

# ***Xenyllodes psammo* sp. n. and *Halisotoma arenicola* sp. n. Two new Norwegian species of psammophilic Collembola (Odontellidae, Isotomidae)**

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Two new species, *Xenyllodes psammo* sp. n. and *Halisotoma arenicola* sp. n., are described from sand dunes and sandy foreshores along the southern coast of Norway. A summary of key characters for separating the world species of *Halisotoma* Bagnall, 1949 is given, as well as a key to the four European species. A new definition of *Halisotoma boneti* (Delamare, 1954) is given based on recent samples from the Black Sea, the Sea of Azov and the Canary Islands.

Key words: Collembola, Odontellidae, Isotomidae, *Xenyllodes*, *Halisotoma*, Norway

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## **Introduction**

New field work along the sandy beaches in the counties Vest Agder and Rogaland in southernmost Norway during 2009 revealed a rich psammophilic Collembola fauna with several species recorded for the first time from Norway and, surprisingly, three species new to science. Two of these species are described in the present paper, the third is published elsewhere (Fjellberg in press).

**Abbreviations.** a, m, p: setae of the anterior (a), median (m) and posterior (p) row on thorax and abdomen; Abd.I–VI: abdominal segments; Ant.I–IV: Antennal segments; Cx: coxa; Fe: femur; ms: microsensillum; PAO: postantennal organ; RY: Rogaland, outer part; Scx: subcoxa; Th.I–III: thoracic segments; Ti.I–III: tibiotarsi of 1.–3. pairs of legs; Tr: trochanter; VAY: Vest Agder, outer part.

## **Genus *Xenyllodes* Axelson, 1903**

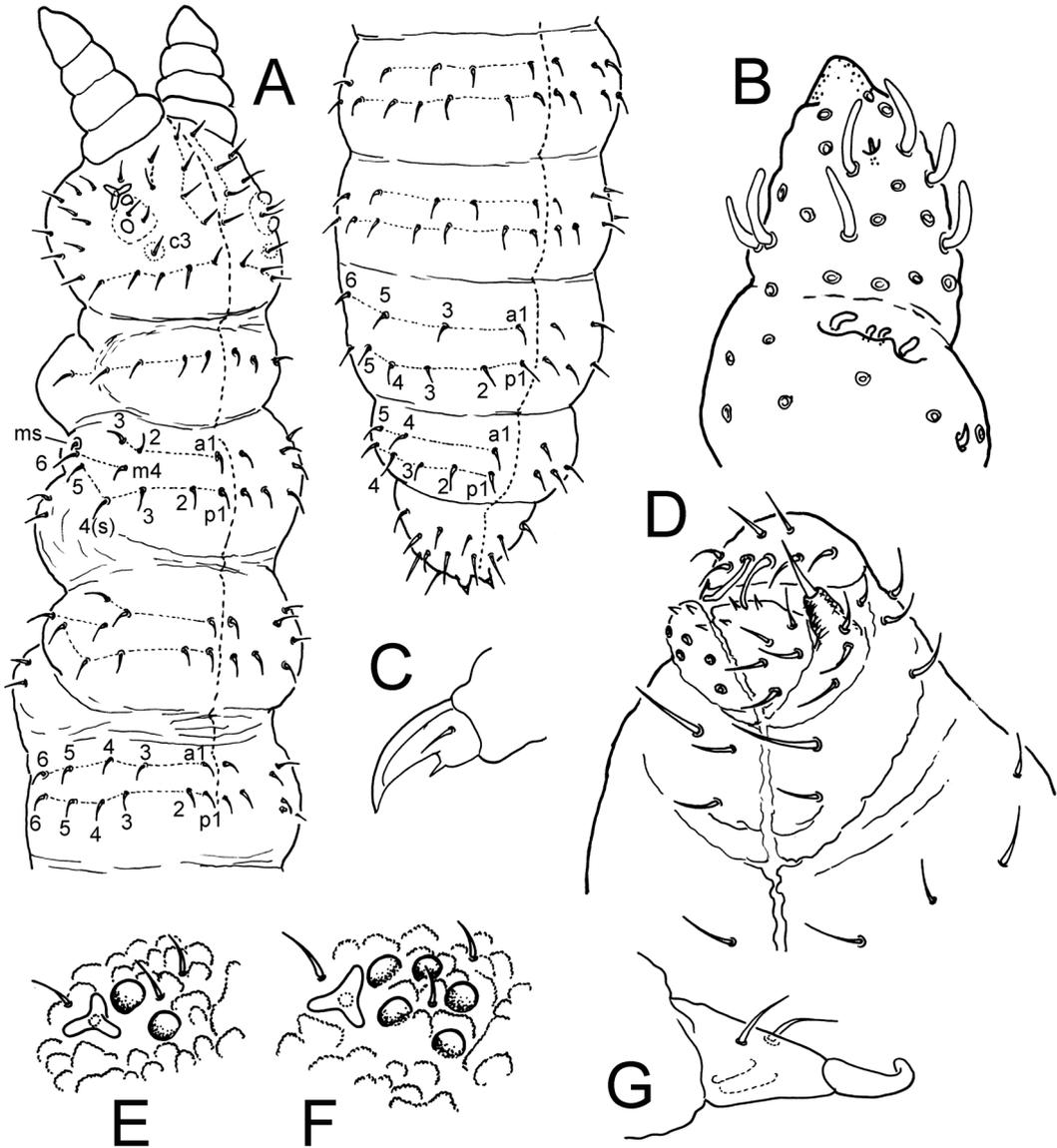
The genus *Xenyllodes* is a small genus with only one known European species, *X. armatus*

