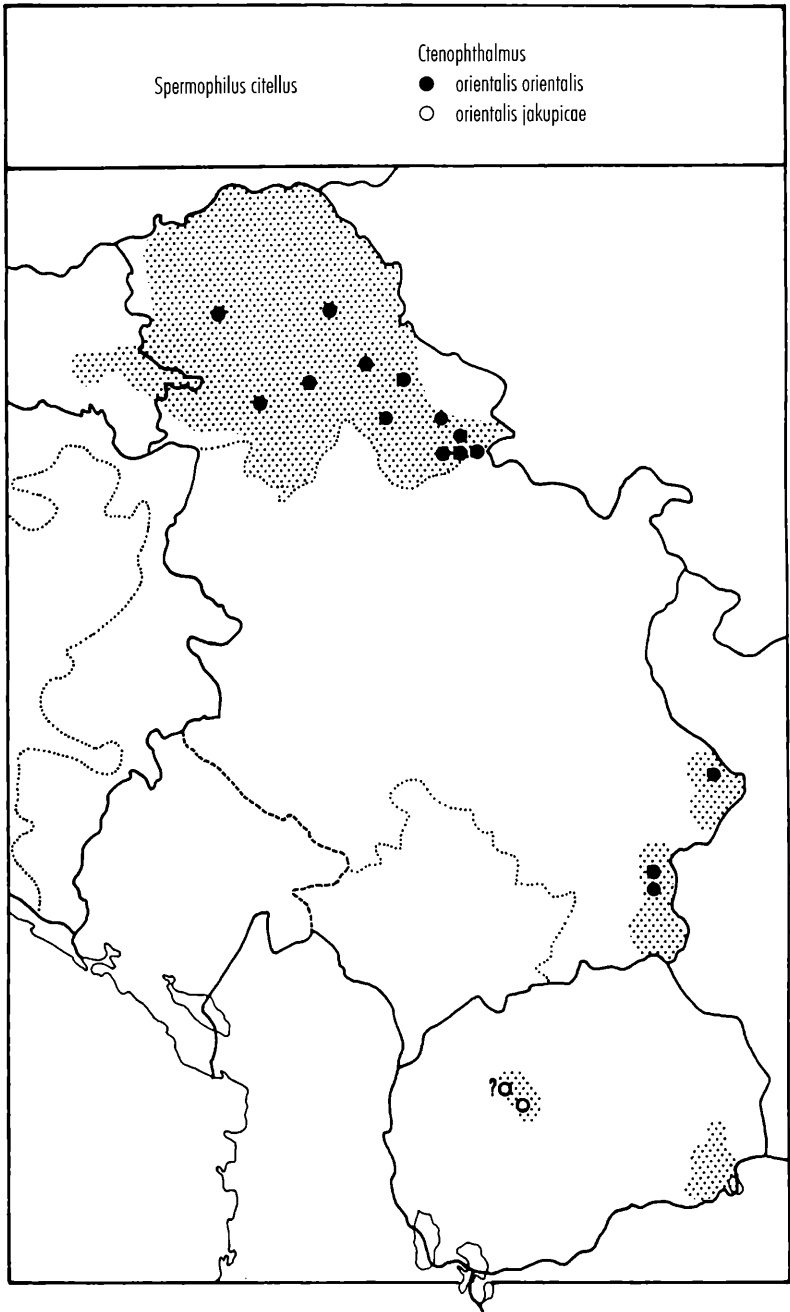


Fig. 9: Distribution of *Spermophilus citellus* (Linnaeus) (adapted from Petrov, 1992), and survey sites of *Ctenophthalmus orientalis* (Wagner)

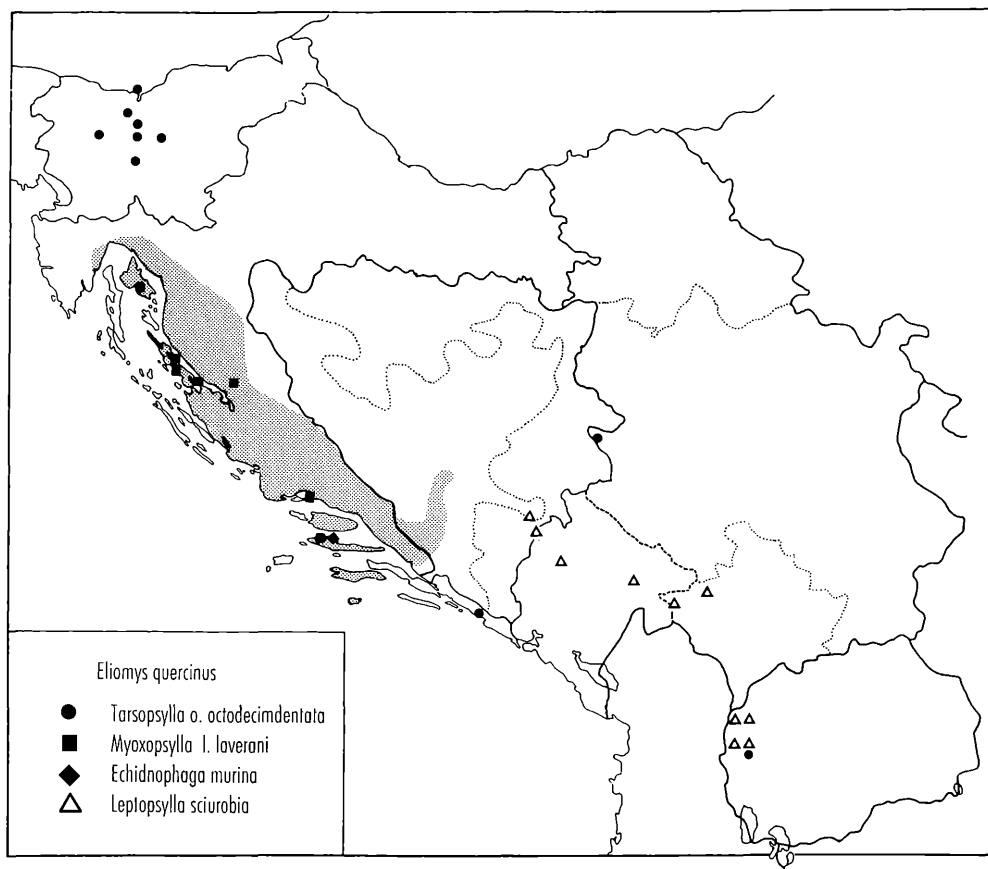


Fig. 10: Distribution of *Eliomys quercinus* (Linnaeus) (adapted from Petrov, 1992 and Tvrtković et al., 1995), and survey sites of *Tarsopsylla octodecimdentata octodecimdentata* (Kolenati), *Myoxopsylla laverani laverani* (Rothschild), *Echidnophaga murina* (Tiraboschi), and *Leptopsylla sciurobia* (Wagner)

22. *Citellophilus simplex simplex* (Wagner, 1902)

Jugoslavija: Srbija: Vojvodina:

1♂ 4♀ Deliblatska Peščara: Samoš, 100 m, 14. 5. 1989, from *Spermophilus citellus*,
leg. B. Kryštufek

11♂ 5♀ Deliblatska peščara (correct Deliblatska Peščara: Deliblato), 7. 5. 1947, from
Citellus citellus (= *Spermophilus citellus*), leg. A. Ružić (Rosický & Todorovič, 1964)

3♀ Deliblato (= Deliblatska Peščara: Deliblato), 100 m, May 1945, from *Citellus citel-*
lus, (= *Spermophilus citellus*), leg. A. Ružić (Rosický & Todorovič, 1964)

12♂ 14♀ Deliblatska Peščara: Deliblato, 100 m, 5. 4. 1949, from *Spermophilus citellus*,
leg. A. Ružić

5♂ 5♀ idem, 20. 4. 1949, leg. B. Petrov

1♂ 1♀ idem, 21. 4. 1949

1♂ Deliblatska Peščara: Šušara, 170 m, 13. 5. 1989, from *Spermophilus citellus*, leg. B.
Kryštufek

1♂ 8♀ Banat: Banatska Palanka, 85 m, 28. 6. 1988, from *Spermophilus citellus*, leg. B.
Kryštufek

1♂ 2♀ idem, 29. 6. 1988

1♂ 6♀ idem, 30. 6. 1988

4♂ 11♀ idem, 15. 4. 1989, leg. B. Kryštufek & T. Trilar

Makedonija:

1♀ Dojransko jezero, Ačikot, 150 m, 31. 5. 1988, from *Spermophilus citellus*, leg. B.
Kryštufek

1♂ idem, 8. 5. 1989

1♂ 1♀ idem, 9. 5. 1989

Two species of the genus *Citellophilus* are distributed in Europe, *C. simplex* and *C. martinoi*. Both species are easily distinguishable, but infraspecific distinctions are very complicated. Almost all taxonomic characters are highly variable, especially the movable process of the clasper. There are some similarities between geographically neighboring populations, but there are also large differences within the same population. Cyprich (1989) discussed this subject in a revision of a large amount of material, and our statements are based on his findings.

