

Hypotrachs (Ciliophora, Hypotrichida) from Ullŭng Island, Korea

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The seven hypotrachs inhabiting the representative aquatic and terrestrial habitats of Ullŭng Island, *Holosticha sylvatica*, *Gonostomum affine*, *Histiculus cavicola*, *H. muscorum*, *Stylonychia mytilus*, *Aspidisca ciccada* and *Euplotes muscicola* are discovered for the first time from Ullŭng Island. Of these, two species of *Gonostomum affine* (Stein, 1859) and *Euplotes muscicola* Kahl, 1932 are newly recorded from Korea. The total seven species are listed and two newly recorded species from Korea are redescribed with illustrations.

KEY WORDS: Hypotrachs Fauna, Hypotrichida, Redescription, Ullŭng Island, Korea

The hypotrachs from Ullŭng Island have not been studied up to now. In the present study, seven hypotrachs were identified. Of these, two species of hypotrachs are discovered for the first time from Korea. We present the list of all hypotrachs from Ullŭng Island and redescribe the two hypotrachs new to Korea with illustrations.

The present study was based on the specimens collected in Ullŭng Island during the periods from August 1992 to October 1993. The collectings were performed from representative aquatic and terrestrial habitats such as streams, roadside ditches, mosses, forests, grasslands and cultivated field. Laboratory cultures were maintained in a commercial mineral water provided with boiled wheat grains and shrimp meats for supplying fungal and bacterial nutrients of hypotrachs.

The shapes of the live specimens on slides were drawn without covering of cover slips. The infraciliature was observed by using the modified protargol method (Wilbert, 1975; Shin and Kim, 1993). The drawings of the impregnated specimens were made with the aid of a drawing tube. Biometrical analysis was performed using

the methods described in Sokal and Rohlf (1981). We adopted the classification schemes established by Small and Lynn (1985) and Lynn and Corliss (1991).

Results

Phylum Ciliophora Doflein, 1901 有毛門

Class Polyhymenophora Jankowski, 1967 多膜綱

Order Hypotrichida Stein, 1859 下毛目

Family Holostichidae Fauré-Fremiet, 1961 全列下毛科

Genus *Holosticha* Wrzesniowski, 1877 全列下毛蟲屬

1. *Holosticha sylvatica* Foissner, 1982 森林全列下毛蟲

Material examined: 10 inds., Tonggumi, Aug. 8, 1992; 9 inds., Chŏdong, Jun. 21, 1993; 7 inds., Hyŏnp'o, Jun. 22, 1993; 5 inds., Tonggumi, Oct. 7, 1993.

Remarks: This species lives in moss-covered soils.

Family Oxytrichidae Fauré-Fremiet, 1961 尖毛
下毛科

Genus *Gonostomum* Sterki, 1878 角口下毛蟲
屬 (新稱)

*2. *Gonostomum affine* (Stein, 1859) 近接
角口下毛蟲 (新稱) (Fig. 1, Table 1)

Oxytricha affinis Stein, 1859 (cited from
Maeda and Carey, 1984)

Plagiotricha (Gonostomum) affinis Kent, 1882
(p.772, pl. 43, fig. 25)

Gonostomum andoi Shibuya, 1929 (p. 156,
fig. 2)

Gastrostyla affine Borror, 1972 (p. 14)

Trachelostyla affine Buitkamp, 1977 (p. 123,
fig. 7)

Gonostomum affine: Wenzel, 1953 (p. 109,
figs. 19-21); Stiller, 1974 (p. 89, figs. 55A-B);
Foissner, 1982 (p. 77, figs. 18a-i, table 17);

Maeda and Carey, 1984 (p. 9, fig. 3); Dragesco
and Dragesco-Kernéis, 1986 (p. 453, figs. 133c,
e, i)

Material examined: 8 inds., Todong, Aug. 7,
1992; 10 inds., Tonggumi, Aug. 8, 1992; 5 inds.,
T'aeha, Aug. 9, 1992; 6 inds., Sömmok, Aug. 10,
1992; 5 inds., Sömmok, Jun. 22, 1993; 15 inds.,
Chukto, Jun. 24, 1993; 8 inds., Chödong, Oct. 8,
1993. Of these, eight protargol impregnated
specimens were analyzed biometrically and their
data were summarized in Table 1.