Axelson, 1903. Four other species are known from the Neotropic and Nearctic regions: *X. ununguidentatus* Palacios-Vargas & Najt, 1985 (Mexico), *X. wapiti* Fjellberg, 1985 (Canada), *X. mohuitli* Vasquez & Palacios-Vargas, 1986 (Mexico), and *X. palaciosi* Mari Mutt, 1987 (Colombia). The type species of the genus, *X. armatus*, is also known from North America. The new species which is described below, is the only member of the genus having only 2+2 ocelli, apart from the Canadian *X. wapiti*. For separation from this species, see discussion below.

## ***Xenyllodes psammo* sp. n.**

(Figures 1A–E, 1G, 2A)

**Type material.** Holotype (preadult ♂, in slide) and 32 paratypes (2 in slide, 30 in alcohol) from Norway **RY**, Hå: Brusand (lat. 58,53063°, lon. 5,76665°) 10 September 2009, *Ammophila arenaria* (L.) roots in sand dunes at beach front, leg A. Fjellberg 9.315. All types are deposited in the Natural History Museum, Oslo (NHMO). Additional material: Several samples from sand dunes over a distance of about two kilometres

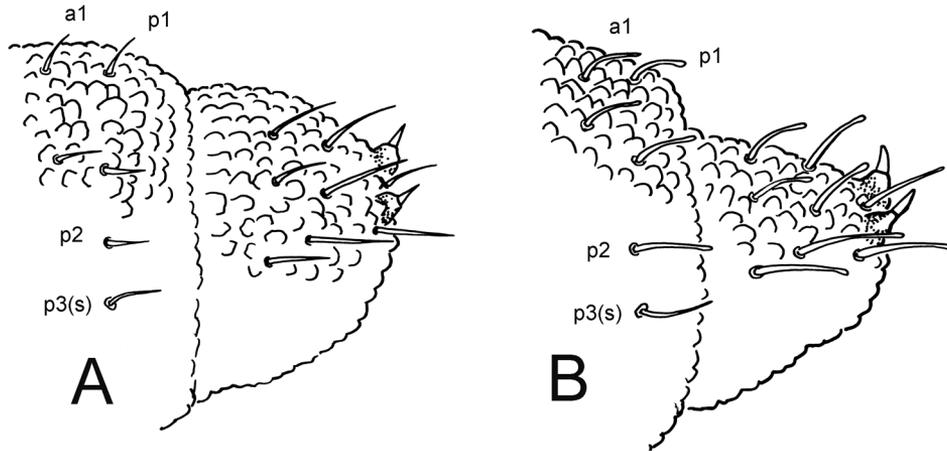


**Figure 1.** *Xenyllodes psammo* sp. n. (A–E, G) and *X. armatus* (F). **A:** chaetotaxy, **B:** sensillary equipment on Ant. III–IV, **C:** claw, **D:** ventral view of mouth region, showing labrum and labium and maxillary palp, **E–F:** postantennal organ and eyes, left side, **G:** dens and mucro.

around the type locality and from the nearby Holmasanden (lat. 58,52464°, lon. 5,77907°) (A. Fjellberg).