Citellophilus simplex is described from the Ukraine and is distributed from Turkey and southern Russia, across Moldavia, Romania, Bulgaria, as far as Yugoslavia (southeastern Vojvodina), Hungary, and Slovakia. In eastern Slovakia both subspecies occur: the nominate subspecies is limited to the extreme eastern part of Slovakia, while *C. s. rosickyi* Cyprich occurs west from there in a limited area (Fig. 20). We found the nominate subspecies in many sites in southeastern Vojvodina (Deliblatska Peščara, Banatska Palanka) and in Macedonia (Dojran), which is the first finding in Macedonia.

Citellophilus simplex has two major hosts: *S. suslicus* in eastern Europe and *S. citellus* in southern and southeastern Europe.

We further discuss this topic in the Discussion section.

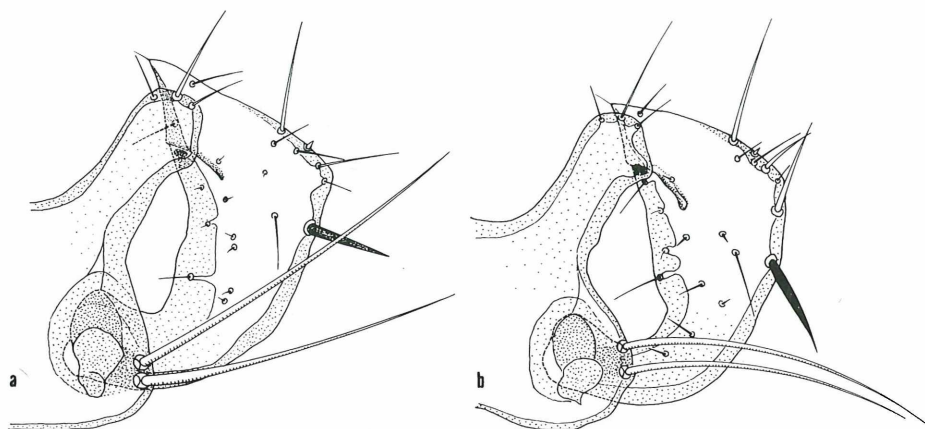


Fig. 11: *Citellophilus simplex simplex* (Wagner): process of clasper of male: a. Banatska Palanka, Banat, Vojvodina; b. Jazak, Fruška Gora, Srem, Vojvodina

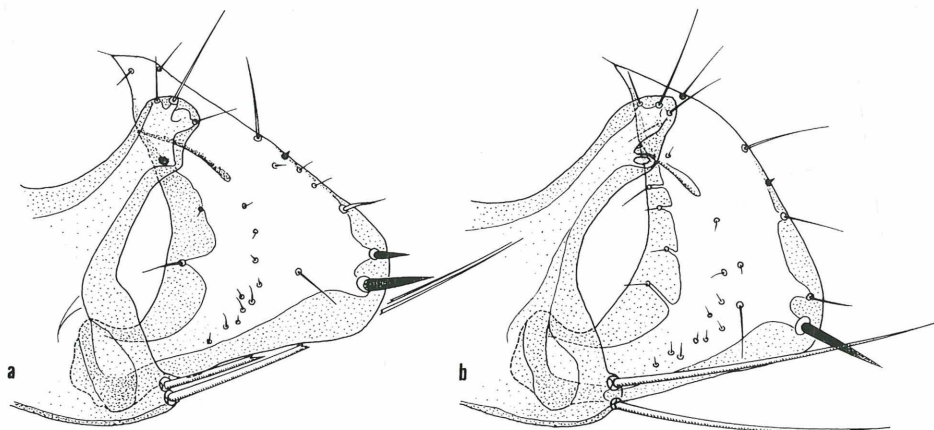


Fig. 12: *Citellophilus martinovi martinovi* (Wagner & Ioff): process of clasper of male: a. Vlasina, southeastern Serbia; b. Begovo Pole, Mt. Jakupica, Macedonia

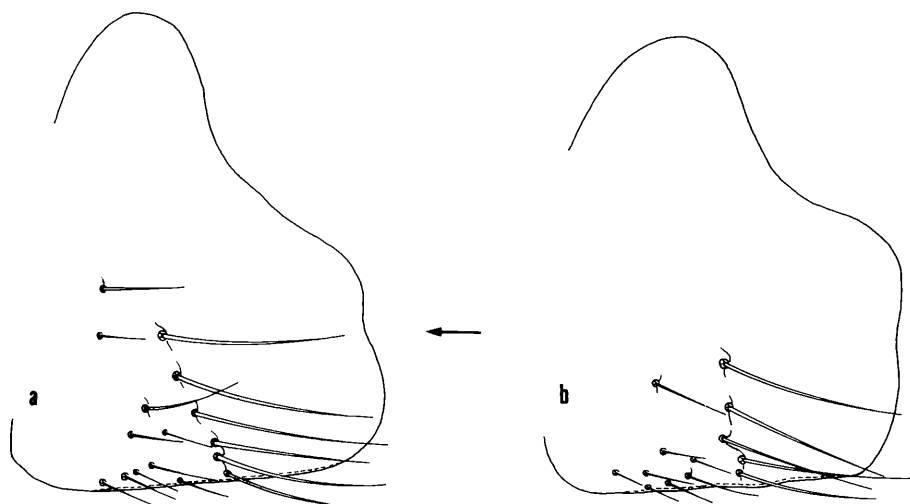


Fig. 13: *Citellophilus simplex simplex* (Wagner): sternum VII of female and outline of sternum VII of female: a. Banatska Palanka, Banat, Vojvodina; b. Ačikot, Dojran, Macedonia

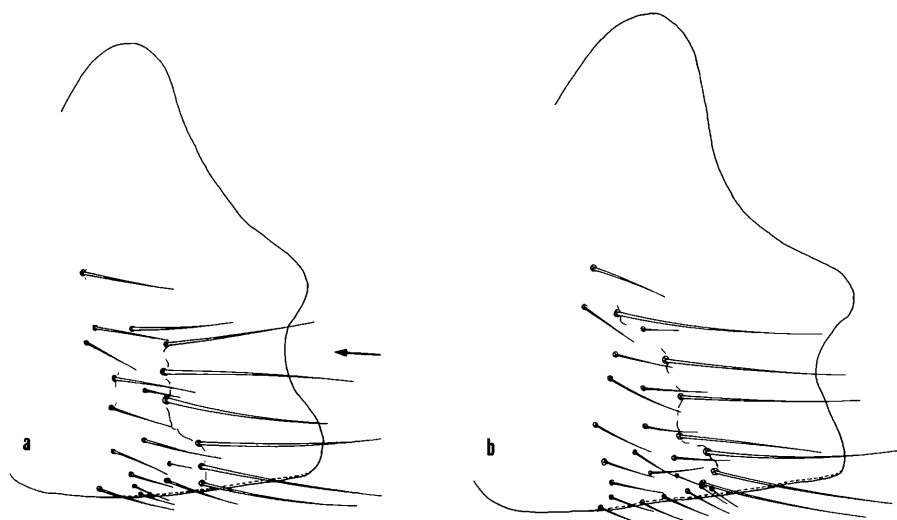


Fig. 14: *Citellophilus martinoi martinoi* (Wagner & Ioff) sternum VII of female and outline of sternum VII of female: a. Jazak, Fruška Gora, Srem, Vojvodina; b. Begovo Pole, Mt. Jakupica, Macedonia

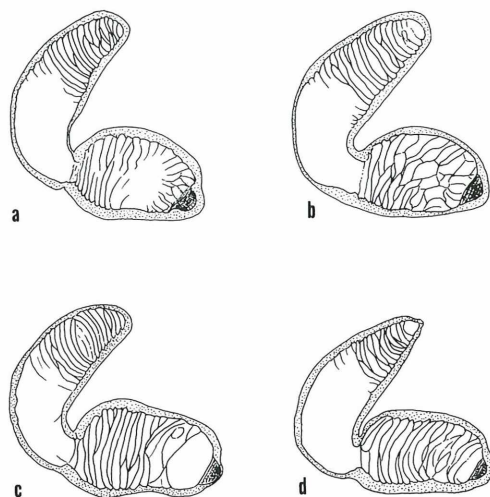


Fig. 15: Spermatheca of female of: a, b. *Citellophilus simplex simplex* (Wagner) (a. Samoš, Deliblatska Peščara, Vojvodina; b. Ačikot, Dojran, Macedonia); and c, d. *Citellophilus martinoi martinoi* (Wagner & Ioff) (c. Jazak, Fruška Gora, Srem, Vojvodina; d. Begovo Pole, Mt. Jakupica, Macedonia)

23. *Citellophilus martinoi martinoi* (Wagner & Ioff, 1926)

Jugoslavija: Srbija: Vojvodina:

Irig, Srem (=Srem: Fruška Gora: Irig), from *Citellus citellus* (=Spermophilus citellus),
24. 9. 1924, leg. V Martino (»Ceratophyllus martinoi«) (Wagner, 1928-29)

2♂ 6♀ Srem: Fruška Gora: Jazak, 180 m, 12. 4. 1989, from *Spermophilus citellus*, leg.
B. Kryštufek & T. Trilar

2♀ Bačka: Titel, Lok, 80 m, 14. 5. 1989, from *Spermophilus citellus*, leg. B. Kryštufek
Melenci, Bačka (correct Banat: Melenci), from *Citellus citellus* (=Spermophilus
citellus), leg. V. Martino (»Ceratophyllus martinoi«) (Wagner, 1928-29)

1♂ 2♀ Banat: Zrenjanin, Orlovat, reka Tamiš, 81 m, 13. 4. 1989, from *Spermophilus
citellus*, leg. B. Kryštufek & T. Trilar

Jugoslavija: Srbija:

1♀ Vlasinska Tresava, 1200 m, 18. 5. 1948, from *Spermophilus citellus*, leg. B. Petrov

2♂ 16♀ Vlasina, 1250 m, August 1947, from *Citellus citellus* (=Spermophilus citellus),
leg. A. Ružić (Rosický & Todorović, 1964)

15♂ 31♀ ibidem, 18. 8. 1947, from *Talpa europaea*, leg. A. Ružić (Rosický &
Todorović, 1964)

10♂ 32♀ ibidem, 25. 7. 1977, from *Spermophilus citellus*, leg. B. Petrov

10♂ 16♀ Stara Planina: Ponor, 17. 6. 1947, from *Citellus citellus* (=Spermophilus citel-
lus), leg. A. Ružić (Rosický & Todorović, 1964)

Citellophilus martinoidi, like *C. simplex*, is a highly variable species. There are morphological similarities especially between geographically neighboring populations, but at the same time there is marked high intrapopulation variation.