Description: General morphology and behavior:
Body soft and flexible, elongate or long oval
in shape, flattened dorso-ventrally, ranging from 80-
120 μm long and 20-60 μm wide *in vivo*; anterior
and posterior ends narrowed and slightly pointed;
anterior part of left body margin oblique and
slightly concave; dorsal surface convex. Movement

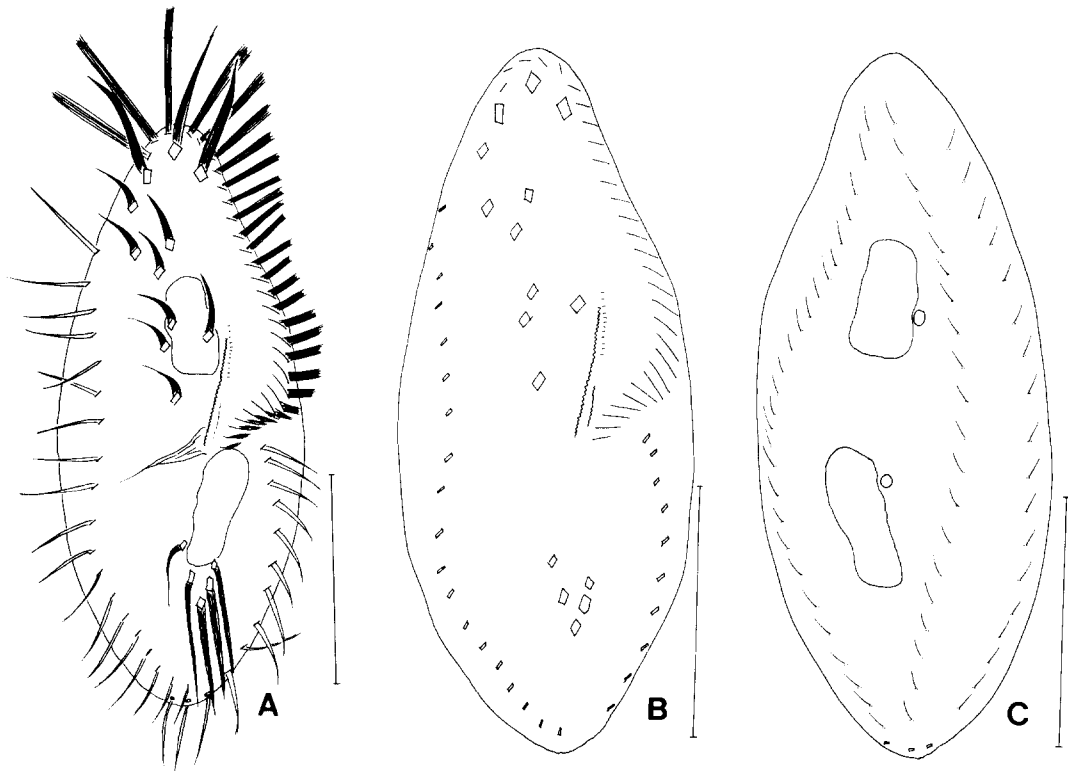


Fig. 1. *Gonostomum affine* (Stein, 1859): A, live specimen, ventral view. B, infraclitature after protargol impregnation, ventral view. C, infraclitature after protargol impregnation, dorsal view (Scale bar = 30 μm).

rapid and its direction changing frequently.