**Description.** Body size up to 0,6 mm. Colour pale bluish grey, body almost white. Head slightly darker dorsally, eyespots dark. Body shape short

and thick, with short extremities which is typical for the genus. Ocelli 2+2, PAO with 3 arms (Figures 1A, E). Labrum with 8 setae, 2 prelabrals. Labial complex as Figure 1D, palps with 5 proximal setae and 3 distal spinules. Head ventrally with 2+2 postlabial setae. Maxillary outer lobe with simple palp and no sublobal hairs. Ant.I with



**Figure 2.** Abdominal segments V–VI in *Xenyllodes psammo* sp. n. (A) and *X. armatus* (B).

7 setae, Ant.II with 10–11 setae, Ant.III organ with 4 exposed sensilla, Ant.IV with 7 curved thick sensilla and a blunt apical lobe (Figure 1B). Internal mouthparts not examined, but apparently much reduced which is typical for the genus. Body hairs short, smooth and acuminate. Sensilla and macrochaetae not differentiated. Chaetotaxy as Figure 1A. Head with only one c-setae (c3). The lateral microsensillum (ms) is present on Th.II, absent on Th.III. Seta m1 absent on Th.II–III. Abd.I–III with setae a3–a4 present, on Abd. IV seta a4 absent. Seta p1 on Abd.V shorter than distance between p1–a1 (Figure 2A). Setae at abdominal end acuminate, not blunt-tipped. Anal spines small, pointed. Body granules relatively small, roundish. No ventral setae on thorax. Ventral tube with 3+3 setae. Retinaculum with 2–3 teeth on each side. Furca (Figure 1G) with two setae on dens, mucro curved and blunt. Chaetotaxy of legs as in Table 1. Ti.I–III with 11–11–10 setae. Claws with indistinct lateral teeth, unguiculus short (Figure 1C).

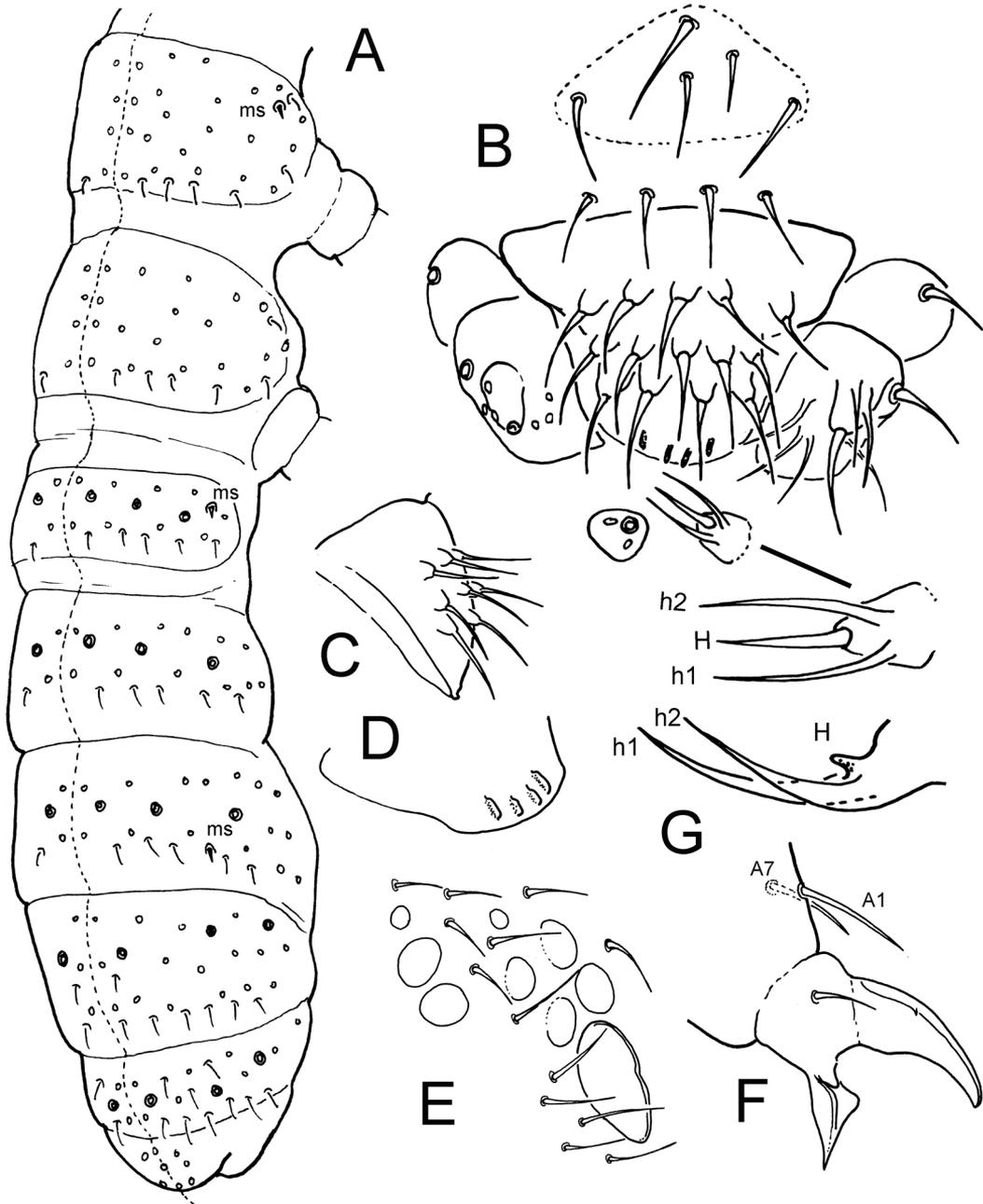
**Discussion.** *Xenyllodes psammo* sp. n. is the only species having 2+2 ocelli (others have 5+5), apart from *X. wapiti* which is described from West Canada. The latter species differs from *X. psammo* by having a more reduced furca (short mucro, dens with one seta only) and a more complete dorsal chaetotaxy (Th.II–III with 3+3 axial setae, m1

