

## ***Sphyrotheca* BÖRNER, 1906 and *Szeptyckitheca* gen. n. (Collembola, Symphypleona) from North Korea**

Jean-Marie BETSCH and Wanda M. WEINER

Received : 16 May 2009

Accepted: 1 June 2009

BETSCH J.-M., WEINER W. M. 2009. *Sphyrotheca* BÖRNER, 1906 and *Szeptyckitheca* gen. n. (Collembola, Symphypleona) from North Korea. *Acta zoologica cracoviensia*, **52B**(1-2): 35-44.

Abstract. A new genus *Szeptyckitheca* gen. n. of the subfamily Sphyrothecinae (Collembola, Symphypleona, Sminthuridae) and two new species: *Szeptyckitheca kesongensis* sp. n. and *Sphyrotheca koreana* sp. n. from North Korea are described and illustrated, the genus *Sphyrotheca* BÖRNER, 1906 is redescribed.

Key words: New genus, new species, taxonomy, chaetotaxy, North Korea

J.-M. BETSCH, Muséum national d'Histoire naturelle (MNHN), Department Ecology and Management of Biodiversity, 4, avenue du Petit-Château, F-91800 Brunoy, France.

E-mail: betsch@mnhn.fr

W. M. WEINER, Institute of Systematics and Evolution of Animals (ISEA), Polish Academy of Sciences, Ślawkowska 17, Pl. 31-016 Kraków, Poland.

E-mail: weiner@isez.pan.krakow.pl

### I. INTRODUCTION

The genus *Sphyrotheca* was defined by BÖRNER (1906) for the species *Sminthurus multifasciatus* REUTER, 1881 briefly described from greenhouses in Finland and partially redescribed by SCHÖTT (1893). BÖRNER (1909), who identified also this species on individuals collected in nature (in Japan), did not find a notable difference between the specimens from Finland and Japan. However, according to SCHÖTT (1893), both mucronal edges are smooth in Finnish specimens, whereas the internal edge is slightly and irregularly dentated in specimens from Japan. Thereafter, this species has been noted several times in the South-East Asia, but its diagnosis is still not very clear. BRETTFELD (2000), on a male specimen from Georgia, confirmed these differences and considered this specimen as belonging to *S. multifasciata*. He suggested to rename the Japanese specimens from Ozé National Park and Kyoto, identified by YOSII (1954) as *Sphyrotheca ozeiana* BRETTFELD, 2000 and the specimens from China figured by STACH (1964) as *Sphyrotheca sinensis* BRETTFELD, 2000.

The material collected in North Korea by A. SZEPTYCKI and W. M. WEINER in 1981 and 1985 comprises specimens of the *multifasciata*-group but also specimens which could not be referred to that group. This enabled us to create a new genus *Szeptyckitheca* and to compare its characters with those of *Sphyrotheca*.

The chaetotaxic notation follows BETSCH & WALLER (1994: head, thoracic and abdominal I-IV segments), BETSCH (1997: abdominal VI segment), NAYROLLES (1988: tibiotarsus; 1991: antenna).

**A b r e v i a t i o n s:** Ant.I-IV – antennal segments I-IV, P1-3 – legs 1-3, an. app. – anal appendage.

## II. SYSTEMATIC PART

### *Sphyrotheca* BÖRNER, 1906

Type-species: *Sphyrotheca multifasciata* REUTER, 1881 *sensu* BRETTFELD: 2000.

**D i a g n o s i s.** Sphyrothecinae without mesothoracic vesicle and without cephalic vesicles or tubercles, characterized by complete bothriotrical pattern (A, B, C, D) from second instar, peculiar shape of curved, warty macrochaeta on frontal area (at least part of these macrochaetae) and large abdomen, cephalic seta A1 present, Ant. IV completely subsegmented, trochanteral spine on P3, claw generally with tunica, pair of neosminthuroid setae, anterior dental chaetotaxy limited to 1 distal row of setae + 1 basal seta, mucro with broad subdistal notch. No mucronal seta.

**R e m a r k s.** The genus *Sphyrotheca* includes the following species: *S. sinensis* BRETTFELD, 2000; *S. minnesotensis* (GUTHRIE, 1903) *sensu* BRETTFELD, 2000; *S. nani* CHRISTIANSEN & BELLINGER, 1992, *S. gangetica* YOSII, 1966; *S. dawydoffi* (DENIS, 1948); *S. nanjingensis* BRETTFELD, 1999, *S. koreana* sp. n. The species of doubtful affiliation is *S. ozeiana* BRETTFELD, 2000 (the illustration of the cephalic chaetotaxy by YOSII 1954 is strange and a dissymmetry is perhaps the reason of the abnormal chaetotaxy). The systematic position of *S. coeruleocapitata* BRETTFELD, 2002 and *S. caputalba* BRETTFELD, 2002 will be discussed later. *S. madagascariensis* BETSCH, 1974 is conditionally included to *Sphyrotheca* but a further analysis is needed.

