

Redescription of Two Terrestrial Hypotrichous Ciliates from Jindo Island, Korea

Choon Bong Kwon and Mann Kyoon Shin*

(Department of Biological Science, University of Ulsan, Ulsan 680-749, Korea)

ABSTRACT

Two hypotrichous ciliates inhabiting the representative terrestrial habitats of Jindo Island, *Holostichides chardezi* Foissner, 1987 and *Rigidocortex octonucleatus* (Foissner, 1988) are found from Jindo Island. These two species are newly recorded from Korea. The description was based on the observation of living specimens, protargol impregnated specimens and biometric analysis. The morphological variations among the populations of these species were investigated with morphometry. The diagnostic characteristics of these species are as follows: *Holostichides chardezi*: elongate body flexible and twisted, yellowish subpellicular granules scattered entire cortex, adoral zone of membranelles covering about 28% of body length, left and right rows of mid-ventral cirri paired, left row ended at buccal vertex and right row extending to center of body, no transverse cirri, both marginal rows of cirri not confluent at posterior end, 28-42 macronuclei and 1-5 micronuclei scattered entire body. 3 caudal cirri and 4 dorsal kineties. *Rigidocortex octonucleatus*: elongate-oval body rigid and not contractile, yellowish cytoplasmic crystals and fat globules densely packed, adoral zone of membranelles covering about 40% of body length, 5 transverse cirri, both marginal rows of cirri not confluent at posterior end, 8 macronuclei longitudinally arranged in median of cell, 3 caudal cirri and 7-10 fragmented dorsal kineties.

Key words: Hypotrichida, *Holostichides*, *Rigidocortex*, redescription, Jindo Island, morphology

*To whom correspondence should be addressed

Tel: 82-52-259-2396, Fax: 82-52-259-1694, E-mail: mkshin@ulsan.ac.kr

INTRODUCTION

Five species of hypotrichous ciliates from Jindo Island have been studied up to now (Shin and Kim, 1996). In the present study, two species of hypotrichs are discovered for the first time from Korea. We present a collection data on hypotrichs from Jindo Island and redescribe the two hypotrichs with illustrations and photos.

The present study was based on the specimens collected from several localities of Jindo Island (between 125°37'-126°28'E and 34°08'-34°35'N) during the period of 29th June-1st July in 2004. The collectings were performed at representative terrestrial habitats such as 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 hypotrichs. The protargol impregnated specimens were deposited in the Dept. of Biology, University of Ulsan, Korea.

The examination of external morphology of living specimens were based on the pictures captured by CCD camera. The infraciliature was observed using the modified protargol method (Wilbert, 1975). The drawings of the impregnated specimens were made with the aid of a drawing tube. The morphometrical analysis was performed using the methods described in Sokal and Rohlf (1973). We adopted the classification schemes established by Small and Lynn (1985) and Lynn and Corliss (1991).

RESULTS AND DISCUSSION

Phylum Ciliophora Doflein, 1901

Class Polyhymenophora Jankowski, 1967

Order Hypotrichida Stein, 1859

Family Holostichidae Fauré-Fremiet, 1961

Genus *Holostichides* Foissner, 1987 근사전열하모충속 (신칭)

1. *Holostichides chardezi* Foissner, 1987 (Fig. 1, Table 1) 근사전열하모충

Holostichides chardezi Foissner, 1987, p. 203

Material examined. 30 living specimens collected from soil under hackberry tree at Paengmok, Yeondong-ri, Imhoe-myeon and Gyodong-ri, Jindo-eup, Jindo-gun, Jeollanam-do, 29th-30th June in 2004; 14 protargol impregnated specimens were observed and analyzed biometrically and their data were summarized in Table 1.