Citellophilus martinoidi is described from Irig (Fruška Gora, Srem) and Melenci (Banat; Bačka is incorrectly cited in the literature), both *loca typica* are in Vojvodina (Yugoslavia). The nominate subspecies occurs also in Bulgaria, Romania, east Serbia, south Hungary, and in the central part of Slovakia (Fig. 20). According to Cyprich (1989) the subspecies *C. m. rotundus* Rosicky is distributed in the Czech Republic, Moravia, part of Slovakia, Hungary and in eastern Austria. Transitional forms between the subspecies are frequent.

The major host of *C. martinoidi* is *S. citellus*. In eastern Serbia it was collected on *T. europaea*. As other species of the genus *Citellophilus*, it lives in the fur of the host.

Citellophilus martinoidi ssp.

Makedonija:

3♂ 15♀ Jakupica: Gorno Begovo, Begovo Pole, 1950-2000 m, 11. 5. 1989, from

Spermophilus citellus, leg. B. Kryštufek

2♀ idem, 27. 6. 1989

2♂ 1♀ idem, 28. 6. 1989

1♂ 5♀ Jakupica: Solunsko Pole, 2100 m, 28. 6. 1989, from *Spermophilus citellus*, leg. B. Kryštufek

Kryštufek collected this material in 1989 in an isolated mountain population of *S. citellus* (*S. c. karamani*) at the Mt. Jakupica in Macedonia. This was the first finding of *C. martinoidi* in Macedonia. The collected 6 males and 23 females were not sufficient for a final determination at the subspecific level. There is also substantial intrapopulation variation. The movable process of the clasper is quite narrow, otherwise there are no relevant differences. Further studies are needed to determine whether they should be considered to represent the nominate subspecies or not.

Citellophilus sp.

Makedonija

Kožuf, from *Citellus citellus* (= *Spermophilus citellus*), leg. J. Wagner (»*Citellophilus martinoidi*« - with the note that it could be another species) (Wagner, 1939)

Wagner probably collected the material somewhere at the foot of the Mt. Kožuf, while *S. citellus* does not live at the mountain.

24. *Ceratophyllus (Monopsyllus) sciurorum sciurorum* (Schränk, 1803)

Slovenija:

5♂ 2♀ Komen, Kobjeglava, 324 m, 30. 7. 1985, from *Glis glis*, leg. B. Petrov

2♂ 2♀ Trnovski gozd: Čaven, 1240 m, 3. 10. 1968, from *Glis glis*, leg. S. Brelj & R. Jelinčič

1♀ ibidem, 10. 7. 1969, from *Apodemus sylvaticus*, leg. S. Brelj & B. Petrov

32♂ 31♀ Hotedršica (= Hotedršica, Novi svet), 700 m, 26. 8. 1956, from *Glis glis*, leg. R. & N. Jelinčič (»*Monopsyllus sciurorum*«) (Rosický & Cernelutti, 1959)

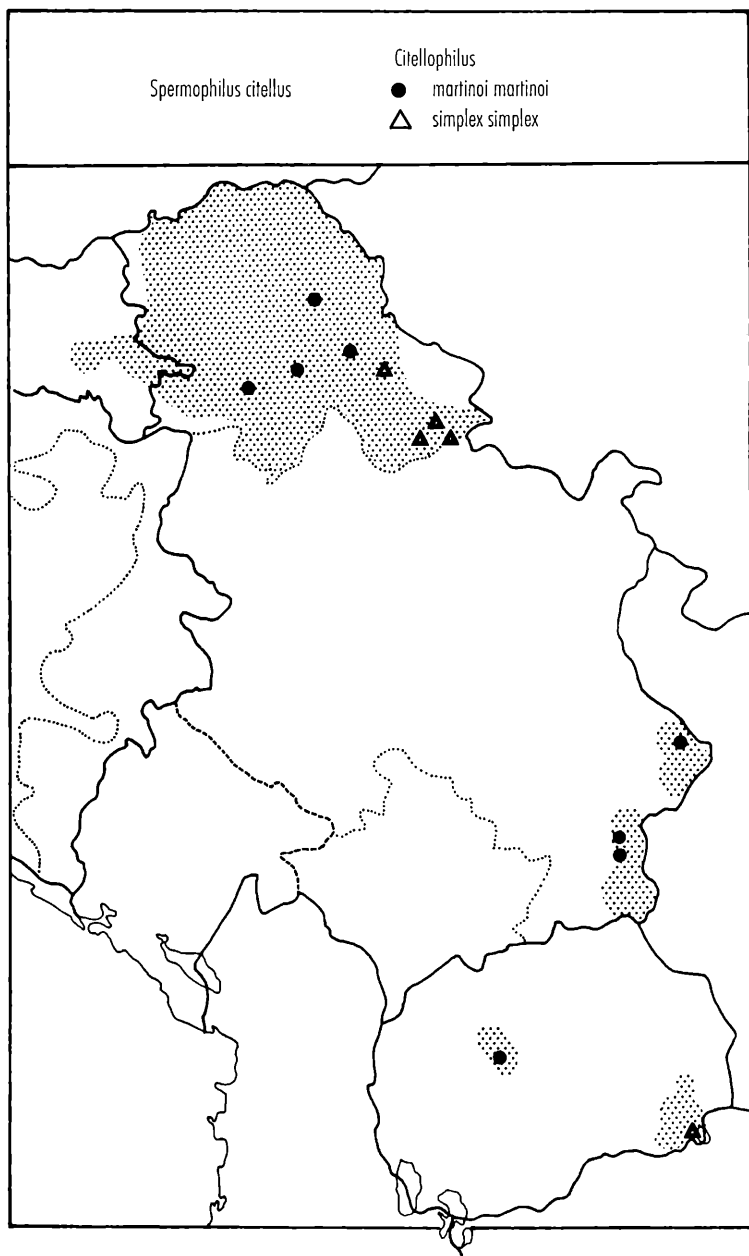


Fig. 16: Distribution of *Sperophilus citellus* (Linnaeus) (adapted from Petrov, 1992), and survey sites of *Citellophilus martinoi martinoi* (Wagner & Ioff) (included *Citellophilus martinoi* ssp. from the Mt. Jakupica in Macedonia), and *Citellophilus simplex simplex* (Wagner)