**D i s c u s s i o n.** See under *Szeptyckitheca* gen. n.

### *Sphyrotheca koreana* sp. n.

(Figs 1-13)

**Type material.** Holotype female (K 81-160) in Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland; paratype female (K 81/162) in Muséum National d'Histoire Naturelle, Paris, France.

**Type locality.** North Korea, Kaesong-si province, Chonma-sun (Mountains), valley near Pagjon waterfall (37°04' 126°34'), thin forest near stream, on boulder (holotype), 16-VII-1981; Hwanghae-pukdo province, near Sohung-ho (lake) (38°25' 126°10'), E shore, rich deciduous forest, (paratype) 17-VII-1981, leg. A. SZEPTYCKI & W. M. WEINER.

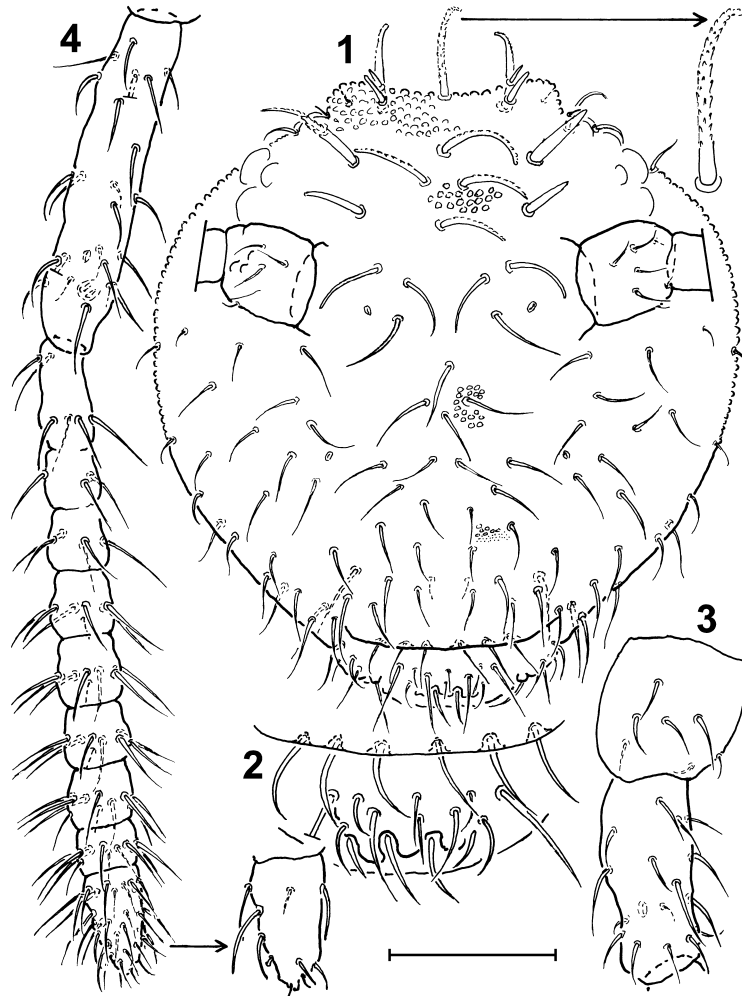
**Other material.** Kangwon-do province, Samil-pho (lake) (38°41' 128°18') poor, thin pins' forest on the granite boulders, rich undergrowth litter, 1 specimen 2<sup>nd</sup> instar (K 81-111), 3-VII-1981; Ryanggang-do province; 790 m a.s.l., ca 6 km south of Pochon (41°33' 128°19'), on basalt rocks, litter, moss from the ledge, 1 specimen 1<sup>st</sup> instar (K 85-39), 6-VII-1985, leg. A. SZEPTYCKI.

**D e s c r i p t i o n.** Body size of adult females: 0.9-1 mm.

**Colour.** Background clear; sides of large abdomen, interocular zone and antennae violet.

**General aspect:** large abdomen globular. On head, except clypeal zone, on dorsal side of large abdomen and 5<sup>th</sup> abdominal segment, the cuticle is covered with heavily elevated secondary granules (diameter up to 5  $\mu$ m).

**Head** (Figs 1-2) with one pair of humps covered with large secondary granules on frontal area. In all instars, axial macrochaetae A1, C1, D1 and pairs of B1, E1, E2 (A1 and E2 being less massive), between eyes and on dorsal area long macrochaetae, thick, curved, warty at convex side, with smooth apex; long pairs (A2 and B2) and short pairs (C2 and D2) as straight spines, sometimes finely dentated apically (B2), with smooth apex; A1 present. Interantennal and clypeal areas cov-