present). *X. psammo* is easily mistaken for a pale *X. armatus* until the reduced number of ocelli is noted. When specimens are compared side by side *X. psammo* generally has smaller skin granules and anal spines than *X. armatus*, and body hairs are shorter and not blunt-tipped as in *X. armatus*. In *X. armatus* setae p1 on Abd.V are as long as or longer than distance p1–a1 (Figure 2B), in *X. psammo* they are shorter (Figure 2A).

At the type locality *X. psammo* was regularly collected in sand among roots of *A. arenaria* growing in the active white front dunes along the seashores. It appears to be a member of a genuine psammophilic community and is often associated with species like *Cryptopygus orientalis* (Stach, 1947), *Archisotoma theae* Fjellberg, 1980, *Jesenikia filiformis* Rusek, 1997, *Folsomia*

**Table 1.** Chaetotaxy of the legs in *Xenyllodes psammo* sp. n.

Subsegments	Leg I	Leg II	Leg III
Scx 1	1	2	2
Scx 2	0	0	1
Cx	3	4	5
Tr	5	5	4
Fe	8	8	8
Ti	11	11	10



**Figure 3.** *Halisotoma arenicola* sp. n. (A–F) and *H. maritima* (G). **A:** Sensillary chaetotaxy of a 2-instar juvenile, **B:** frontoclypeal field (encircled), labrum, maxillary outer lobe and hypostomal group (H, h1, h2), **C:** labrum, profile, **D:** apical edge of labrum, **E:** postantennal organ and eye field, right side, **F:** left hind leg, distal part of tibiotarsus, **G:** hypostomal group, note the reduced H.

*bisetosella* Fjellberg, 2005, *Psammaphorura gedanica* Thibaud & Weiner, 1994, *Friesea baltica* Szeptycki, 1964, *Axenyllodes echinatus* Fjellberg, 1988 and *Willemia scandinavica* Stach, 1949. Its congener *X. armatus* is common in damp habitats with high organic content in the back dune area near the type locality.