Description. Size about in vivo 120-180 × 30-50 μm and 125-178 × 32-67 μm in protargol preparations. Length/width ratio in vivo 4/1 and 3.4/1 in protargol stained. Body slightly flattened dorso-ventrally (Fig. 1D), elongate ellipsoidal and slightly twisted (Fig. 1E and 1F), left margin slightly convex and right nearly straight (Fig. 1A); anterior somewhat broad or nearly similar than posterior ends in width; flexible, but not contractile (Fig. 1F); subpellicular granules about 1 μm in diameter, yellowish in color, scattered widely as patch in entire cortex (Fig. 1G and 1I). Cytoplasm colorless and transparent with food vacuoles about 10 μm in diameter. Contractile vacuole in or

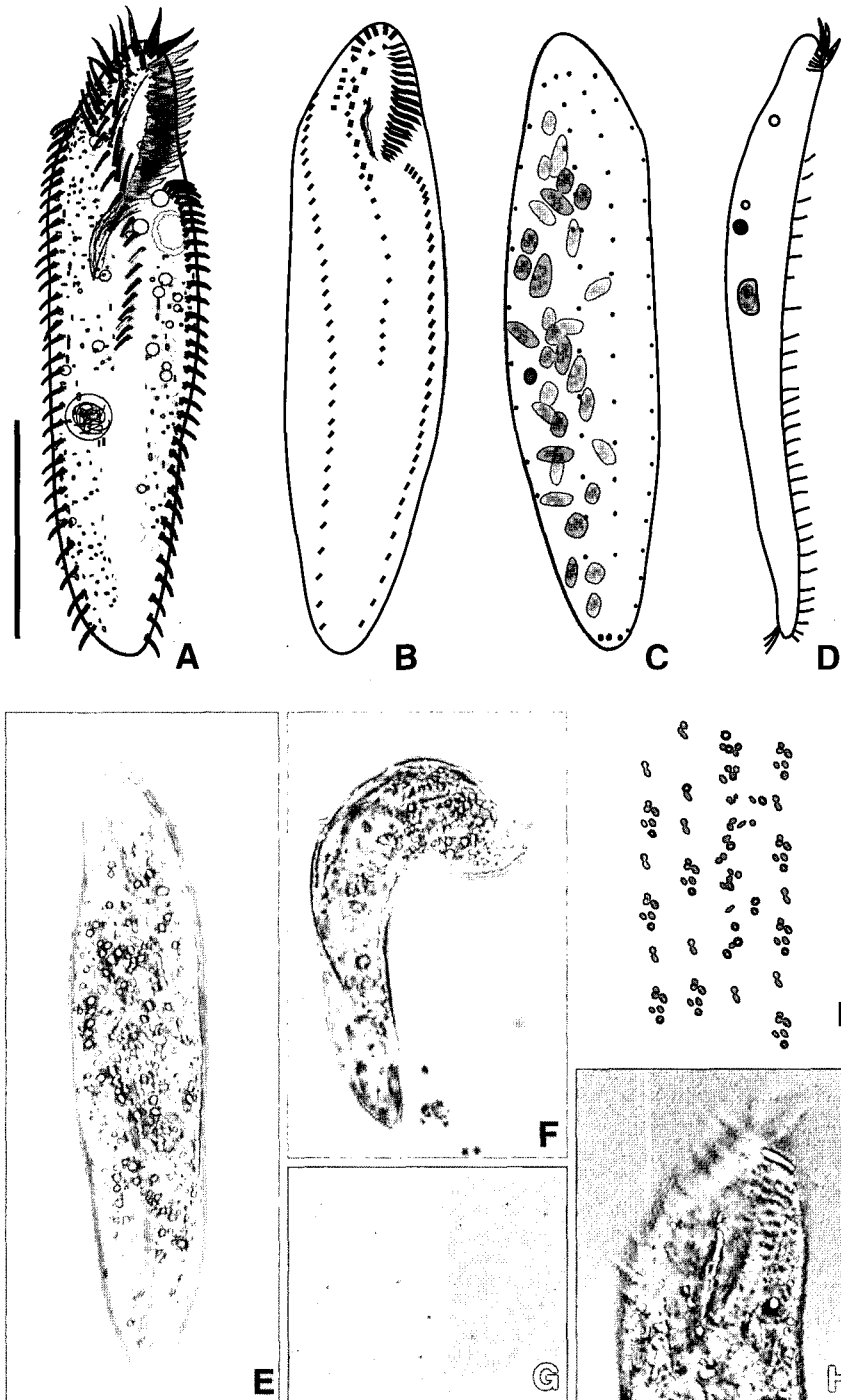


Fig. 1. *Holostichides chardezi* Foissner, 1987. A, E, Living specimens, ventral view; B, Infraciliature after protargol impregnation, ventral view; C, Dorsal kineties and nuclear state, dorsal view; D, Lateral view; F, Twisted and flexible body; G, I, Subpellicular granules; H, Ciliature in frontal field and undulating membranes pattern (scale bar in A = 50 μ m).

Table 1. Morphometric data of *Holostichides charzei* (upper line) and *Rigidocortex octonucleatus* (lower line). All data are based on protargol-impregnated specimens. The abbreviations in the table are as follows: AZM = adoral zone of membranelles; AM = adoral membranelle; BC = buccal cirrus; CC = caudal cirri; Cv = coefficient of variation in %; DK = dorsal kinety; FC = frontal cirri; FTC = frontoterminal cirri; FVC = frontoventral cirri; L (R)MC = left (right) marginal cirri; L (R)MVC = left (right) mid-ventral cirri; Ma = macronuclei; Max = maximum; Med = median; Mi = micronuclei; Min = minimum; n = population size; nd = not detected; UM = undulating membrane; SD = standard deviation; SE = standard error; - = none; TC = transverse cirri.