Frontal and buccal fields: Three frontal cirri (FC) large and prominent, located at ventral surface of anteriormost part; seven frontoventral cirri (FVC) arranged as 2+2+2+1 cirral pattern at right side of buccal field; one buccal cirrus (BC) located at anteriormost point of paroral membrane. Adoral zone of membranelles (AZM) of 33-49 μm long with 22-29 prominent adoral membranelles (AM), covering approximately 48% of body length, chiefly confined to left side of anterior lateral margin, bending abruptly inwards at buccal cavity and terminating near center of body. Buccal field deep, comprising of endoral membrane (EM) and paroral membrane (PM), 7-11 μm and 12-16 μm long, respectively; EM bearing approximately 11 cilia. Pharyngeal fibers (PF) at base of buccal field extending to near right margin of body and 9-14 μm long.

Somatic infraciliature: No ventral cirri near transverse cirri (VCnTC); posterior region of ventral surface bearing four J like TC and extending beyond posterior end of body. Three caudal cirri (CC) located on dorsal surface of posterior end between right marginal cirri (RMC) and left marginal cirri (LMC). Both rows of marginal cirri extending almost to posterior end and not confluent posteriorly; RMC beginning near second anteriormost frontoventral cirri and bearing 14-20 cirri; LMC beginning at region beneath 1st-2nd AM and bearing 8-14 cirri; number of RMC more than LMC by six. Dorsal surface bearing three dorsal kineties (DK); mid-dorsal kinety with approximately 18 cilia; cilia on dorsal surface bristle-like, approximately 5 μm long, some of them more or less shortened.

Nuclear organelles with two oval macronuclei (Ma), 13-20 μm long and 5-9 μm wide; two micronuclei (Mi) spherical, approximately 2 μm in diameter. Contractile vacuole spherical, positioning near middle of left margin of body, on diastole bearing one collecting canal.

Discussion: This species is very similar to three hitherto known species of the same genus, *Gonostomum kuehnelti* Foissner, 1987, *G. spirotrichoides* Gellért, 1956 and *G. bryonicolum* Gellért, 1956 with respect to the shape of body and adoral zone of membranelles,

and pattern of ventral cirri. The present species can be distinguished from the above mentioned species by the following characteristics. (1) This species has two macronuclei, while *G. kuehnelti* has 14. (2) This species has three caudal cirri, while *G. spirotrichoides* and *G. bryonicolum* have two. (3) This species has three dorsal kineties, while *G. bryonicolum* has four (Gellért, 1956; Buitkamp, 1977; Foissner, 1982, 1987; Maeda and Carey, 1984).

As a part of the biometrical data (Table 1), the coefficients of variation (CV) were calculated. The following characters showed the CV of 0.00: the numbers of macronucleus, dorsal kinety, buccal cirri, frontal cirri, frontoventral cirri and caudal cirri. Thus these characters are found to be very constant and considered as the important diagnostic features of this genus. Comparatively low CV ranging from 8.27 to 10.64 were shown in the following characters: the numbers of adoral membranelles and transverse cirri, and diameter of micronucleus, and length of body and undulating membrane. These characters are very important for identification of the species because of their low variability. Other characters showed fairly high value of CV ranging from 11.20 to 28.87.

Genus *Histiculus* Corliss, 1960 組織下毛蟲 屬
3. *Histiculus cavicola* (Kahl, 1935) 四核組織下毛蟲

Material examined: 7 inds., Ch'önbu, Jun. 22, 1993; 5 inds., Hyönp'o, Jun. 22, 1993; 15 inds., Ch'önbu, Oct. 8, 1993; 7 inds., Hyönp'o, Oct. 8, 1993.

Remarks: This species lives in cultivated fields.

4. *Histiculus muscorum* Kahl, 1932 藓苔組織下毛蟲

Material examined: 10 inds., Tonggumi, Aug. 8, 1992; 6 inds., T'aeha, Aug. 9, 1992; 5 inds., Todong, Jun. 21, 1993; 7 inds., Hyönp'o, Jun. 22, 1993; 5 inds., Chödong, Jun. 21, 1993; 4 inds., Todong, Oct. 7, 1993; 5 inds., Chödong, Oct. 8, 1993.