- 3♂ 3♀ Hotedršica, Novi Svet, 650 m, 4. 8. 1967, from *Glis glis*, leg. S. Brelih & R. Jelinčič
- 4♂ 2♀ Hotedršica, Ravnik, 650 m, 5. 8. 1967, from *Glis glis*, leg. S. Brelih & R. Jelinčič
- 1♂ Snežnik, 1600 m, 25. 9. 1968, from *Glis glis*, leg. F. Leben
- 3♂ 17♀ Snežnik: Sviščaki, 1250 m, 2. 9. 1992, from 1 nest of *Muscardinus avellanarius*, leg. T. Trilar
- 2♂ 1♀ ibidem, 1. 6. 1993, from 1 nest of *Muscardinus avellanarius*
- 2♂ 2♀ Borovnica, Pako, 400 m, 15. 9. 1968, from *Glis glis*, leg. F. Leben
- 1♀ Turjak, 500 m, 4. 12. 1977, from *Martes foina*, leg. A. Šmuc
- 92♂ 184♀ Goteniška gora: Draga, 840 m, 9. 9. 1992, from 3 nests of *Glis glis*, leg. T. Trilar (Trilar, 1995, 1997)
- 231♂ 258♀ idem, 29. 9. 1998, from 3 nests of *Glis glis*, leg. K. Koselj
- 1♀ idem, from 1 nest of *Muscardinus avellanarius*
- 1♀ idem, 29. 9. 1998, from 1 nest of *Muscardinus avellanarius*, leg. K. Koselj
- 3♂ 2♀ idem, 6. 11. 1996, from 1 nest of *Glis glis*, leg. T. Trilar & M. Perušek
- 1♂ 2♀ Kočevje, environs, 15. 10. 1958, from *Glis glis*, leg. S. Brelih
- 3♂ 4♀ Bohinj, Ukanc, 560 m, 28. 7. 1957, from *Glis glis*, leg. S. Brelih (»*Monopsyllus sciurorum*«) (Rosický & Carnelutti, 1959)
- 2♂ 3♀ Trenta: Julijana, 720 m, 13. 9. 1968, from *Glis glis*, leg. S. Brelih & J. Dovič
- 1♀ Rateče, Zelenci, 834 m, 14. 7. 1974, from *Apodemus flavicollis*, leg. S. Brelih & J. Gregori
- 1♂ Cerkno, 400 m, 6. 2. 1969, from *Sciurus vulgaris*, leg. F. Leben
- 7♂ 7♀ Jelovica: Goška ravan, 970 m, 11. 9. 1973, from *Glis glis*, leg. B. Kryštufek
- 170♂ 297♀ Rudno, 680 m, 3. 11. 1999, from 1 nest of *Glis glis*, leg. T. Trilar
- 105♂ 204♀ Rudno, Hujska, 710 m, 3. 11. 1999, from 1 nest of *Glis glis*, leg. T. Trilar
- 2♀ Kranj, Sveti Jošt, 800 m, 15. 5. 1983, from *Glis glis*, leg. J. Perovič
- Tržič, series from *Sciurus vulgaris*, leg. S. Brelih & D. Tovornik (»*Monopsyllus sciurorum*«) (Rosický & Carnelutti, 1959)
- 30♂ 101♀ Podljubelj, Čizovnik, 950 m, 5. 11. 1999, from 1 nest of *Glis glis*, leg. T. Trilar
- 1♀ Ljubljana: Vrhovci, 300 m, 17. 1. 1972, from *Sciurus vulgaris*, leg. J. Dovič
- 1♀ Medvode, 320 m, 1. 3. 1956, from *Vulpes vulpes*, leg. J. Carnelutti (»*Monopsyllus sciurorum*«) (Rosický & Carnelutti, 1959)
- 1♀ Sorško polje, Žabnica, 370 m, 3. 11. 1999, from 1 nest of *Glis glis*, leg. T. Trilar
- 6♂ 16♀ Cerklje, Štefanja gora, 750 m, 28. 6. 1975, from nest of *Parus major*, leg. D. Šere
- Kranj, 385 m, from *Glis glis*, leg. L. Kuščer (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
- 1♂ 1♀ Kranj, Milje, 420 m, 20. 3. 1992, from *Sciurus vulgaris*, leg. I. Zavrl
- 3♂ 1♀ ibidem, 30. 9. 1973, from *Glis glis*, leg. B. Kryštufek
- 1♀ Šenčur, Voglje, 370 m, 25. 8. 1986, from *Sciurus vulgaris*, leg. A. Kajzer
- 4♂ 5♀ Lom, Grahovše, Gaberčev rovt, 1290 m, 5. 11. 1999, from 1 nest of *Glis glis*, leg. T. Trilar
- 4♂ 2♀ Črnuče, 320 m, from *Glis glis*, leg. J. Carnelutti (»*Monopsyllus sciurorum*«)

- (Rosický & Cernelutti, 1959)
- 1♀ Ljubljana, 300 m, 15. 5. 1983, from *Homo sapiens*, leg. I. Sivec
- 2♂ Gameljne, 320 m, winter 1954, from *Sciurus vulgaris*, leg. J. Cernelutti
(»*Monopsyllus sciurorum*«) (Rosický & Cernelutti, 1959)
- Kamnik, environs, big series from *Glis glis*, leg. J. Wagner (»*Ceratophyllus sciurorum*«)
(Wagner, 1928-29)
- idem, from *Sciurus vulgaris* (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
- 1♂ Kamniška Bistrica, 600 m, from *Apodemus flavicollis*, 26. 6. 1957, leg.
Czechoslovak Slovenian expedition (»*Monopsyllus sciurorum*«) (Rosický &
Cernelutti, 1959)
- Jezersko (=Zgornje Jezersko), from *Eliomys quercinus* (correct *Dryomys nitedula*), leg.
J. Wagner (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
- idem, from *Evotomys glareolus* (= *Clethrionomys glareolus*) (»*Ceratophyllus sciurorum*«)
(Wagner, 1928-29)
- 1♂ Zgornje Jezersko, 1000 m, 12. 12. 1965, from *Martes martes*, leg. A. Šmuc
- 4♂ 9♀ Litija, 300 m, 1. 12. 1971, from *Martes martes*, leg. F. Leben
- 8♂ 11♀ Mirna na Dolenjskem, 300 m, 28. 4. 1969, from *Martes martes*, leg. S. Brelih
- 1♀ Kostanjevica, Šentjernej, 159 m, 11. 2. 1976, from *Felis silvestris*, leg. A. Šmuc
- 177♂ 195♀ Slovenj Gradec, 460 m, 20. 9. 1996, from 1 nest of *Glis glis*, leg. T. Novak
- 1♂ Pohorje: Lobnica, 1000 m, 18. 7. 1969, from *Clethrionomys glareolus*, leg. S. Brelih
& B. Petrov
- 1♀ Kozje, Lesično, Gruska jama, 16. 10. 1978, found in the pitfall, leg. T. Novak & I.
Sivec
- 1♀ Poljčane, Studenice, Jama v kamnolomu, 260 m, 16. 10. 1978, found in the pitfall,
leg. T. Novak & I. Sivec
- 1♀ Dvorjane, Vurberg, Grmada, 360 m, 8. 5. 1994, from *Micromys minutus*, leg. F.
Janžekovič
- 1♂ Srednja Bistrica, 170 m, 19. 6. 1957, from *Clethrionomys glareolus*, leg.
Czechoslovak Slovenian expedition (»*Monopsyllus sciurorum*«) (Rosický &
Cernelutti, 1959)
- Hrvatska:
- Babja Gora, Slavonija (=Slavonija: Babja Gora), from *Sciurus vulgaris*, leg. V. Martino
(»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
- 1♂ Velebit: Mirevo, 1400 m, 15. 8. 1976, from *Dryomys nitedula*, leg. N. Tvrtković
- 2♂ idem, 7. 8. 1977
- 3♀ Velebit: Zavižan, 1594 m, 24. 6. 1971, from *Glis glis*, leg. G. Džukić
- 4♂ 7♀ Velebit: Zavižan, Modrića dolac, 1460 m, 10. 7. 1984, from *Dryomys nitedula*,
leg. A. Vukušić
- 1♀ Gorski Kotar: Risnjak, 1400 m, 9. 8. 1967, from *Dryomys nitedula*, leg. S. Brelih &
B. Petrov
- 2♂ 1♀ Velebit: Baške Oštarije, 900 m, 11. 8. 1968, from *Eliomys quercinus*, leg. S.
Brelj
- 1♂ ibidem, 925 m, 26. 6. 1981, from *Apodemus flavicollis*, leg. N. Tvrtković
- 1♀ Velebit: Papratnjak, 920 m, 30. 7. 1976, from *Dryomys nitedula*, leg. N. Tvrtković

- 1♀ Velebit: Bunjevac, 1200 m, 15. 6. 1986, many specimens on the soil, leg. B. Jalžić
 2♂ ibidem, 7. 8. 1977, from *Dryomys nitedula*
 2♂ Velebit: Predzid, 800 m, 2. 8. 1975, from *Glis glis*, leg. N. Tvrtković & B. Kryštufek
 1♂ 2♀ ibidem, 740 m, 2. 8. 1975, from *Eliomys quercinus*, leg. N. Tvrtković & B. Kryštufek
 1♂ Vukomeričke gorice: Prkovec, 200 m, 10. 8. 1974, from *Glis glis*, leg. N. Tvrtković
 1♂ Turopolje: Peščenica, near the river Odra, 95 m, 7. 4. 1974, from *Apodemus flavicollis*, leg. N. Tvrtković
 3♂ 3♀ Zagreb, Dugo Selo, 100 m, 5. 4. 1959, from *Martes martes*, leg. K. Igalfy
 3♀ Brač Island: Dol, 600 m, 4. 9. 1975, from *Glis glis*, leg. N. Tvrtković
 9♂ 3♀ idem, from *Apodemus sylvaticus*
 9♂ 8♀ Biokovo: Sveti Jura, 1650 m, 31. 7. 1970, from *Glis glis*, leg. B. Petrov & G. Džukić
 Bosna i Hercegovina:
 Sjetlino, Bosna (=Sjetlino), from *Glis glis*, leg. Zjuzin (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
 1♂ 2♀ Bjelašnica (Gacko), 1600 m, 4. 8. 1970, from *Glis glis*, leg. B. Petrov
 Igman, from *Glis glis*, leg. V. Martino (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29) idem, from *Sciurus vulgaris* (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
 2♂ Zelengora: Orlovačko jezero, 1500 m, 9. 9. 1984, from *Dryomys nitedula*, leg. B. Kryštufek
 1♂ Gazivoda, 26. 10. 1988, from *Glis glis*, leg. B. Kryštufek
 2♂ 4♀ Šator planina: Šatorsko jezero, 1490 m, 20. 9. 1988, from *Glis glis*, leg. B. Kryštufek
 5♂ 2♀ Šator planina: Babina greda, 1620 m, 5. 9. 1984, from *Glis glis*, leg. B. Kryštufek
 1♂ Svinjača, Blidinje jezero, 1170 m, 20. 6. 1971, from *Microtus arvalis*, leg. G. Džukić
 2♂ Velež, Rujište, 1050 m, 18. 5. 1971, from *Glis glis*, leg. B. Petrov
 Jugoslavija: Crna Gora:
 3♀ Hercegnovi, 50 m, 15. 6. 1990, from *Dryomys nitedula*, leg. B. Kryštufek
 Cetinje, Crna Gora (=Cetinje), from *Glis glis*, leg. V. Martino (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
 1♀ Orjen, 1100 m, 13. 10. 1990, from *Sciurus vulgaris*, leg. B. Kryštufek
 1♀ Bjelasica: Zekova Glava, 2050 m, 19. 9. 1981, from *Dinaromys bogdanovi*, leg. B. Petrov & M. Milenković (Brelih, 1986)
 Jugoslavija: Srbija: Vojvodina:
 1♀ Srem: Erdevik, 119 m, 29. 10. 1963, from *Apodemus flavicollis*, leg. Đ. & N. Heneberg
 1♂ Srem: Fruška Gora: Zmajevac, 450 m, 28. 10. 1963, from *Apodemus flavicollis*, leg. Đ. & N. Heneberg
 1♂ Deliblatska Peščara: Kremenjak, 100 m, 27. 2. 1987, from *Sciurus vulgaris*, leg. M. Milenković
 Jugoslavija: Srbija:
 4♂ 1♀ Tara Planina: Kremići, 950 m, 20. 6. 1949, from *Glis glis*, leg. B. Petrov
 2♂ 2♀ Tara Planina: Predov Krst, 1100 m, 29. 10. 1968, from *Sciurus vulgaris*, leg. B.