### Genus *Halisotoma* Bagnall, 1949

The genus *Halisotoma* was erected by Bagnall (1949) to include the species *Isotoma maritima* Tullberg, 1871 (type of the genus, cosmopolitan distribution), *Isotoma poseidonis* Bagnall, 1939 (North Europe), *Isotoma pritchardi* Womersley, 1936 (New Zealand, Australia) and *Parisotoma sindentata* Salmon, 1943 (New Zealand). Bellinger et al. (1996–2009) include four additional species: *Isotoma boneti* Delamare Deboutteville, 1954 (Mediterranean coasts), *Isotoma kainui* Christiansen & Bellinger, 1992 (Hawaii (USA)), *Isotoma marisca* Christiansen & Bellinger, 1998 (California (USA)) and *Parisotoma pacifica* Yosii, 1971 (Japan). The last species is now considered to be a synonym of *I. maritima* (Fauna Europaea 2007). Several of these species are not well known and exact identities are pending on redescriptions and revisions. This is not the place to make a revision of the genus, but enough information has been gathered from original and subsequent descriptions to establish a diagnosis of the new species (see discussion below).

#### *Halisotoma arenicola* sp. n.

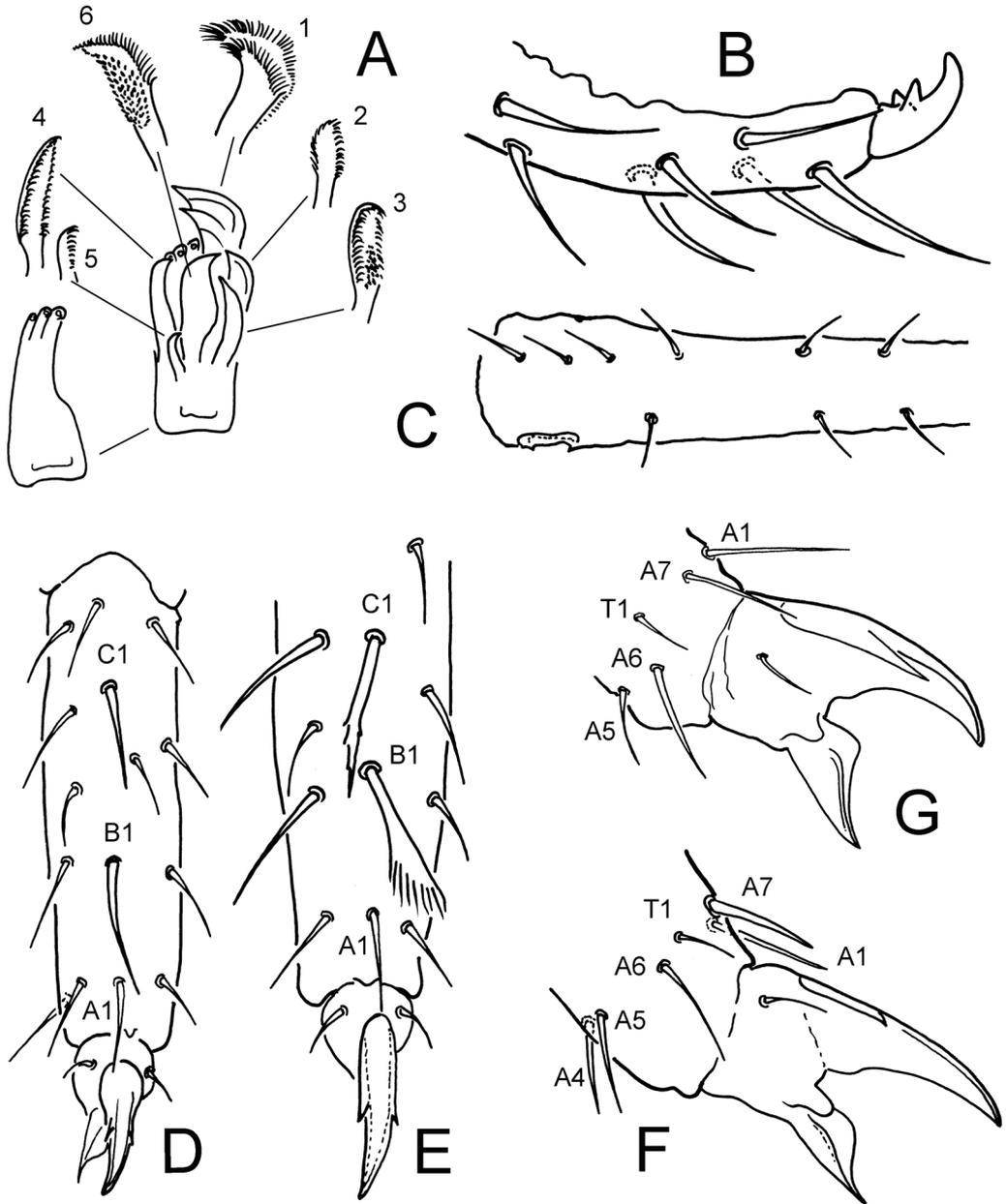
(Figures 3A–F, 4A–D)