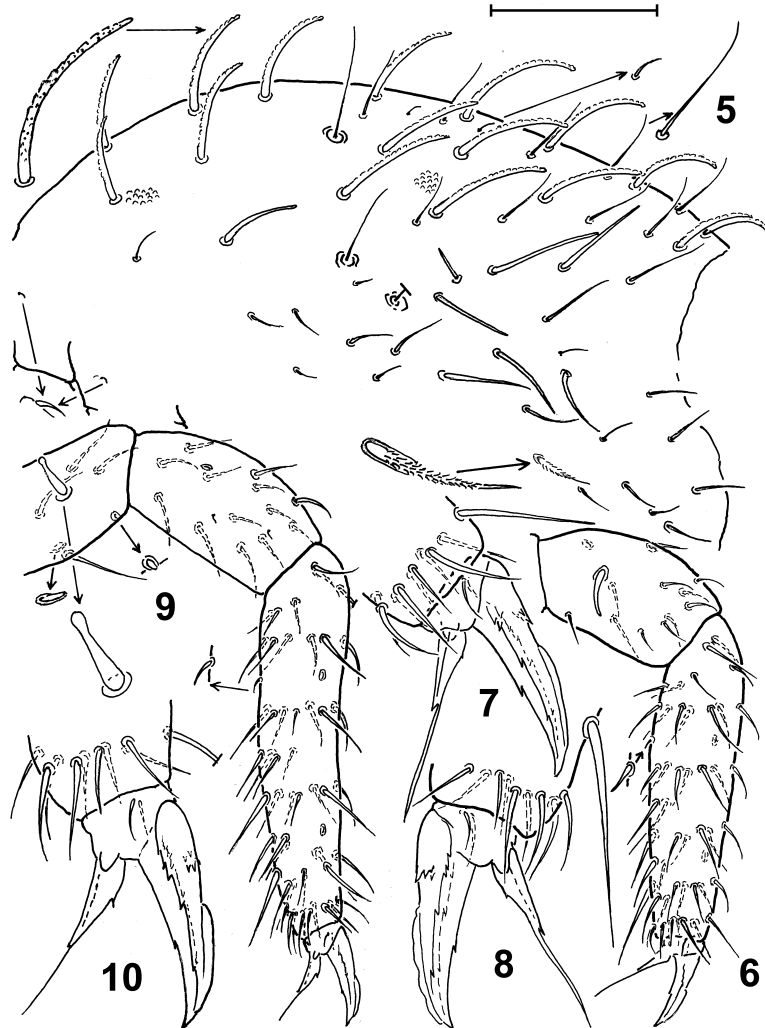


Figs 1-4 – *Sphyrotheca koreana* sp. n. 1 – cephalic chaetotaxy; 2 – labrum; 3 – antennal segments I and II; 4 – antennal segments III and IV (detail of sensilla on distal subsegment). (scale bars: Fig. 1 – 100  $\mu\text{m}$ ; Figs 2, 3 and 4 – 60  $\mu\text{m}$ ).

ered with relatively long, curved setae, apex being smooth on interocular pairs  $\alpha 1$ ,  $\gamma 1$ ,  $\gamma 2$ , pointed on clypeal area; interocular pair and 1 clypeal pair of “oval organ”. Six prelabral setae.

Antennae (Figs 3-4). Antennae relatively short; antennae : head diagonal = 1.51. Ratios of antennal segments I : II : III : IV = 1 : 1.45 : 2.45 : 4.45. Shape of antennae regular. Almost all setae fine, with pointed apex, on Ant. I, II and III; 1 subapical oval organ on Ant. II and Ant. III. Ant. III with one pair of short sensilla in two invaginations situated in common hole and 2 guard sensilla Ant. IV completely subsegmented (1 basal + 7 intermediate + 1 distal subsegments), fully covered with setae in distal half where differentiated almost into whorls composed of 8 setae + 2 sensilla on subsegments 7 and 8; basal zone with reduced chaetotaxy.

Large abdomen (Fig. 5). Trichobothrium D present in 1<sup>st</sup> instar, backward, persistent at all instars; trichobothria A, B and C present since 2<sup>nd</sup> instar. Large abdomen covered with 3 types of setae: long, thick, curved macrochaetae, warty at convex side on thorax III (2 dorsal pairs), on



Figs 5-10 – *Sphyrotheca koreana* sp. n. 5 – large abdomen chaetotaxy; 6 – leg I seen from anterior; 7 – claw and empodium of leg I; 8 – claw and empodium of leg II; 9 – leg III seen from posterior; 10 – claw and empodium of leg III. (scale bars: Fig. 5 – 150  $\mu\text{m}$ ; Figs 6 and 9 – 100  $\mu\text{m}$ ; Figs 7, 8 and 10 – 40  $\mu\text{m}$ ).

abdominal segment I (3 dorsal pairs on median row and 1 pair on posterior row) and on abdominal segments II to IV (11 pairs); long, fine, curved setae dorsally on abdominal segments II to IV, and laterally, from thorax III to abdominal segment IV with some thicker setae behind trichobothrium C; 2 subsagittal short setae behind trichobothrium A (details on Fig. 5). Thorax II without macrochaetae, but with only 1 pair of very small lateral setae, thorax III also with 1 pair of very small lateral setae, both on anterior row. One pair of neosminthuroid setae (detail on Fig. 5), covered with small scale-like specula (RICHARDS 1968), appressed to tegument, with relatively long base (third of the length of the seta); at 1<sup>st</sup> instar, this seta very small, appressed to tegument, but fully developed from 2<sup>nd</sup> instar.