Remarks: This species lives in mosses or moss-covered soils.

Genus *Stylonychia* Ehrenberg, 1830 尾棘下毛蟲屬 (新稱)

5. *Stylonychia mytilus* (Müller, 1773) 貝形尾棘下毛蟲 (新稱)

Material examined: 5 inds., Chödong, Jun. 21, 1993; 7 inds., Hyönp'o, Jun. 22, 1993.

Remarks: This species lives in streams or roadside ditches.

Family Aspidiscidae Ehrenberg, 1838 防牌下毛蟲科 (新稱)

Genus *Aspidisca* Ehrenberg, 1830 防牌下毛蟲屬 (新稱)

6. *Aspidisca ciccada* Kahl, 1932 背肋防牌下毛蟲 (新稱)

Material examined: 5 inds., Hyönp'o, Jun. 22, 1993; 5 inds., Ch'önbu, Jun. 22, 1993; 8 inds., Mt. Sönginbong, Jun. 23, 1993.

Remarks: This species lives in water submerged mosses or liverworts.

Family Euplotidae Ehrenberg, 1838 자라下毛蟲科 (新稱)

Genus *Euplotes* Ehrenberg, 1831 자라下毛蟲屬 (新稱)

***7. *Euplotes muscicola* Kahl, 1932** 이끼자라下毛蟲 (新稱) (Fig. 2, Table 2)

Euplotes muscicola Kahl, 1932 (p. 212, figs. 49-55, table 8); Curds, 1975 (p. 46, figs. 46a-c); Foissner, 1982 (p. 121, figs. 37a-e, 81, 84, table 28)

Material examined: 10 inds., Todong, Aug. 7, 1992; 5 inds., Hyönp'o, Jun. 22, 1993; 5 inds., Ch'önbu, Jun. 22, 1993. Of these, eight protargol impregnated specimens were analyzed biometrically and their data were summarized in Table 1.

Description: General morphology and behavior: Body stiff and inflexible, oval or ellipsoidal, flattened dorso-ventrally, ranging from 55-70 μm long and 40-45 μm wide *in vivo*; anterior and posterior ends broadly round; ventral surface flattened and slightly concave; dorsal surface convex and ridged with nine kineties; anterior and posterior part thin. Movement slow to rapid, sometimes gliding and rotating around long axis of body.

Frontal and buccal fields: Five frontal cirri (FC)

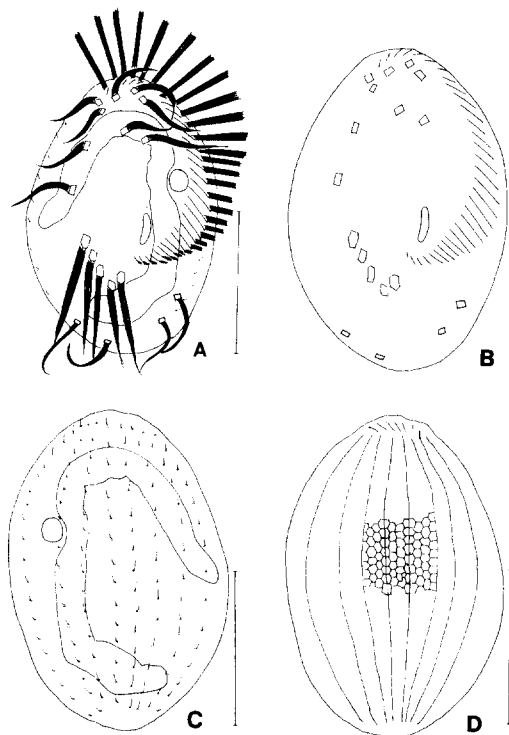


Fig. 2. *Euplotes muscicola* Kahl, 1932: A, live specimen, ventral view. B, infraciliature after protargol impregnation, ventral view. C, dorsal kineties and nuclear state, dorsal view. D, silver line system, dorsal view (Scale bar = 30 μm).