Characters	Mean	Med	Min	Max	SD	SE	Cv(%)	n
body length (μm)	147.9	147.5	125	178	15.2	4.1	10.3	14
	237.1	230.3	187.5	287.5	33.1	8.3	13.9	16
body width (μm)	45.7	43.5	32.5	67.5	11.8	3.2	25.8	14
	128.3	137.5	87.5	175.0	30.8	10.3	24.0	9
AZM length (μm)	42.1	41.5	38	50	3.1	0.8	7.3	14
	93.1	91.3	52.0	132.5	17.9	4.2	19.2	18
AM number	27.8	27.5	24	34	2.5	0.6	8.9	14
	44.8	46.0	4.0	59.0	11.1	2.6	24.9	19
UM length (μm)	20.8	21.5	10	26	4.9	1.3	23.5	14
	58.7	62.5	8.0	75.0	14.9	3.4	25.4	19
Ma number	33.0	32	28	42	4.2	1.1	12.7	14
Ma length (μm)	3.6	3.5	3	4.5	0.6	0.2	17.0	7
	7.7	8.0	3	10	1.4	0.3	18.2	18
Mi number	2.6	3	1	5	1.4	0.3	54.4	14
	nd	nd	nd	nd	nd	nd	nd	nd
Mi diameter (μm)	3.7	3	2.5	5	1.1	0.3	29.8	13
	3.8	3.5	2	6	1.1	0.3	29.5	18
BC number	1	1	1	1	0.0	0.0	0.0	7
	1	1	1	1	0.0	0.0	0.0	18
FC number	3.0	3	3	3	0.0	0.0	0.0	7
	3.0	3	3	3	0.0	0.0	0.0	18
FTC number	5.1	5	4	7	0.9	0.2	18.1	14
	-	-	-	-	-	-	-	-
FVC number	-	-	-	-	-	-	-	-
	4.0	4	4	4	0.0	0.0	0.0	18
LMVC number	6.3	6	5	8	0.9	0.3	15.0	13
	-	-	-	-	-	-	-	-
RMVC number	15.6	15.5	13	18	2.0	0.6	12.9	12
	-	-	-	-	-	-	-	-
LMC number	33.7	35	25	38	4.2	1.1	12.4	13
	22.6	23.0	5.0	32.0	5.1	1.2	22.6	19
RMC number	37.2	38	32	43	4.0	1.1	10.9	14
	25.9	25.0	22.0	34.0	3.3	0.8	12.8	19
CC number	2.8	3	2	4	0.6	0.2	22.6	10
	3.0	3.0	3.0	3.0	0.0	0.0	0.0	9
TC number	-	-	-	-	-	-	-	-
	4.8	5	3	5	0.5	0.1	11.3	16
DK number	4	4	4	4	0.0	0.0	0.0	12
	8.1	8.0	7.0	10.0	1.0	0.3	12.3	12

slightly above mid-body, with 2 long collecting canals (Fig. 1A). Movement irregular and slow on petridish, its direction changing frequently.