Petrov

- 2♂ 1♀ Golija: Biser Voda, 1200 m, 19. 6. 1970, from *Glis glis*, leg. B. Petrov
 Arandelovac, from *Glis glis*, leg. V Martino (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
- 1♂ Niš: Sičevo, 13. 5. 1970, from *Apodemus sylvaticus*, leg. B. Petrov
- 1♀ Veliki Jastrebac, Ravnište, 600 m, 14. 6. 1979, from *Apodemus flavicollis*, leg. B. Petrov
- 5♂ 5♀ Suva Planina, 7. 6. 1947, from *Rattus rattus*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 3♂ idem, 9. 6. 1947, from *Sciurus vulgaris* (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- Donji Milanovac, from *Glis glis*, leg. V Martino (»*Ceratophyllus sciurorum*«) (Wagner, 1928-29)
- 1♀ Besna Kobila, ~ 1600 m, August 1947, from *Mus musculus*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 2♂ 3♀ Vlasina, 1250 m, August 1947, from *Sciurus vulgaris*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 1♂ 1♀ idem, August 1947, from *Glis glis* (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 2♂ Suva Planina: Tri lokve, 1400 m, 14. 8. 1981, from *Glis glis*, leg. B. Petrov
- 2♂ idem, from *Rattus rattus*
- 1♀ Vidlič: Basara: Planinica, 1200 m, 17. 8. 1981, from *Glis glis*, leg. B. Petrov
- 11♂ 10♀ Stara Planina: Dojkinci, ~ 900 m, 25. 6. 1947, from *Glis glis*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 1♀ Stara Planina: Dojkinci, Bašta, 13.-17. 10. 1947, from *Apodemus sylvaticus*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 1♂ 2♀ Stara Planina, October 1947, from *Glis glis*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 2♂ 5♀ idem, 27. 6. 1947 (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 3♂ 4♀ idem, September 1947, from *Sciurus vulgaris* (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 8♂ idem, 21. 6. 1947 (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- 1♀ Stara Planina: Kopren, ~ 1850 m, 29. 6. 1947, from *Apodemus sylvaticus*, leg. B. Petrov (»*Monopsyllus sciurorum*«) (Rosický & Todorović, 1964)
- Jugoslavija: Srbija: Kosovo:
- 9♂ 2♀ Žljeb: Kula, 1600 m, 24. 6. 1980, from *Glis glis*, leg. B. Petrov
- 1♂ idem, 1750 m, 14. 6. 1977, from *Dryomys nitedula*
- Makedonija:
- Bistra, 25. 7. 1933, series from *Sciurus vulgaris*, leg. V Martino (»*Monopsyllus sciurorum*«) (Wagner, 1934)
- 2♀ Kičevo, Dolenci, 620 m, 15. 9. 1989, from *Glis glis*, leg. B. Kryštufek
- 1♀ Šar Planina: Jelak, 1900 m, 21. 7. 1978, from *Apodemus flavicollis*, leg. G. Džukić
- 3♂ Prilep, 700 m, 21. 4. 1969, from *Dryomys nitedula*, leg. B. Petrov

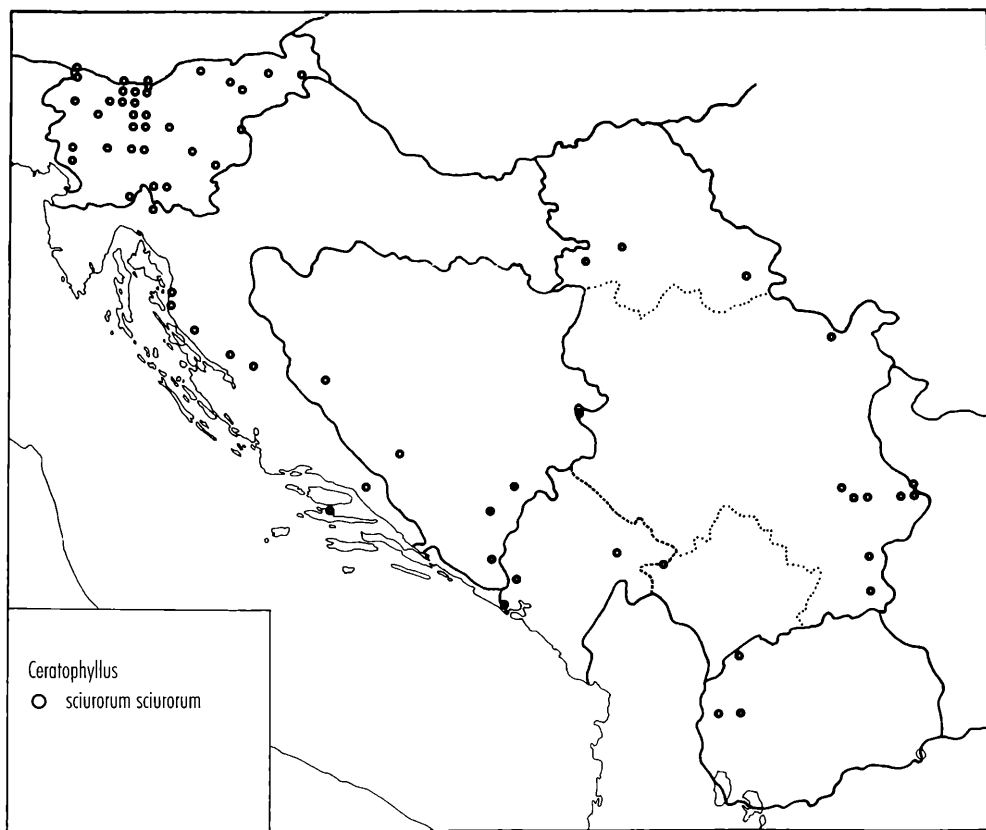


Fig. 17: Distribution of *Ceratophyllus sciurorum sciurorum* (Schrank) in the Western and Central Balkans

Ceratophyllus s. sciurorum is the most common flea species of our red squirrels and dormice, especially *G. glis*. It often passes to other hosts, which come in contact with squirrels and dormice as predators or during nesting. It is a widespread sylvatic flea in the Western and Central Balkans found on the following hosts: *S. vulgaris*, *G. glis*, *D. nitedula*, *E. quercinus*, *M. avellanarius*, *M. martes*, *M. foina*, *V. vulpes*, *F. silvestris*, *A. flavicollis*, *A. sylvaticus*, *M. musculus* s. lat., *M. minutus*, *R. rattus*, *C. glareolus*, *M. arvalis*, *D. bogdanovi*, in the nest of *P. major*; and also on humans, on floors, the soil, and even in carstic caves in traps with beetle bait.

25. *Ceratophyllus* (*Monopsyllus*) sp.

Slovenija:

1♀ Snežnik: Sviščaki, 1250 m, 22. 7. 1997, from 1 nest of *Glis glis*, leg. T. Trilar

2♂ ibidem, 3. 9. 1999

2♂ ibidem, 30. 10. 1999, from 2 nests of *Glis glis*

During the determination of a great amount of material from the nests of *G. glis* from Sviščaki, Mt. Snežnik (Slovenia) (Tab. 1) we found 4 males and 1 female, which are clearly distinguishable from the all known species from the genus *Ceratophyllus*. The males differ in the shape of sternum VIII and females in the shape of sternum VII and in the shape of spermatheca. These most likely represent an undescribed species.

26. *Ceratophyllus (Ceratophyllus) gallinae* (Schrank, 1803)

Slovenija:

1♀ Snežnik: Sviščaki, 1250 m, 24. 10. 1997, from 1 nest of *Glis glis*, leg. T. Trilar

1♀ ibidem, 16. 7. 1999, from 1 nest of *Glis glis*

1♂ Podljubelj, Čizovnik, 950 m, 5. 11. 1999, from 1 nest of *Glis glis*, leg. T. Trilar

Ceratophyllus gallinae ecologically belongs to the group of fleas of small passeriform birds which nest in tree canopies, holes, nest boxes, and bushes (Rosický, 1950, 1957; Jurík, 1975, 1976, 1978). *Glis glis* is an occasional host (Traub et al., 1983).