enlarged and prominent, located at ventral surface of anterior most part; four frontoventral cirri (FVC) located ventral surface beneath FC. Adoral zone of membranelles (AZM) with 25-31 very prominent adoral membranelles (AM), 37-45 μm long, covering approximately 71% of body length. Buccal field large, comprising very short undulating membrane (UM) of 7-12 μm long. Posterior region of ventral surface bearing five transverse cirri (TC) and each TC very prominent and extending beyond posterior end of body; distance between 2nd and 3rd TC 1-2 μm long.

Somatic infraciliature: Four caudal cirri (CC) located on dorsal surface of posterior border and very conspicuous *in vivo*. Dorsal surface bearing nine dorsal kineties (DK); mid-dorsal kinety with 20-30 cilia; cilia on dorsal surface bristle-like, approximately 5 μm long, some of them more or less shortened; dorsal argyrome multiple type with

Table 1. Biometrical characterization of *Gonostomum affine* (upper line) and *Euplotes muscicola* (lower line). All data were based on protargol impregnated specimens. The abbreviations in the table are the same as in the description except statistical terms (Max.: maximum; Min.: minimum; SD: standard deviation; SE: standard error; CV: coefficient of variation in %; n: population size).

CHARACTERS	Mean	Median	Max.	Min.	SD	SE	CV(%)	n
Body length	83.13	83	97	73	6.88	2.43	8.27	8
	58.00	56	67	52	4.63	1.64	7.98	8
Body width	31.88	28.5	52	24	8.87	3.14	27.83	8
	40.00	40	44	37	2.14	0.76	5.35	8
Body length/width	2.71	2.81	3.19	1.9	0.43	0.15	15.74	8
	1.45	1.44	1.55	1.37	0.06	0.02	4.34	8
AZM length	40.25	39	49	33	5.55	1.96	13.79	8
	41.25	41	45	37	2.55	0.90	6.18	8
Body length/AZM length	2.09	2.13	2.48	1.8	0.22	0.08	10.64	8
	1.41	1.40	1.49	1.33	0.06	0.02	4.01	8
UM length	19.63	19.5	23	18	1.77	0.63	9.01	8
	8.19	7.75	12	7	1.69	0.60	20.63	8
UM/AZM length	0.49	0.5	0.61	0.4	0.07	0.02	13.21	8
	0.20	0.19	0.27	0.17	0.04	0.01	18.03	8
Ma length	17.13	17.5	20	13	2.64	0.93	15.43	8
	-	-	-	-	-	-	-	-
Ma width	6.31	6	9	5	1.28	0.45	20.28	8
	7.00	7	9	6	1.20	0.42	17.07	8
Mi diameter	2.06	2	2.5	2	0.18	0.06	8.57	8
	4.38	4	5	4	0.52	0.18	11.83	8
Ma number	2.00	2	2	2	0.00	0.00	0.00	8
	1.00	1	1	1	0.00	0.00	0.00	8
Mi number	2.00	2	3	1	0.58	0.22	28.87	7
	1.00	1	1	1	0.00	0.00	0.00	8
DK number	3.00	3	3	3	0.00	0.00	0.00	8
	9.00	9	9	9	0.00	0.00	0.00	8
AM number	25.13	25	29	22	2.53	0.90	10.08	8
	27.88	28	31	25	1.81	0.64	6.49	8
BC number	1.00	1	1	1	0.00	0.00	0.00	8
	-	-	-	-	-	-	-	-
FC number	3.00	3	3	3	0.00	0.00	0.00	8
	5.00	5	5	5	0.00	0.00	0.00	8
FVC number	7.00	7	7	7	0.00	0.00	0.00	8
	4.00	4	4	4	0.00	0.00	0.00	8
TC number	4.13	4	5	4	0.35	0.13	8.57	8
	5.00	5	5	5	0.00	0.00	0.00	8
CC number	3.00	3	3	3	0.00	0.00	0.00	5
	4.00	4	4	4	0.00	0.00	0.00	8
LMC number	10.13	10	14	8	1.73	0.61	17.06	8
	-	-	-	-	-	-	-	-
RMC number	16.38	16	20	14	2.07	0.73	12.62	8
	-	-	-	-	-	-	-	-
Pharyngeal fiber length	11.13	10.5	14	9	1.73	0.61	15.52	8
	-	-	-	-	-	-	-	-
PM length	13.50	13.5	16	12	1.51	0.53	11.20	8
	-	-	-	-	-	-	-	-
EM length	9.25	9	11	7	1.16	0.41	12.59	8
	-	-	-	-	-	-	-	-
Number of cilia in EM	10.63	11	14	8	1.92	0.68	18.10	8
	-	-	-	-	-	-	-	-
Distance between TC	-	-	-	-	-	-	-	-
	1.38	1	2	1	0.44	0.16	32.23	8