Legs (Figs 6-10). Trochanters with posterior capitate spines. Femur of P1 with anterior spine inserted transversally on long basis. Tibiotarsi with external setae relatively short, curved, except on

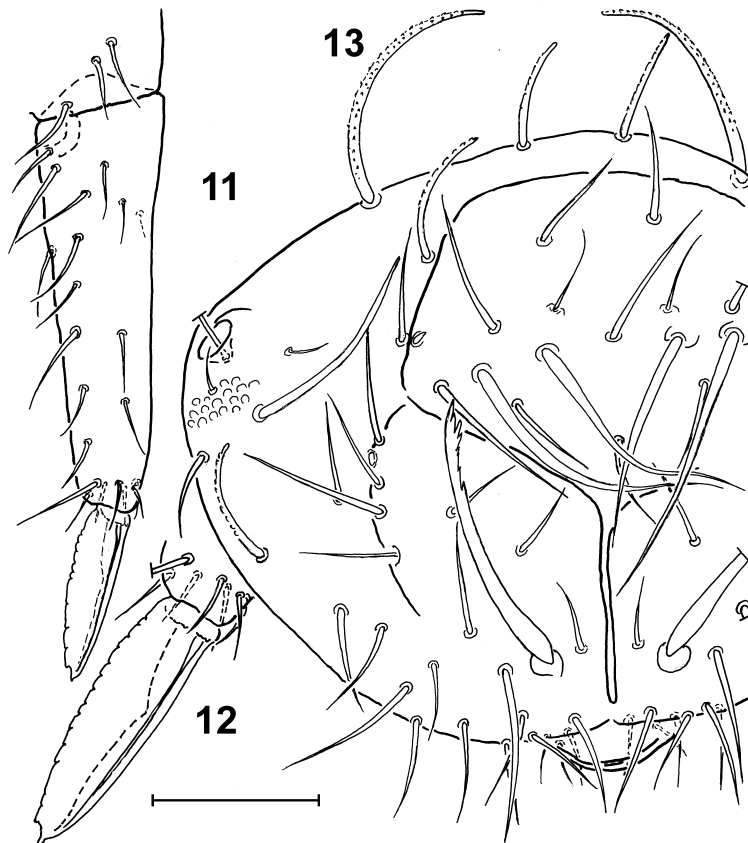
distal whorl with seta Ie linear; internal setae long, pointed, some of them massive; internal seta Vi very short. Claw with tunica, pseudonychia denticulate, 1 tooth on inner crest. On all legs, empodium without basal tooth on inner lamella, with weak tooth on outer lamella. Empodial filament long (length of P3 claw), somewhat thickened and overpassing claw apex on P1 and P2.

Retinaculum. Corpus with 2 setae, pair of basal tubercles, 2 teeth on each ramus.

Furca (Fig. 11). Anterior chaetotaxy reduced to 1 short basal seta and 1 distal row of 2 or 3 setae. Inner chaetae relatively long, not thickened at their basis. Mucro (Fig. 12), 85-90  $\mu\text{m}$  in holotype, outer lamella smooth with constriction, inner lamella toothed with subdistal large notch. No mucronal seta.

Small abdomen (Fig. 13). Chaetotaxy of female abdominal segment VI: among circumanal setae ms1 long and pointed, mps1, mps2 long, thickened and pointed, mpi1, mpi2, mi3 and mi4 relatively long and pointed; ms3 and mi2 fine long sensilla. Anal appendage long (85  $\mu\text{m}$  in holotype), curved and toothed in distal third; ratio an. app.: mucro = 1.

R e m a r k s. *S. koreana* sp. n. is close to *S. multifasciata*, *S. sinensis* and *S. minnesotensis* but it differs from these species by the combination of the following characters: the shape of each cephalic macrochaeta (interocular and frontal areas: A2 and B2 very rough in *S. multifasciata*; C2 and B2 very minute in *S. sinensis*; A1 setaceous in *S. minnesotensis*), of the length of empodial filament



Figs 11-13 – *Sphyrotheca koreana* sp. n. 11 – dens, posterior side; 12 – mucro, posterior side; 13 – chaetotaxy of abdominal segments V and VI of female. (scale bars: Fig. 11 – 100  $\mu\text{m}$ ; Fig. 12 – 40  $\mu\text{m}$ ; Fig. 13 – 60  $\mu\text{m}$ ).

on each leg (shorter on P1 in *S. minnesotensis*, and on P1 and P3 in *S. sinensis*) and of the internal mucronal lamella (smooth or very slightly dentated in *S. multifasciata*).

Two specimens: first instar (K 85-39) and second instar (K 81-111), have to be referred to this species; even if young individuals do not present all the characters of the adults, they inform about the evolution of the trichobothrial pattern and of the neosminthuroid seta.

***Szeptyckitheca* gen. n.**

Type-species. *Szeptyckitheca kesongensis* sp. n.