27. *Ceratophyllus (Ceratophyllus) hirundinis* (Curtis, 1826)

Slovenija:

3♂ 3♀ Snežnik: Sviščaki, 1250 m, 22. 8. 1990, from 1 nest of *Glis glis*, leg. T. Trilar
(Trilar, 1995, 1997)

28. *Ceratophyllus (Ceratophyllus) rusticus* Wagner, 1903

Slovenija:

1♀ Snežnik: Sviščaki, 1250 m, 22. 8. 1990, from 1 nest of *Glis glis*, leg. T. Trilar
(Trilar, 1995, 1997)

The presence of *C. hirundinis* and *C. rusticus* in *G. glis* nests was very surprising (Trilar, 1995, 1997). Both belong to the group of swallow fleas (Rosický, 1950, 1957; Jurík, 1975, 1976, 1978), and *G. glis* is an accidental host (Traub et al., 1983). Which intermediate host mediates transfer from swallows to dormice is unknown, because swallows nest at great distances from rodent dens.

Discussion

We have studied fleas (Siphonaptera) from the territory of the Western and Central Balkans (former Yugoslavia) (Fig. 1) whose hosts are rodents from the family of squirrels (Sciuridae) and dormice (Gliridae). Three species of squirrels live in this area: the red squirrel (*S. vulgaris*), the European souslik (*S. citellus*), and the Alpine marmot (*M. marmota*), and four species of dormice: the fat dormouse (*G. glis*), the common dormouse (*M. avellanarius*), the garden dormouse (*E. quercinus*), and the forest dormouse (*D. nitedula*). Tables 2 through 7 provide results of our survey of fleas found on *S. vulgaris*, *S. citellus*, *G. glis*, *M. avellanarius*, *E. quercinus*, and *D. nitedula* in the Western and Central Balkans.

Date	Nests No.	♂♂	♀♀
6. 3. 1990	6	226	311
2. 6. 1990	1	1	8
22. 8. 1990	4	190	221
30. 6. 1992	8	649	752
2. 9. 1992	12	556	614
17. 2. 1993	11	249	432
27. 9. 1993	3	21	34
22. 6. 1994	7	4	10
6. 10. 1994	8	417	562
4. 7. 1995	10	150	294
1. 8. 1996	7	88	122
19. 9. 1996	3	469	659
22. 7. 1997	3	81	86
24. 10. 1997	5	176	152
9. 10. 1998	6	129	122
28. 5. 1999	2	0	6
16. 7. 1999	9	64	107
3. 9. 1999	8	110	166
30. 10. 1999	16	569	1039
Total	83	3781	5166

Tab. 1: Survey of *Ceratophyllus sciurorum sciurorum* in the nests of *Glis glis* from Sviščaki, Mt. Snežnik (1250 m, leg. T. Trilar) data from 1990 to 1993 according to Trilar (1995, 1997).

		SI		HR		BH		MTG		VOJ		SRB		KOS		MK	
		No	L	No	L	No	L	No	L	No	L	No	L	No	L	No	L
<i>L. sciurobia</i>	♂															1	
	♀															2	1
<i>T. octodecimdentata octodecimdentata</i>	♂	3	4				1					1				+	
	♀	5				3						4	1				1*
<i>C. sciurorum sciurorum</i>	♂	3	4	+		+			1	1	1	7				+	
	♀	3	2*		1*		1*	1				5	4				1*

Tab. 2: Survey of fleas on *Sciurus vulgaris* Linnaeus in the Western and Central Balkans:

No - Number of specimens

L - Number of UTM squares with survey sites

+ - Species present, but without a citation of the number of specimens

- Number of UTM squares, without a citation of the number of specimens

		SI		HR		BH		MTG		VOJ		SRB		KOS		MK	
		No	L	No	L	No	L	No	L	No	L	No	L	No	L	No	L
<i>N. setosa spinea</i>	♂									5							
	♀									11	4						
<i>C. agyrtes graecus</i>	♂															1	
	♀															1	2
<i>C. orientalis orientalis</i>	♂									15		10					
	♀									21	8 1*	19	3				
<i>C. orientalis jakupicae</i>	♂															24	
	♀															33	1 1*
<i>Citellophilus</i> sp.	♂															+	
	♀																1*
<i>C. simplex simplex</i>	♂									38						2	
	♀									59	4					2	4
<i>C. martinoi martinoi</i>	♂									3		22				6	
	♀									10	3 2*	65	3			23	
<i>C. martinoi</i> ssp.	♂															6	
	♀															23	1

Tab. 3: Survey of fleas on *Spermophilus citellus* (Linnaeus) in the Western and Central Balkans:

No - Number of specimens

L - Number of UTM squares with survey sites

+ - Species present, but without a citation of the number of specimens

- Number of UTM squares, without a citation of the number of specimens

		SI		HR		BH		MTG		VOJ		SRB		KOS		MK	
		No	L	No	L	No	L	No	L	No	L	No	L	No	L	No	L
<i>Pulex irritans</i>	♂		1														
	♀	1															
<i>H. orientalis</i>	♂						1										
<i>H. orientalis</i>	♀					1											
<i>C. monticola</i>	♂											1	2				
	♀											1					
<i>C. agyrtes</i>	♂		2														
<i>C. agyrtes</i>	♀	3															
<i>C. agyrtes</i>	♂			4													
<i>C. agyrtes</i>	♀				1												
<i>C. ohridanus ↔ dinarus</i>	♂			6													
	♀																
<i>C. nifetodes</i>	♂	3															
<i>C. nifetodes</i>	♀		1														
<i>C. nifetodes</i>	♂	4															
<i>C. nifetodes</i>	♀																
<i>C. nifetodes</i>	♂				1												
<i>C. nifetodes</i>	♀			1													
<i>C. nifetodes</i>	♂																
<i>C. nifetodes</i>	♀					2		1	1								
<i>C. congener</i>	♂																
<i>C. congener</i>	♀	1	1														
<i>L. segnis</i>	♂			1													
	♀			2	1												
<i>L. sciurobia</i>	♂													1			
	♀													1	1		
<i>C. sciurorum</i>	♂	4662		12		11						34		9			
<i>C. sciurorum</i>	♀	21		4		4		+				7		1		1	
	♂	6476	2*	14		8	2*		1*			25	2*	2		2	
<i>C. hirundinis</i>	♀	3															
	♂		1														
<i>C. rusticus</i>	♀																
	♂		1														
	♀	1															

Tab. 4: Survey of fleas on *Glis glis* (Linnaeus) in the Western and Central Balkans:

No - Number of specimens

L - Number of UTM squares with survey sites

+ - Species present, but without a citation of the number of specimens

- Number of UTM squares, without a citation of the number of specimens

		SI		HR		BH		MTG		VOJ		SRB		KOS		MK	
		No	L	No	L	No	L	No	L	No	L	No	L	No	L	No	L
<i>C. sciurorum</i> <i>sciurorum</i>	♂	5	2														
	♀	20															

Tab. 5: Survey of fleas on *Muscardinus avellanarius* (Linnaeus) in the Western and Central Balkans:

No - Number of specimens

L - Number of UTM squares with survey sites

+ - Species present, but without a citation of the number of specimens

- Number of UTM squares, without a citation of the number of specimens

		SI		HR		BH		MTG		VOJ		SRB		KOS		MK	
		No	L	No	L	No	L	No	L	No	L	No	L	No	L	No	L
<i>E. murina</i>	♂				1												
	♀			2													
<i>M. laverani</i> <i>laverani</i>	♂			11													
	♀			15	1*												
<i>C. sciurorum</i> <i>sciurorum</i>	♂			3													
	♀			3	2												

Tab. 6: Survey of fleas on *Eliomys quercinus* (Linnaeus) in the Western and Central Balkans:

No - Number of specimens:

L - Number of UTM squares with survey sites

+ - Species present, but without a citation of the number of specimens

- Number of UTM squares, without a citation of the number of specimens

		SI		HR		BH		MTG		VOJ		SRB		KOS		MK	
		No	L	No	L	No	L	No	L	No	L	No	L	No	L	No	L
<i>C. agyrtes graecus</i>	♂																1
	♀															1	
<i>C. congener troilus</i>	♂															1	
	♀																1
<i>L. sciurobia</i>	♂					1	2	1	1							2	1
	♀					1										4	
<i>C. sciurorum sciurorum</i>	♂	+		9	4	2	1		1					1		3	1
	♀		1*	9				3						1			

Tab. 7: Survey of fleas on *Dryomys nitedula* (Pallas) in the Western and Central Balkans:

No - Number of specimens

L - Number of UTM squares with survey sites

+ - Species present, but without a citation of the number of specimens

Number of UTM squares, without a citation of the number of specimens

M. marmota was introduced into the Alps (Julijske Alpe - Julian Alps), Kamniško-Savinjske Alpe (Kamnik-Savinja Alps) and Karavanke (Karawanken) in northwestern Slovenia beginning in 1953. Indigenous populations of *M. marmota* were already extinct in this area at the end of the Pleistocene or the beginning of the Holocene (Kryštufek, 1991). We did not examine any individuals or nests of this species so we do not have data on their ectoparasites.