Cirral pattern rather constant, most cirri about 10 μm long in vivo, except marginal cirri about 5 μm long. Three frontal cirri slightly enlarged and located at ventral surface of anterior end; 4-7 frontoterminal cirri located at right anterior margin of cell, between anterior right marginal cirral row and mid-ventral cirral rows. One buccal cirrus moderate and located close to anterior end of paroral membrane. Undulating membranes straight or slightly curved, 10-26 μm long, not distinctly intersecting of paroral and endoral membranes, intersection of them usually at middle of them (Fig. 1B and 1H). Buccal cavity rather small and shallow. Pharyngeal fibers at base of buccal vertex, slanted toward posterior of body and 15-18 μm long. Adoral zone of membranelles covering about 28.5% of body length, with 24-34 adoral membranelles. Mid-ventral cirral rows rather conspicuous, paired as left and right mid-ventral cirral rows comprising 5-8 and 13-18 cirri in number, respectively; size of their cirri decreasing from anterior to posterior, left cirral row ended nearby buccal vertex while right cirral row extending to the center of ventral side. Transverse cirri absent. One left row and 1 right row of marginal cirri comprising 25-38 and 32-42 in number, respectively, extending to near posterior end, however these two marginal rows not confluent at posterior end (Fig. 1A and 1B). 2-4 caudal cirri rather fine and short, and located on dorsal surface of posterior end (Fig. 1C). Four dorsal kineties on dorsal side (Fig. 1C).

Macronuclear nodules in entire portion of cell, globular to elongate ellipsoidal, 28-42 in number, on average size $7 \times 3 \mu\text{m}$. Micronuclei globular to ellipsoidal, 1-5 in number, 3-5 μm in length (Table 1).

Distribution. Cape Verde Island (west off-sea Africa) and Korea.

Remarks. The present specimens are well accorded with the original description of *Holostichides chardezi* Foissner, 1987, but have some differences: (1) The body size of Korean population is slightly larger than that of original. (2) The number of macronuclei, left and right midventral cirri of the Korean population are approximately 33, 6 and 15, respectively, however, 35, 7 and 18 in the original type population.

Up to now, four to five species of *Holostichides* were described (Eigner, 1994; Foissner, 1988, 1997 and 2000). Of them, the species reported here is very close to *H. typicus* (Song and Wilbert, 1988). The distinctive differences between these two species are: (1) The numbers of frontal cirri and frontoterminal cirri are 3 and 4-7 in *H. chardezi*, while 4 and 7-10 in *H. typicus*. (2) *H. chardezi* has cortical granules, while these are not found in *H. typicus*. (3) *H. typicus* has slightly relatively long pair of mid-ventral cirral rows and additional ventral cirral row, while *H. chardezi* short pair of mid-ventral cirral rows and no ventral cirral row (Song and Wilbert, 1988).

Family Oxytrichidae Ehrenberg, 1830

Genus *Rigidocortex* Berger, 1999 경피하모충 속(硬皮下毛虫) (신칭)

2. *Rigidocortex octonucleatus* (Foissner, 1988)

팔핵경피하모충(八核硬皮下毛虫) (신칭) (Fig. 2, Table 1)

Australocirrus octonucleatus Foissner, 1988, p. 123 (in part).

Rigidocortex octonucleatus: Berger, 1999, p. 718.