**D i a g n o s i s.** Sphyrothecinae without mesothoracic vesicle and without cephalic vesicles or tubercles, characterized by complete bothriotrical pattern (A, B, C, D) from second instar, no peculiar shape of cephalic, thoracic and abdominal macrochaetae, cephalic seta A1 often absent, Ant. IV completely subsegmented, trochanteral spine on first and third legs (sometimes also on second leg), pair of neosminthuroid setae, anterior dental chaetotaxy including at least 2 rows of setae (1 distal and 1 or 2 subdistal) + 1 basal seta, mucro with narrow, almost distal, notch. Claw generally with tunica. No mucronal seta.

**R e m a r k s.** The new genus *Szeptyckitheca* includes the following species: *S. boneti* (DENIS, 1948); *S. santiagoi* YOSII, 1959 *sensu* LAWRENCE 1968; *S. formosana* YOSII, 1965; *S. bellingeri* BETSCH, 1965; *S. mucroserrata* SNIDER, 1978; *S. vanderdrifti* DELAMARE & MASSOUD, 1964; *S. machadoi* (DELAMARE & MASSOUD, 1964); *S. implicata* HÜTHER, 1967; *S. coerulea* BRETFFELD, 2005. The species *S. nepalica* YOSII, 1966 needs a re-examination.

**D i s c u s s i o n.** The genus *Sphyrotheca* BÖRNER, 1906 seems to be a heterogeneous taxonomic entity for a long time: the species of the intertropical zone formed a group being different from the type-species *Sphyrotheca multifasciata* described from greenhouses in Finland. Several authors reported the same species from the South-East Asia: BÖRNER 1909 (Central Japan); YOSII 1954 (Japan, Ozé); STACH 1964 (China, Nankin); UCHIDA 1957 (Japan, Hokkaido). In 2000, BRETFFELD revised the *multifasciata*-group and in 2005 indicated in the key the presence of two groups characterized by the anterior dental chaetotaxy: the *multifasciata*-group carrying to the maximum a distal row of setae + a basal seta and an unnamed, second group carrying distally at least 2 rows of setae + a basal seta. Further differentiating characters are: the form of mucro whose distal notch is broad in species of the *multifasciata*-group and narrow in the new genus; the presence of seta A1 (= m1 after BRETFFELD) in *Sphyrotheca*, while in *Szeptyckitheca* seta A1 is lacking in the majority of species in the genus; the shape of cephalic and abdominal (on large abdomen) macrochaetae (curved and warty in the genus *Sphyrotheca* and normal in the new genus), the number of trochanteral spines (one spine on P3 in *Sphyrotheca*, one spine on P1, P3 and sometimes on P2 in the new genus).

***Szeptyckitheca kesongensis* sp. n.**

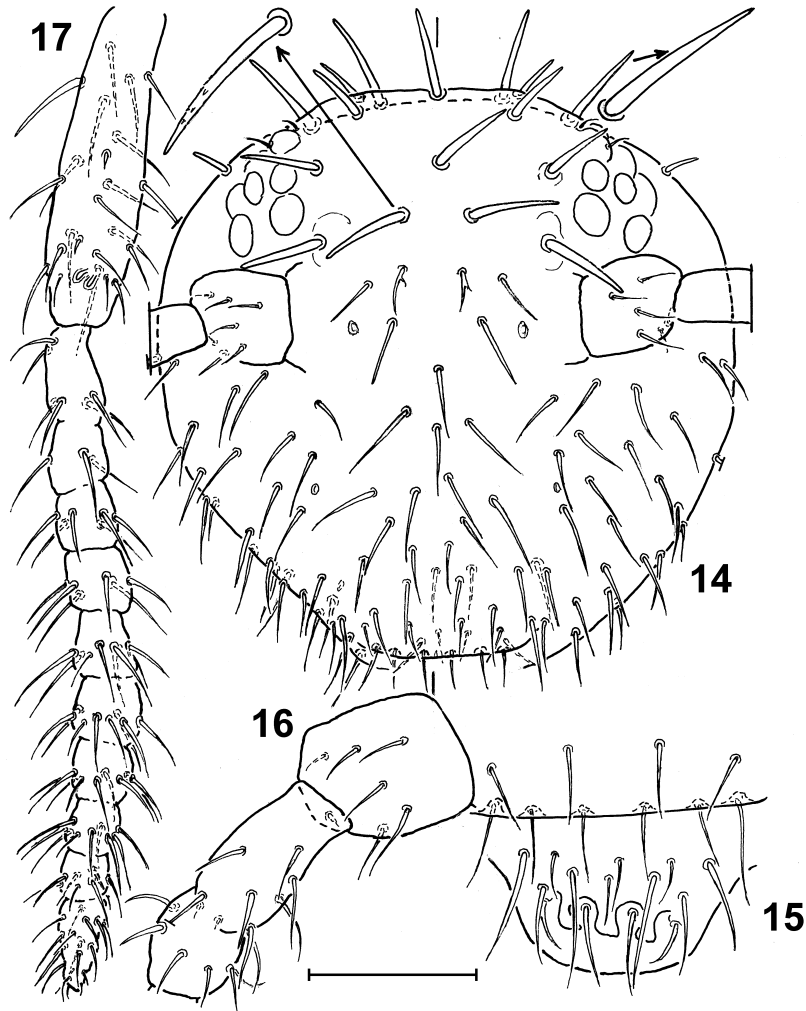
(Figs 14-29)

**Type material.** Holotype adult female (K 81-139/1) in Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland; paratype adult male (K 81-139/2) in Muséum National d'Histoire Naturelle, Paris, France.