**Type material.** Holotype (alc.) and 44 paratypes (30 in alcohol, 14 in slide) from Norway VAY, Farsund: Kviljo-odden, (lat. 58,06657°, lon. 6,70027°) 14 October 2009, among roots of *A. arenaria*, pioneer community on sandy foreshore, leg. A. Fjellberg 9.343. All types deposited in the NHMO. **Additional material.** Several samples from *Ammophila* pioneer vegetation and beds of seaweeds on the sandy foreshores at Ognastranda (lat. 58,51136°, lon. 5,79618°), Holmasanden (lat. 58,52464°, lon. 5,77907°) and Brusand

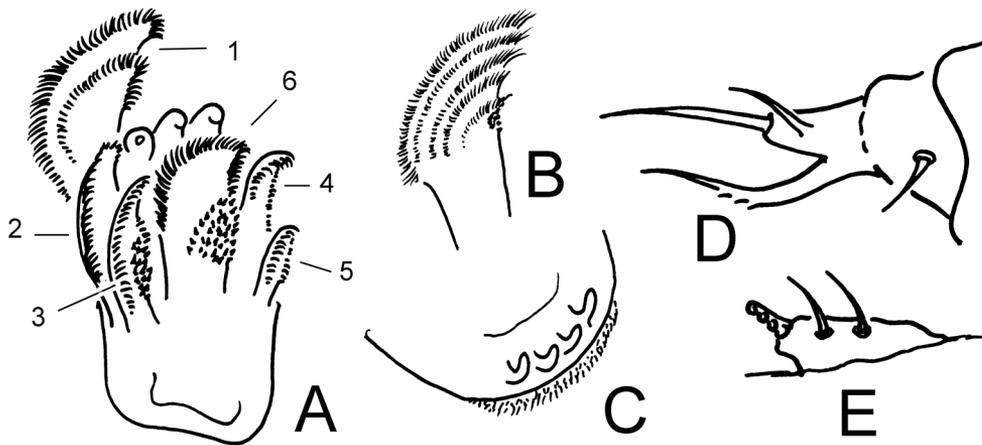
(lat.58,53063°, lon. 5,76665°) in RY Hå (A. Fjellberg).

**Description.** Body size up to 1,2 mm, reproductive individuals from 0,8 mm. Head and body with greyish black pigmentation of variable intensity. Body shape slender with pear-shaped abdomen, typical for the genus. Ocelli 8+8, rather small. Postantennal organ broad oval, about 2,5 as long as diameter of nearest ocellus (Figure 3E). Ant.I with 8–10 hair-like ventral sensilla. Ant.II with a few similar sensilla in lateroapical part. Ant. III organ with freely exposed apical sensilla, of normal size and shape. In addition Ant.III has a few hair-like sensilla in dorsal and outer lateral parts. Ant.IV with many undifferentiated hair-like sensilla. Apical lobes blunt, pin-seta simple. Labrum swollen, with a spiny appearance, with 5-5-4 setae. Prelabral setae 4. Apical edge blunt, with 4 small keel-like papillae (Figures 3C–D). Ventoapical ciliation absent. Frontoclypeus with 4 setae in the central field, large specimens usually with 1–2 additional setae (Figure 3B). Labium unmodified, with a full set of papillae and guards. Guard e7 present, guards b3–4 set close together, with separate roots. Proximal setae 4. Basal fields with 5 median and 5 lateral setae. Hypostomal group normal, H not reduced, h1–2 long and slender (Figure 3B). Head with 5-6 postlabial setae on each side along ventral line. Maxillary outer lobe with trifurcate palp and 4 sublobal hairs. Mandibles normal, strong. Maxilla with 3-toothed capitulum and 6 lamellae (Figure 4A). Lam.1 strongly expanded at apex, with two fringes of long cilia. Lam.2–3 with long ciliation along the margins, Lam.3 in addition with a small denticulate proximal field. Lam.4–5 with long marginal ciliation only. Lam.6 with a single row of long marginal ciliation and a large denticulate field.