Material examined. 30 living specimens collected from soil under thunbergii camphor tree

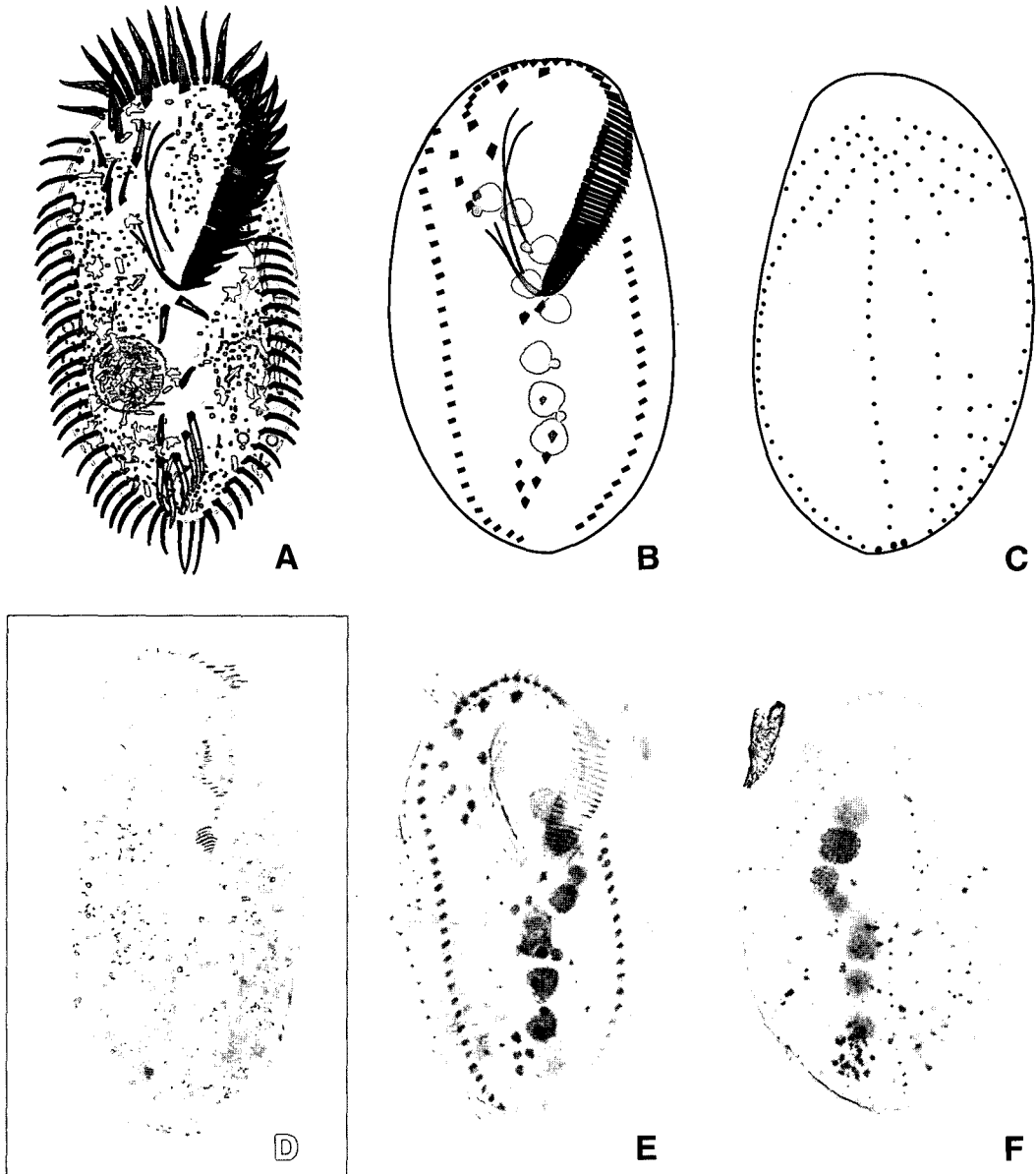


Fig. 2. *Rigidocortex octonucleatus* (Foissner, 1988). A, D, Living specimens, ventral view; B, E, Infraciliature after protargol impregnation, ventral view; C, F, Dorsal kineties and caudal cirri, dorsal view (scale bar in A = 100 μ m).