**Type locality.** North Korea, Kaesong-si province, about 6 km north of Kaesong (37°58' 126°33'), slope of valley covered with *Robinia*, other shrubs and some scattered pins, plant debris (mainly grasses), 13-VII-1981, leg. A. SZEPTYCKI and W. M. WEINER.

**D e s c r i p t i o n.** Size of adults: holotype female: 1.25 mm; paratype male: 0.85 mm. Colour: discoloured (or very clear).

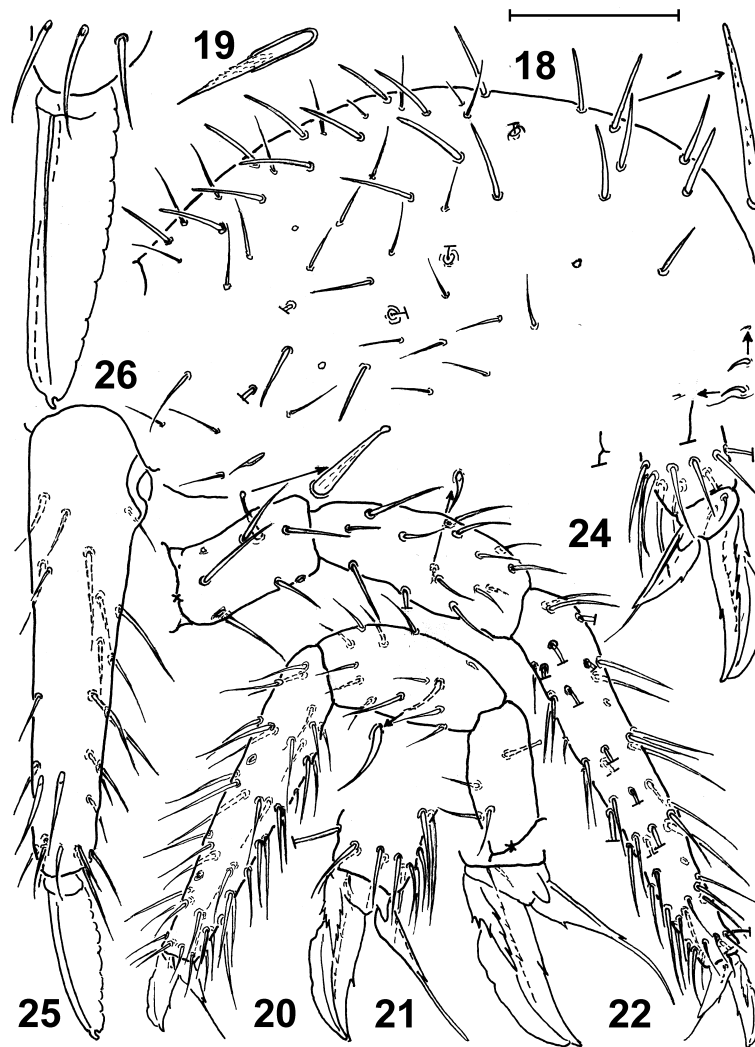
**General aspect:** large abdomen globular. On head, except clypeal zone, on dorsal side of large abdomen and 5<sup>th</sup> abdominal segment, cuticle covered with heavily elevated secondary granules (diameter up to 3 µm). Female specimen with lost Ant. IV on both sides.



Figs 14-17 – *Szeptyckitheca kesongensis* gen. n., sp. n. 14 – cephalic chaetotaxy; 15 – labrum; 16 – antennal segments I and II of female; 17 – antennal segments III and IV of male. (scale bars: Fig. 14 – 100  $\mu\text{m}$ ; Figs 15 and 17 – 50  $\mu\text{m}$ ; Fig. 16 – 60  $\mu\text{m}$ ).

Head (Figs 14-15). Frontal area without humps or vesicles. In all instars, axial macrochaetae C1, D1 and pairs A2, B1, B2, C2, D2, E1, E2, between eyes and on dorsal area long, thick, moderately curved macrochaetae, slightly toothed, with smooth apex; short pairs (C2, D2 and E3) slightly curved spines, with smooth apex; A1 absent. Interantennal area:  $\alpha$ 1 slightly thickened with smooth apex, 1 interocular pair of “oval organ” in  $\alpha$ 2 position,  $\gamma$ 1,  $\gamma$ 2 pointed ( $\gamma$ 2 bifid in female specimen, but not in male specimen; perhaps anomalous). Clypeal area covered with long, slightly curved setae, apex being pointed; 1 clypeal pair of “oval organ”. Six prelabral setae.