Body hairs short and uniform, macrochaetae poorly developed. Median macrochaeta on abd.5 about 1.8 as long as inned edge of last claw. Sensilla in a 2.instar juvenile distributed as 66/55579, in addition there are 10/101 spine-like microsensilla (ms) (Figure 3A). Adults with more unstable number of sensilla on thorax and



**Figure 4.** *Halisotoma arenicola* sp.n. (A–D), *H. boneti* (E–F) and *H. poseidonis* (G). **A:** left maxilla, **B:** mucro and apical part of dens, **C:** dorsal setae in proximal part of dens, **D–E:** left Ti.II, **F–G:** distal part of right Ti.III with claw.



**Figure 5.** *Halisotoma boneti* (A, D–E) and *H. maritima* (B–C). **A:** right maxilla, **B:** maxillary Lam.1, **C:** apical part of labrum, **D:** left maxillary palp, **E:** retinaculum.

abd.4–5, but the 5 sensilla in the p-row on each side of abd.1–3 appear to be constant in number. No ventral setae on thorax. Ventral tube on each side with 3–4 frontal setae and 2 laterodistal setae. Back side with 3–4 setae. Retinaculum with up to 9 setae in large specimens. Manubrium with blunt ventroapical teeth and 2+2 short ventroapical setae. Dens almost invariably with 9 dorsal setae in proximal half (Figure 4C). Ventral setae on dens numerous, the apical seta prolonged but hardly beyond tip of mucro. Mucro 3-toothed with small proximal teeth (Figure 4B). Tibiotarsi with 8 setae in the apical whorl (A1–7, T1). On Ti.III seta A7 shorter than A1, not thickened (Figure 3F). Seta A6 slightly thicker than others. Ti.II without differentiated outer setae, all smooth and

pointed (Figure 4D). Claws with almost invisible lateral teeth, inner tooth absent (Figure 3F). Males present, reproductive from about 0.8 mm size.

**Discussion.** The new species differs from the two other North European species by lack of feathered tib.2 setae and details of the mouthparts. *H. maritima* and *H. poseidonis* both have serrated and apically expanded outer setae (B1 and C1) on tib.2, while the corresponding setae are simply pointed in *H. arenicola* (Figure 4D). Labrum in *H. arenicola* is apically blunt without ventral ciliation (Figure 3C), while the other two species have labrum apically upturned with a clear ventroapical ciliation. The maxilla of *H. arenicola* is much like that of *H. poseidonis*, in particular by having

**Table 2.** Diagnostic characters of *Halisotoma*

Characters	<i>arenicola</i>	<i>poseidonis</i>	<i>maritima</i>	<i>boneti</i>	<i>pritchardi</i>	<i>sindentata</i>	<i>kainui</i>	<i>marisca</i>
Formula ms Th.II-Abd.III	10/101	11/111	11/111	11/111	?	?	?	?
Frontotype setae	4-7	>10	>10	>10	?	?	?	?
PAO/eye	2.5	1.5	2.0-3.0	1.4	1.0-1.5	4.0	1.0-1.5	2.0
Ti.II serrated setae	0	2	2	1(2)	?	?	?	?
Max.lam.1 ciliated fringes	2	2	5-6	2	?	?	8	?
Ant.I-II corner tooth present	No	No	Yes/No	No	?	?	?	Yes
Hypostomal H reduced	No	No	Yes	No	?	?	?	?
Retinacular setae (max)	9	5	9	2	?	?	?	?
Labral edge ciliated	No	Yes	Yes	Yes	?	?	Yes	No (?)
Ti.III A7 thicker than A1	No	No	Yes	Yes	?	?	?	?
Shape of labral edge	4 low ridges	4 low ridges	4 finger-like pap.	4 low ridges	-	-	4 low ridges	4 low ridges
Max. size, mm	1.2	2.5	1.7	1.4	1.8	1.5	?	?
Labial guards b3-b4 with common root	No	No	Yes	No	?	?	?	?
Distribution	Norway	N.Europe	Cosmopolitan	S.Europe	Australia, New Zealand	New Zealand	Hawaii	California



**Figure 6.** Kviljo-odden in Hå, Rogaland. Type locality of *Halisotoma arenicola* sp.n. which occurred in high numbers among roots and organic debris in the foreground pioneer vegetation of *Ammophila arenaria* and *Cakile maritima*. Associated species were *Archisotoma theae* and *Hypogastrura viatica*.