(*Machilus thunbergii*) at Paengmok, Yeondong-ri, Imhoe-myeon and Geumgolsan Mt., Dunjeon-ri, Gunnae-myeon, Jindo-gun, Jeollanam-do, 29th June and 1st July in 2004;. 19 protargol impregnated specimens were observed and analyzed biometrically and their data were summarized in Table 1.

Description. Size in vivo 200-250 × 75-125 μm. Length/width ratio about 2.5/1 (Fig. 2A, Table 1). Shape elongate-oval, almost parallel in both side, both ends rounded (Fig. 2A and 2D). Body rigid and partly flexible and not contractile. Contractile vacuole above mid-body at left margin of cell, during diastole with distinct collecting canals (Fig. 2A). Cortex colorless without special granules. Cytoplasm densely filled with, yellowish cytoplasmic crystals about 5 μm in size, cells appearing dark at low magnification of bright field illumination, and packed with fat globules of 2-5 μm in diameter. Movements hasty, to and fro, stiff like board.

Three frontal cirri prominently enlarged in vivo 25 μm long, and located at ventral surface of anterior end. One buccal cirrus prominent and located close to mid-anterior end of paroral membrane. Undulating membranes distinctly curved, about 58 μm long, intersecting of paroral and endoral membranes somewhat at the middle of them (Fig. 2B and 2E). Buccal field broad and proximal part deep. Adoral zone of membranelles covering about 40% of body length (Fig. 2A and 2E), with about 44 adoral membranelles. Bases of largest membranelles in vivo about 25 μm wide, cilia of adoral membranelles 20-25 μm long. Fronto-ventral cirri rather conspicuous, comprising 4 cirri in number, V-shaped arrangement, located at right ventral side of undulating membranes. Five ventral cirri located below buccal vertex, 3 near the buccal vertex and 2 near and above transverse cirri. Five transverse cirri prominent and located posteriorly, slightly fringed and not protruding beyond posterior end. One left row and 1 right row of marginal cirri in vivo about 12-15 μm long, comprising about 22 and 25 in number, respectively, extending to near posterior end, however these two marginal rows not confluent at posterior end (Fig. 2B). Three caudal cirri rather fine and short, and located on dorsal surface of posterior end (Fig. 2A, 2C and 2F). 7-10 dorsal kineties on dorsal side, of them, some kineties slightly to distinctly fragmented and shortened (Fig. 2C and 2F).

Macronuclear nodules spherical to slightly ellipsoidal, about 7 μm in diameter, longitudinally arranged in about median of cell; number of nodules invariably on average of 8. Micronuclei globular to ellipsoidal, about 5 in number in vivo, about 4 μm in diameter (Table 1).

Distribution. Australia, Austria, Brazil, Germany, Kenya, Peru and Korea

Remarks. The specimens examined in this study are well coincide with *Australocirrus octonucleatus* sensu Foissner, 1988, with an exception of the number of dorsal kineties; 9-13 kineties in European population, while 7-10 kineties in Korean population. Berger (1999) made a new genus *Rigidocortex* and changed combination of *Australocirrus octonucleatus* Foissner, 1988 to *Rigidocortex octonucleatus* (Blatterer and Foissner, 1988; Foissner, 1988), because of rigid body and the multiple fragmentation of dorsal kineties in the *Australocirrus octonucleatus* sensu Foissner, 1988. Up to now, only one species of this genus was recorded in the world.

ACKNOWLEDGEMENTS

This research was supported by a grant (no. 052-052-040) from the Core Environmental Technology Development Project for Next Generation funded by the Ministry of Environment of the Korean Government.