Fleas in Europe based on hosts belong to thirteen ecological groups, where the systematic relationships are not important (Rosický, 1957). The fleas from these hosts ecologically belong to the flea group of large ground rodents (*Cricetus*, *Spermophilus*) and the fleas of red squirrels and dormice but there are also others in tree canopies and tree hollow nesting birds and mammals.

The most common flea from the ecological group of red squirrels and dormice is *C. s. sciurorum*. Its major hosts are *S. vulgaris* and *G. glis*. All examined individuals and nests of both hosts were infested with *C. s. sciurorum*. This flea was also common on *D. nitedula*, but surprisingly rare on *M. avellanarius* and *E. quercinus*. It was often found on *M. martes* and once on *M. foina*, as these predators visit nests of squirrels and dormice. It was found on *C. glareolus*, *D. bogdanovi*, *M. arvalis*, *M. minutus*, *M. musculus* s. lat., *A. flavicollis*, and *A. sylvaticus*, all of which are hosts of fleas which are belonging to the ecological group of small terrestrial mammals that nest on the ground. In Slovenia it has also been found in the nests of *P. major*. Some were also found on the floor of underground caves and buildings. We presume that fleas were

transferred to such places by *G. glis*, a species known to use both caves (Polak, 1997) and buildings as shelter. *Ceratophyllus s. sciurorum* can also pass to humans and can also bite. It seems likely that in human habitations they also passed to *R. rattus* and *M. musculus* s. lat. In Slovenia, *C. s. sciurorum* was found also on two large predators, *Vulpes* and *F. silvestris*.

Tarsopsylla o. octodecimdentata and *M. l. laverani* also occur on squirrels and dormouse. The major host of the first is *S. vulgaris* and are often passed to the predators *M. martes* and *M. foina*. This conclusion is based on our findings from Slovenia because only a few *S. vulgaris* from other areas of the Western and Central Balkans were examined. In general *T. o. octodecimdentata* is much rarer than *C. s. sciurorum*.

The major host of *M. l. laverani* is not known (Rosický, 1957). In the Western and Central Balkans all the specimens were collected within the range of *E. quercinus*. Thus all the findings are from *E. quercinus* and a single female from *A. sylvaticus*. Although a great number of specimens from the Balkans were examined, *M. l. laverani* was never collected from *G. glis* which is usually cited as a major host. Our results suggest that *E. quercinus* is the major host of *M. l. laverani*. In Central Europe and the Balkans where *G. glis* and *E. quercinus* occur in the same habitats, it is possible that *M. l. laverani* passes from one host to another.

The first known host of *L. sciurobia* was *S. vulgaris*, which also gave it its name. It was also collected on *G. glis* and *D. nitedula*. Based on this data it belongs ecologically to the red squirrel and dormouse group of fleas. But it was also collected from *A. sylvaticus* and *A. mystacinus* and therefore could be regarded as belonging to the ecological group of fleas of small terrestrial mammals which also include the majority of species of *Leptopsylla*. The distribution of *L. sciurobia* includes the Central and Southern Balkans (Montenegro, Kosovo, Macedonia, Albania, and Greece). However the data are insufficient to determine their ecological affinity at present time.

From the ecological group of fleas of large ground rodents (*Cricetus*, *Spermophilus*) we will discuss only fleas from *S. citellus*, as the common hamster (*C. cricetus*) belongs to the family Cricetidae.

Spermophilus citellus is the major host of four flea species: *N. setosa*, *Ct. orientalis*, *C. simplex*, and *C. martinoi*. The first two species are typically found in nests and the latter two from fur. The distribution of *C. simplex* and *C. martinoi* is very complex.

Spermophilus citellus is endemic to Europe. The range is divided by the Carpatians into two main parts (Fig. 18). One includes the Pannonian basin and adjacent plains of the Czech Republic, Austria, Hungary, Slovakia, western Romania, and Yugoslavia. The other is to the south and east of the Carpatians in southern Romania, Bulgaria, Thrace, Moldavia, and Ukraine. Small peripheral isolated populations are present in Slovakia, Macedonia, and northern Greece (Kryštufek, 1996; Mitchell-Jones et al., 1999), as well as recently extinct populations from southern Poland and eastern Germany. Eight subspecies were described, but authors disagrees as to infraspecific classification. Đulić & Mirič (1967) reported five subspecies for the Western and Central Balkans: *Citellus* (= *Spermophilus*) *citellus citellus* (Linnaeus, 1766) from eastern Slavonia and Vojvodina, *C. c. gradojevici* Martino & Martino, 1929 from southern Macedonia, *C. c. karamani* Martino & Martino, 1940 from the Mt. Karadžica in

Macedonia, *C. c. laskarevi* Martino & Martino, 1940 from Dolovo in southeastern Banat, and *C. c. balcanicus* Markov, 1957 from eastern Serbia. Kryštufek (1990, 1996, 1998) and Kryštufek & Hrabě (1996) confirmed the differences between these groups of populations on the basis of cranial measurements, variations in the pelvis (*os coxae*) and baculum (*os penis*). Only isolated mountain population (*S. c. karamani*) from the Mt. Jakupica and Mt. Karadžica in Macedonia is morphologically distinct in categorical criteria. The complexity of phenetic relations are shown in Fig. 18 and 19 (after Kryštufek, 1996). Unfortunately, molecular analysis has not yet been performed. The research of fleas specific for *S. citellus* shows some similarities in geographic distribution between hosts and parasites.

Three subspecies of *N. setosa* are described. The range of *N. s. setosa* (Wagner, 1898) extends from Tien Shan in southwestern China across Kazakhstan to southwestern Russia and the Caucasus. Their major host is *S. pygmaeus*. *Neopsylla s. moravica* Rosický, 1965 occurs in Moravia and Slovakia; its major host is *S. citellus*. *Neopsylla s. spinea* Rothschild, 1915 occupies Armenia, Romania, Bulgaria, and Yugoslavia. A major host is also *S. citellus*. Wagner (1939) reported this species from southern Serbia but without the exact locality, making it impossible to use these data. We provide four new localities from Yugoslavia, all located in Vojvodina: Jazak and Čortanovci from Fruška Gora in Srem, and Deliblato and Čoka from Deliblatska Peščara. There are no data for Serbia and Macedonia but they are probably distributed there because they are present in Bulgaria and Greece. The species is only rarely found on fur; it mainly lives in host nests. We examined only the fur of collected sousliks and not nests, therefore our Central Balkan findings are limited. The species is probably more common than we realize and probably occupies the entire host area.

Ctenophthalmus orientalis is distributed over the entire range of *S. citellus* and in the Ukraine to the Čkalsky steppe (=Čkalovnow Oreńburg) in southeastern European Russia, where it parasitizes other souslik species. The nominate subspecies *Ct. o. orientalis* lives in the entire distribution area of *S. citellus*. A newly described subspecies, *Ct. o. jakupicae*, is found only in isolated mountain population (*S. c. karamani*) from the Mt. Jakupica and Mt. Karadžica in Macedonia. This agrees with earlier taxonomic conclusions (Kryštufek, 1990, 1996, 1998; Kryštufek & Hrabě, 1996) who considered these this population of *S. citellus* as morphologically most distinct from other populations.

The geographic distribution of both species from the genus *Citellophilus* is more complex than for *N. setosa* or *Ct. orientalis*. Both species are allopatric. *Citellophilus simplex* is distributed in the eastern part of the range of *S. citellus* while *C. martinoides* mainly occupies the western part. In the central region is a mosaic of small and large populations, but the two are never sympatric. This distribution is shown on Figs. 16 and 20.

Both, *C. simplex* and *C. martinoides*, are highly variable species. Intrapopulation variation was as great as that between different populations. Variations pertain to the shape of the fixed and movable process of the clasper. Cyprich (1989) found bigger similarities in geographically neighboring than in remote populations, but they were not on the subspecific level. From both species, *C. simplex* and *C. martinoides*, is described one subspecies, which is not sharply separated from the closest populations of nominate