Antennae (Figs 16-17). Relatively short, antennal ratios in male – ant. : head diagonal = 1.55; ant. I : II : III : IV = 1 : 1.5 : 2.4 : 5.1; in female – ant. I : II : III = 1 : 1.9 : 2.65. Shape of Ant. II little irregular, with median bulge, 4 somewhat thickened setae (IIBa, IIBai, IIApe, IIAe), 2 minute spines in positions Ap and Api. On Ant. III, 2 minute spines in positions IIIBp and IIIAp, one pair of short

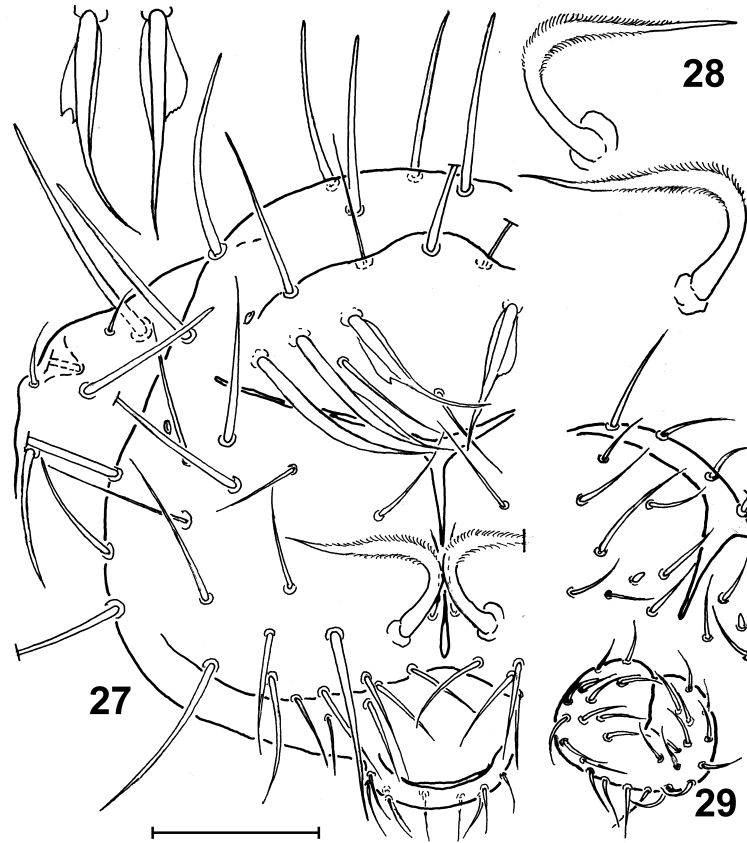


Figs 18-26 – *Szeptyckitheca kesongensis* gen. n., sp. n. 18 – large abdomen chaetotaxy; 19 – neosminthuroid seta; 20 – leg I seen from posterior; 21 – claw and empodium of leg I; 22 – claw and empodium of leg II; 23 – leg III seen from posterior; 24 – claw and empodium of leg III; 25 – dens, anterior side; 26 – mucro. (scale bars: Fig. 18 – 200  $\mu\text{m}$ ; Fig. 20 – 100  $\mu\text{m}$ ; Figs 19 and 23 – 50  $\mu\text{m}$ ; Figs 21, 22, 24 and 26 – 40  $\mu\text{m}$ ; Fig. 25 – 80  $\mu\text{m}$ ).

sensilla in two invaginations situated in common hole and 2 guard sensilla. On Ant. IV, completely (in male) subsegmented (1 basal + 8 intermediate + 1 distal subsegments), almost all chaetae fine, with pointed apex; distal half with whorls composed of 8 setae + 2 sensilla, basal zone with reduced chaetotaxy.

Large abdomen (Fig. 18). Trichobothria A, B and C present in adults (juveniles unknown). Large abdomen covered with 3 types of setae: long, thick, slightly curved macrochaetae, finely toothed on thorax III (2 dorsal pairs), on abdominal segment I (3 dorsal pairs on median row and one pair on posterior row) and on abdominal segments II to IV (13 pairs); long, fine, curved setae dorsally on abdominal segments II to IV, and laterally, from thorax III to abdominal segment IV, with





Figs 27-29 – *Szeptyckitheca kesongensis* gen. n., sp. n. 27 – chaetotaxy of abdominal segments V and VI of female; 28 – anal appendages; 29 – chaetotaxy of abdominal segments V and VI of male. (scale bars: Figs 27 and 29 – 50  $\mu\text{m}$ ; Fig. 28 – 30  $\mu\text{m}$ ).

some thicker setae behind trichobothrium C; 2 subsagittal short setae behind trichobothrium A. Thorax II without macrochaetae, but with only one pair of very small lateral setae (anterior row); thorax III also with one pair of very small lateral setae (anterior row). One pair of neosminthuroid setae (Fig. 19), covered with minute teeth, appressed to the tegument, with relatively long base (half of length of seta).