REFERENCES

- Berger, H., 1999. Monograph of the Oxytrichidae (Ciliophora, Hypotrichia). Kluwer Academic publishers. pp. 718-722.
- Blatterer, H. and W. Foissner, 1988. Beitrag zur Ciliatenfauna (Protozoa: Ciliophora) Australiens. *Stapfia*, **17**: 1-84.
- Eigner, P., 1994. Divisional morphogenesis and reorganization in *Eschaneustyla brachytoma* Stokes, 1886 and revision of the Bakuellinae (Ciliophora, Hypotrichida). *Europ. J. Protistol.*, **30**: 462-475.
- Foissner, W., 1987. Neue und wenig bekannte hypotriche und colpodide Ciliaten (Protozoa: Ciliophora). *Zool. Beitr. N. F.*, **31**: 187-282.
- Foissner, W., 1988. Gemeinsame Arten in der terricolen Ciliaten fauna (Protozoa: Ciliophora) von Australien und Afrika. *Stapfia*, **17**: 85-133.
- Foissner, W., 1997. Soil ciliates (Protozoa: Ciliophora) from evergreen rain forests of Australia, South America and Costa Rica: diversity and description of new species. *Biol. Fertil. Soils*, **25**: 179-238.
- Foissner, W., 2000. A compilation of soil and moss ciliates (Protozoa, Ciliophora) from Germany, with new records and descriptions of new and insufficiently known species. *European J. Protistol.*, **36**: 253-283.
- Lynn, D. H. and J. O. Corliss, 1991. Ciliophora. In Harrison, F. W. and J. O. Corliss, eds., *Microscopic anatomy of invertebrates*. Vol. 1. Protozoa. New York, Wiley-Liss, pp. 333-467.
- Shin, M. K. and W. Kim, 1996. Terrestrial hypotrichous ciliates from Chindo Island, Korea. *Korean J. Zool.*, **12**: 17-24.
- 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, 1973. *Introduction to biostatistics*. Freeman Co., San Francisco, 368 pp.
- Song, W. and N. Wilbert, 1988. *Parabakuella typica* nov. gen., nov. spec. (Ciliata, Hypotrichida) aus den Edaphon eines Standortes in Qingdao, China. *Arch. Protistenkd.*, **135**: 319-325.
- Wilbert, N., 1975. Eine Vertesserte Technik der Protargoimpragnation für Ciliaten. *Mikrokosmos*, **64**: 171-179.

RECEIVED: 29 August 2005

ACCEPTED: 25 October 2005

진도의 육상 하모섬모충류 2미기록 종의 재기재

권 춘 봉·신 만 균*

(울산대학교 자연과학대학 생명과학부)

요 약

진도의 육상에 서식하는 하모섬모충류 2종, 근사전열하모충 (*Holostichides chardezi* Foissner, 1987)과 팔핵경피하모충 [*Rigidocortex octonucleatus* (Foissner, 1988)]은 한국에서 처음으로 발견된 종으로서 이들에 대해서 자세히 재기재하고 이들의 형태적 변이에 대해서 고찰하였다. 이 두 종의 식별형질에 대해서 요약하면 다음과 같다. 근사전열하모충은 길쭉한 몸을 가지며 뒤틀리거나 유연하다. 표층에는 연노랑의 알갱이 고루 분포하고, 막판구대는 체장의 약 28%를 차지한다. 좌우의 중앙복극모열이 쌍으로 존재하며 좌측열은 구부정점까지 이르고, 우측열은 몸의 중앙까지 이른다. 후방극모가 없고, 좌우 측극모열은 몸의 후단까지 이르지만 서로 연결되지 않는다. 28-42개의 대핵과 1-5개의 소핵은 몸 전체에 흩어져 있다. 미극모는 3개, 등쪽섬모열은 4열이다. 팔핵경피하모충은 계란형의 몸을 가지며 뺏뺏하거나 잘 수축하지 않는다. 연노랑의 세포질 결정체와 지방체가 촘촘히 존재한다. 막판구대는 체장의 약 40%를 차지한다. 후방극모는 5개이고, 좌우 측극모열은 몸의 후단까지 이르지만 서로 연결되지 않는다. 8개의 대핵이 몸의 중앙에 세로로 배열한다. 미극모는 3개, 등쪽섬모열은 분절된 것이 많으며 7-10열이다.