four rows of regular small polygons between dorsal kineties.

Nuclear organelles with one “C”-shaped or “3”-shaped macronucleus (Ma) 6-9 μm wide, lying along entire of body; one micronucleus (Mi) spherical, approximately 4 μm in diameter, located close to central left edge of Ma. Pellicle and cytoplasm colorless, subpellicular granules absent. Contractile vacuole spherical, positioning near anterior part of TC.

Discussion

This species is very similar to *E. muscorum* Dragesco, 1970 with respect to the shapes of body and adoral zone of membranelles, and patterns of frontal cirri, buccal cirri and frontoventral cirri. This species is, however, distinguished from *E. muscorum* by the following characteristics. (1) This species has multiple type argyrome, while *E. muscorum* complex type. (2) The micronucleus of this species is located close to central left edge of macronucleus, while that of *E. muscorum* to anterior left edge of macronucleus. (3) This species has approximately nine dorsal kineties, while *E. muscorum* eight (Kahl, 1932; Dragesco, 1970; Foissner, 1982; Dragesco and Dragesco-Kernéis, 1986).

The body size of Korean population of *Euplotes muscicola* is slightly larger than that of European population (Foissner, 1982). As a part of the biometrical data (Table 1) of this species, the coefficients of variation (CV) were calculated. The following characters showed the CV of 0.00: The numbers of frontal cirri, frontoventral cirri, transverse cirri, caudal cirri, macronucleus, micronucleus and dorsal kineties. Thus these characters are found to be very constant and therefore considered as important diagnostic features of this genus. Comparatively low CVs ranging from 4.01 to 11.83 were shown in the following characters: The lengths or widths of body, adoral zones of membranelles and micronucleus, ratio of body-length/width and body-length/AZM-length, and number of adoral membranelles. These characters are very important for the identification of the species of

this genus because of their low variability. Other characters showed fairly high value of CV ranging from 17.07 to 32.23.