Legs (Figs 20-24). Trochanter: posterior capitate spine on all legs present. Femur of P1 with anterior spine inserted transversally on long basis, and one, shorter, inserted transversally on P3. Tibiotarsus: all setae relatively long, pointed, except of external setae in distal whorl; internal seta Vi very short. Oval organs: 2 pairs on trochanter II and III, 1 pair on femur I, II, III, 2 pairs on tibiotarsus I, II, III. Claw with well developed tunica, pseudonychia denticulate with 1 tooth on inner crest. Empodium of all legs without basal tooth on its inner lamella, with weak tooth on outer lamella on P1 and P2. Empodial filament fine, shorter than claw on P3, somewhat thickened and overpassing claw apex on P1 and P2.

Retinaculum. Corpus with 2 setae, pair of basal tubercules, 2 teeth on each ramus.

Furca (Fig. 25). Anterior chaetotaxy reduced to 1 short basal seta, 2 rows of: 2 (subdistal row) and 3 setae (distal row). Inner chaetae not thickened at their basis. Mucro (Fig. 26), 83-85  $\mu\text{m}$  on

holotype, outer lamella smooth with little constriction, inner lamella toothed with subdistal minute notch. No mucronal seta.

Small abdomen. Chaetotaxy of female abdominal segment VI (Figs 27-28): among circumanal setae, ms1 long and pointed, mps1, mps2 long, thickened, pointed and bear respectively 2 and 1 wings, mpi3 thickened, pointed, mpi1, mpi2 and mi4 relatively long and pointed; ms3 and mi2 fine long sensilla. Anal appendage (mi5) long (75  $\mu$ m in holotype), strongly curved and finely toothed in the median and distal thirds (detail on Fig. 28); ratio an. app.: mucro = 0.88.

Chaetotaxy of male abdominal segment VI (Fig. 29): 28 setae on genital plate; mi5 short spine, with smooth apex.

**R e m a r k s.** *Szeptyckitheca kesongensis* sp. n. is close to *S. bellingeri* and *S. vanderdrifti*, but differs from them by the shape of macrochaetae on large abdomen, the upper circumanal setae and the anal appendages in female. All these species are characterized by the absence of seta A1 on the head.

#### REFERENCES

- BETSCH J. M. 1997. An ontogenetically focused chaetotaxical scheme in Symphypleona (Collembola): the 6th abdominal segment. *Pedobiologia*, **41**: 13-18.
- BETSCH J. M., WALLER A. 1994. Chaetotaxic nomenclature of the head, thorax and abdomen in Symphypleona (Insecta, Collembola). *Acta Zoologica Fennica*, **195**, 5-12.
- BÖRNER C. 1906. Das System der Collembolen nebst Beschreibung neuer Collembolen des Hamburger Naturhistorischen Museums. *Mitteilungen des Naturhistorischen Museums Hamburg*, **23**: 147-188.
- BÖRNER C. 1909. Japans Collembolenfauna. *Sitzungsberichten der Gesellschaft Naturforschender Freunde*, **2**: 99-135.
- BRETFELD G. 1999. Symphypleona. [In:] W. DUNGER (ed.) – Synopses on Palearctic Collembola. Vol. 2., *Abhandlungen und Berichte des Naturkundemuseums Görlitz*, **71**(1): 1-318.
- BRETFELD G. 2000. Third report on Symphypleona from Russia, and also from Georgia, Kazakhstan, Kirghizia, and the Ukraine (Insecta, Collembola). *Abhandlungen und Berichte des Naturkundemuseums Görlitz*, **72**(1): 1-57.
- BRETFELD G. 2005. Collembola Symphypleona (Insecta) from the Republic of Yemen. Part 2: Samples from the Isle of Socotra. *Abhandlungen und Berichte des Naturkundemuseums Görlitz*, **77**(1): 1-56.
- LAWRENCE P. N. 1968. South Pacific Symphypleona (Collembola). *Pacific Insecta*, **10**(2): 325-340.
- NAYROLLES P. 1988. Chétotaxie tibiotarsale des Collemboles Symphypléones. *Travaux du Laboratoire d'Écobiologie des Arthropodes édaphiques, Toulouse*, **5**(4): 1-19.
- NAYROLLES P. 1991. La chétotaxie antennaire des Collemboles Symphypléones. *Travaux du Laboratoire d'Écobiologie des Arthropodes édaphiques, Toulouse*, **6**(3): 1-94.
- RICHARDS W. R. 1968. Generic classification, evolution and biogeography of the Sminthuridae of the world (Collembola). *Memoirs of the Entomological Society Canada*, **53**: 1-54.
- SCHÖTT H. 1893. Zur Systematik und Verbreitung palaeartischer Collembola. *Kongliga Svenska Vetenskaps-Akademiers Handlingar*, **25**(11): 1-100.
- STACH J. 1964. Materials to the knowledge of Chinese collembolan fauna. *Acta zoologica cracoviensia*, **6**(1): 1-26.
- UCHIDA H. 1957. On some Sminthurid Collembolans from Hokkaidō. *Insecta Matsumurana*, **21**: 22-30.
- YOSHII R. 1954. Sprinschwänze des Ozé-Naturschutzgebietes. [In:] Y. OGURA (ed.) – Ozegahara, *Scientific Researches of the Ozegahara Moor*, Japan Society for the Promotion of Science, Tokyo, 777-830.