only two fringes of cilia on Lam.1 (*H. maritima* has 5–6 fringes, Figure 5B). It differs from *H. poseidonis* in having only one apical fringe of cilia on lam.6 (Figure 4A), while *H. poseidonis* has 3–4 apical fringes in addition to the denticulate field. The central frontoclypeal field in *H. arenicola* at most have 7 setae (Figure 3B), while this field is densely pilose in large *H. maritima*/*H. poseidonis*. A decisive diagnostic character is the absence of spine-like microsensilla on Th.III and Abd. II in *H. arenicola* (Figure 3A). In the other two species these sensilla are present (formula of ms as 11/111).

*H. arenicola* is much smaller (max. 1.2 mm) than *H. maritima* (max 1.7 mm) and *H. poseidonis* (max.2.5 mm) and becomes reproductive at a very small size (0.8 mm). Also it differs in habitat choice from the two others. While *H. maritima*/*H. poseidonis* are typically found among decaying seaweeds and under stones in the littoral zone of seashores with coarse substrate and high organic content, all samples of *H. arenicola* are from very exposed sandy seashores where it occurred among plant roots of pioneer communities (*Ammophila* (L.) Link, *Cakile* Mill., *Atriplex* L.) and in buried decaying seaweeds deposited high up on the shore (Figure 6). The lower littoral zone of these

beaches is apt to very hard wave action and the only Collembola regularly found there are stray individuals of *Hypogastrura viatica* (Tullberg, 1872). *H. arenicola* lives higher up on the beach and is usually associated with *Archisotoma theae* and *Hypogastrura viatica*.

The fourth European species, *H. boneti*, is not well known. Potapov (2001) gives as the only diagnostic character the presence of one expanded and serrated outer seta on Ti.II, whereas *H. maritima* has two such setae. This character, however, is not sharp as *H. maritima* may have either one (B1) or two (B1, C1), partly depending on size of the animal. I have at my hand several samples of a characteristic *Halisotoma* from the shores of Black Sea (W and E Crimea), Sea of Azov (Berdyansk Spit) and Canary Islands (Tenerife) which mostly have only one, rarely two, expanded/serrated seta on Ti.II (Figure 4E). This species is probably identical to the Mediterranean *H. boneti*. It comes close to *H. poseidonis*, sharing the same type of maxilla (only two ciliated fringes on Lam.1), labrum (4 low ridges, ventroapical ciliation present), labial palp (guards b3-b4 with separate roots) and hypostomal group (H not reduced). All these characters differ from *H. maritima* (Table 2). Unlike *H. poseidonis* it has

**Table 3.** Key to European species of *Halisotoma* Bagnall, 1949

1. Labrum with 4 low ridges (Figure 3D). Maxillary Lam.1 with two ciliated fringes (Figure 4A). Hypostomal seta H not reduced, almost as long as h1-h2 (Figure 3B).....	2
- Labrum with 4 finger-like projections (Figure 5C). Maxillary Lam.1 with 5-6 ciliated fringes (Figure 5B). Hypostomal seta H reduced to a small pailla (Figure 3G).....	<i>H. maritima</i> (Tullberg, 1871)
2. Microsensilla present on all segments Th.II-Abd.III (ms formula 11/111). Frontoclypeal field in adults with more than 10 setae.....	3
- Microsensilla absent from Th.III and Abd.II (ms formula 10/101, Figure 3A). Frontoclypeal field usually with only 4 setae (sometimes 1-2 additional, Figure 3B).....	<i>H. arenicola</i> sp.n.
3. Retinaculum in adults with more than two setae. Ti.III with seta A7 slender, not thicker than A1 (Figure 4G). Maxillary palp with lower branch slender. Claws strongly curved, with large lateral teeth (Figure 4G).....	<i>H. poseidonis</i> (Bagnall, 1939)
- Retinaculum in adults with two setae (Figure 5E). Ti.III with seta A7 thicker than A1, claws normal, lateral teeth small (Figure 4F).....	<i>H. boneti</i> (Delamare, 1954)

a thickened seta A7 on Ti.III (Figures 4F-G). Unique characters are presence of only two setae on retinaculum (Figure 5E) and a strongly enlarged and sometimes serrated lower branch on the maxillary palp (Figure 5D). Table 2 summarizes some key characters for all recognized species of *Halisotoma*.

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