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References

- Borror, A.C., 1972. Revision of the order Hypotrichida (Ciliophora, Protozoa). *J. Protozool.* **19**: 1-23.
- Buitkamp, 1977. Über die ciliatenfauna zweier mitteleuropäischer bodenstandorte (Protozoa; Ciliata). *Decheniana* **130**: 114-126.
- Curds, C.R., 1975. A guide to the species of the genus *Euplotes* (Hypotrichida, Ciliata). *Bull. Br. Mus. nat. Hist.* **28**: 1-61.
- Dragesco, J., 1970. Ciliés libres du Cameroun. *Ann. Fac. Sci. Univ. féd. Cameroun, Yaoundé (hors-série)*, pp.1-141.
- Dragesco, J. and A. Dragesco-Kernéis, 1986. Cilié libres de l'Afrique intertropicale. Introduction à la connaissance et à l'étude des cilié. *Faune tropicale* **26**: 1-559.
- Foissner, W., 1982. Ökologie und Taxonomie der Hypotrichida (Protozoa: Ciliophora) einiger sterreichischer Böden. *Arch. Protistenkd.*, **123**: 19-143.
- Foissner, W., 1987. Neue terrestrische und limnische Ciliaten (Protozoa, Ciliophora) aus Österreich und Deutschland. *Sber. Akad. Wiss. Wien* **195**: 217-268.
- Gellért, J., 1956. Ciliaten des sich unter dem moosrasen auf felsen Gebildeten humus. *Acta Biol. Hung.* **6**: 337-359.
- Kahl, A., 1932. Urtiere oder Protozoa I: Wimpertiere oder Ciliata (Infusoria) 3. Spirotricha. *Tierwelt Dtl.* **25**: 1-650.
- Kent, W.S., 1882. A manual of the Infusoria: including a description of all known flagellates, ciliate and tentaculiferous protozoa, British and foreign, and an account of the organization and affinities of the sponges. David Bogue. London.
- Lynn, D.H. and J.O. Corliss, 1991. Ciliophora. In: Harrison, F.W. and J.O. Corliss (eds). *Microscopic*

- anatomy of invertebrates. Protozoa. New York, Vol. 1, 333-467.
- Maeda, M. and P.G. Carey, 1984. A revision of the genera *Trachelostyla* and *Gonostomum* (Ciliophora, Hypotrichida), including redescrptions of *T. pediculidormis* (Cohn, 1866) Kahl, 1932 and *T. caudata* Kahl, 1932. *Bull. Br. Mus. nat. Hist.* **47**: 1-17.
- Shibuya, M., 1929. Notes on two new hypotrichous ciliates from the soil. *Proc. Imp. Acad.* **5**: 155-156.
- Shin, M.K. and W. Kim, 1993. New records of three oxytrichid hypotrichs (Ciliophora: Hypotrichida: Oxytrichidae) from the Han river in Seoul, Korea. *Korean J. Zool.* **36**: 223-230.
- Small, E.B. and D.H. Lynn, 1985. Phylum Ciliophora Doflein, 1901. In: Lee, J.J., S.H. Hutner and E.C. Bovee (eds), An illustrated guide to the protozoa. Society of Protozoologists, Lawrence, KS, pp. 393-575.
- Sokal, R.R. and F.J. Rohlf, 1981. Biometry. The principles and practice of statistics in biological research. W.H. Freeman and Company, San Francisco.
- Stiller, J., 1974. Hypotrichida. Magyarorsz Allatvilaga, *Fauna Hung.* **115**: 1-187.
- Wenzel, F., 1953. Die ciliaten der moosrasen trockner standorte. *Arch. Protistenkd.* **99**: 70-141.
- Wilbert, N., 1975. Eine Vertesserte Technik der Protargoimpragnation für Ciliaten. *Mikrokosmos* **64**: 171-179.
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울릉도산 육상 하모섬모충류(유모 문, 하모 목)

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울릉도의 육상 및 담수생태계에서 서식하는 하모섬모충류 7종인 *Holosticha sylvatica*, *Gonostomum affine*, *Histiculus cavicola*, *H. muscorum*, *Stylonychia mytilus*, *Aspidisca ciccada*, *Euplotes muscicola*가 울릉도에서 처음으로 밝혀져서 이들의 분류목록을 작성하였다. 이 가운데 *Gonostomum affine* (Stein, 1859)(近接角口下毛蟲)와 *Euplotes muscicola* Kahl, 1932(이끼자라下毛蟲)의 2종은 한국에서 처음으로 밝혀지는 종으로서 이들에 대해서 재기재하였다.