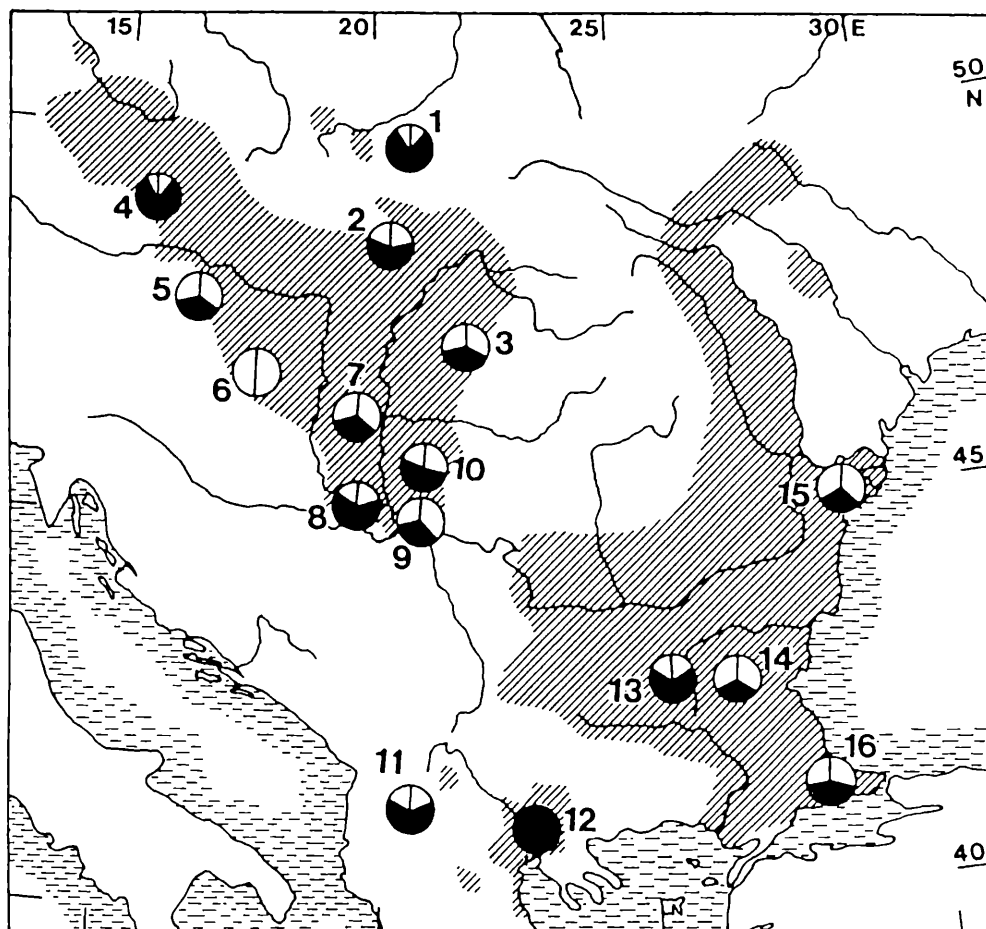


Fig. 18: Geographical variations in Morphological Principal Component 1 of 16 *Spermophilus citellus* localities. The values are proportional to the black area in the pie diagrams, the higher the score, the darker the circle. Open circles represent the smallest sousliks, filled circles represent the largest. Male scores are on the right and female scores are on the left side of individual circles (according to Kryštufek, 1966). The approximate range of the species (shaded) follows Ružić (1978). The geographic samples are listed in Kryštufek (1966).

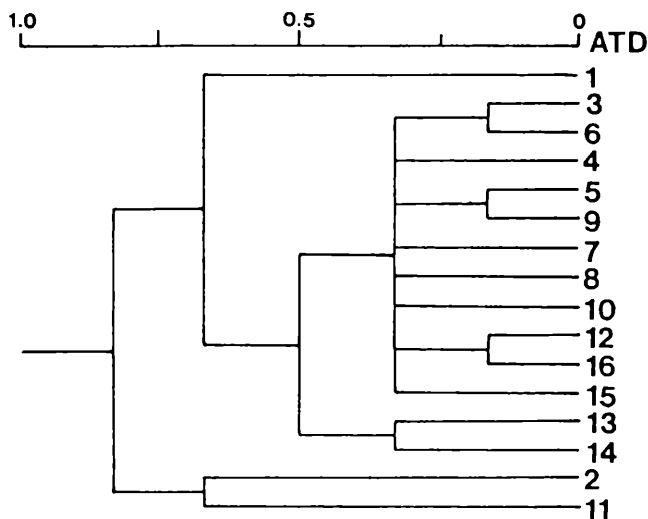


Fig. 19: Consensus tree summarizing ATD matrices for 16 samples of male and female *Spermophilus citellus* (according to Kryštufek, 1966). For sample designation see Fig. 18. ATD - Average taxonomic distance, based on 13 size-adjusted cranial variables.

subspecies. *Citellophilus m. rotundus* Rosický, 1956 is restricted to the Czech Republic, Moravia, eastern Austria, western Hungary, and southern Slovakia, while *C. s. rosicky* Cyprich, 1989 is found in eastern Slovakia (Fig. 20). According to Cyprich (1989) all other populations of both species from the entire range are the nominate subspecies. Cyprich was not familiar with the material from the Mt. Jakupica, where the population is morphologically different from the nominate subspecies. On the basis of 6 males, with narrower and longer fixed and narrower movable processes of the clasper (Fig. 12b), it is not possible to determine whether this material should be recognized as an independent subspecies.

Based on the distribution of *C. simplex* and *C. martinoi* and findings on the variability of *S. citellus* (Kryštufek, 1990, 1996, 1998; Kryštufek & Hrabě, 1996) (Fig. 18 and 19), it may be possible to determine postglacial migrations of *S. citellus* in Central and Eastern Europe. Further conclusions will be possible when molecular analysis of *S. citellus* is performed. They most probably spread in two directions: from the south towards the north and northwest and from the east towards the west. The first group, infested with *C. martinoi*, from central Bulgaria and western Serbia dispersed north to Romania and northwest to Vojvodina, Hungary, Austria, the Czech Republic, Moravia, and Slovakia. The second group is infested with *C. simplex* and spread from southern Ukraine to eastern Slovakia, eastern parts of the Pannonian lowland and to northern, eastern, and southern Bulgaria.

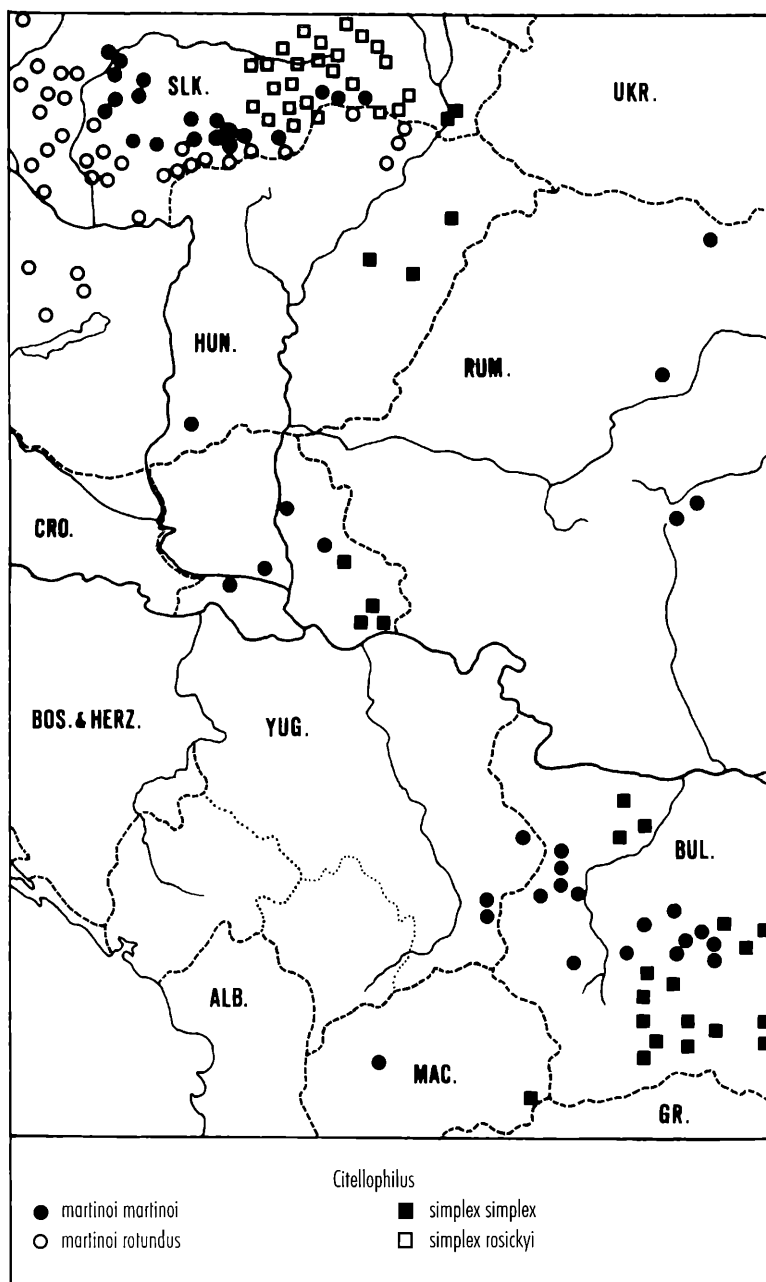


Fig. 20: Southeastern Europe with survey sites of *Citellophilus martinoi* (Wagner & Ioff) and *Citellophilus simplex* (Wagner) (adapted from Cyprich, 1989 and supplemented with new findings of Brelih and Trilar).

Acknowledgements

We would like to thank to academician Professor Bohumír Rosický, Praha, Czech Republic; for donated material, advises and comments. Dr. Georg Džukić, Belgrade, Yugoslavia; Dr. Boris Kryštufek, Ljubljana, Slovenia; Dr. Miroljub Milenković, Belgrade, Yugoslavia; Dr. Boris Petrov, Belgrade, Yugoslavia; Dr. Anka Ružić, Belgrade, Yugoslavia; and Dr. Nikola Tvrčković, Zagreb, Croatia, are thanked for provided material and useful comments. We are very grateful for improvements of our English text and other suggestions by Professor Jim E. Platz (Omaha, Nebraska). The research in Slovenia was partly supported by the Ministry of Science and Technology of the Republic of Slovenia (project J1-7409).

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Received / Prejeto: 12. 7. 2000