

Rotifer Fauna of Natal Streams of Chum Salmon (Oshipcheon)

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Rotifers inhabiting Oshipcheon (Samcheog-city), one of the natal streams of chum salmon in the east coast, were studied taxonomically. As a result, 19 species/subspecies were identified, and of which five rotifers are newly recorded from Korea: *Cephalodella forficula*, *Dicranophorus forcipatus*, *Notommata glyphura*, *Bryceella tenella*, and *Habrotrocha collaris*. Among these Korean new records, *Habrotrocha collaris* is also new to Asia.

Key words: Rotifera, Oshipcheon, natal stream, taxonomy, new records, Korea.

Introduction

Nine streams in the east coast of Kangwon-do and Kyeongsangbuk-do, including Oshipcheon in Samcheog City, have been known as very important natal streams of chum salmon (*Oncorhynchus keta*). Yangyang Regional Inland Fisheries Institute has release about 20 million salmon fingerlings to 14 streams annually since 1985 and the percentage of returning of these released salmons has been elevated to 1.4% after 1995 (Baek, 1998).

But, unfortunately, the researches on the zooplankton of these streams have been poorly performed and the biodiversity and taxonomical characteristics of the zooplankton fauna have been little known so far. Zooplanktons are extremely important in freshwater environment, because they convert primary (algal and bacterial) production into a form usable for secondary consumers such as insect larvae, fish fry and macroinvertebrates (Nogrady *et al.*, 1993). Therefore, the present study was performed to clarify the diversity and to discuss taxonomical characteristics of rotifers inhabiting Oshipcheon in Samcheog City.

The phylum Rotifera is a group of aquatic or semiaquatic invertebrates of microscopic size,

encompassing about 2000 species of unsegmented and bilaterally symmetrical pseudocoelomates. Although rotifers are a small phylum, they are very important in freshwater environments, because their reproductive rates are the highest among metazoans. They can populate vacant niches with extreme rapidity, producing up to 30% of the total plankton biomass (Nogrady *et al.*, 1993). Because of their great adaptability, rotifers are widely distributed in various freshwater, brackish, marine and terrestrial habitats from the Arctic and Antarctic regions to the tropics.

Materials and Methods

The materials examined in the present study consist of benthic and planktonic rotifers collected from salmon capturing spot under the Oshipcheon bridge on June 13, 1999 and October 17, 1999. Collections were made with a plankton net and a dipnet of 60 μ m mesh-size. The plankton net was pulled horizontally and diagonally from the bottom. The dipnet was used for collecting benthic and periphytic rotifers. A half of water sample was fixed with 7~8% (final concentration) buffered formalin solution for the identification of loricate rotifers. The other half of sample was kept in refrigerator, because bdelloid and illoricate monogonont rotifers should be examined in live state. For the methods

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of trophi observation and preparing permanent slide mount of specimens, Song (1999) and Stemberger (1979) were referred to. The specific identification was performed at $\times 400$ and $\times 1000$ on the stage of a light microscope. Both of microphotography and permanent slides were used for illustrations.

The classification scheme is based on Nogrady *et al.* (1993).

Results and Discussion

As a result of the present study, 19 species/subspecies were identified (Table 1). Among these, five rotifers, *Cephalodella forficula*, *Dicranophorus forcipatus*, *Notommata glyphura*, *Bryceella tenella*, *Habrotrocha collaris* are new to the Korean fauna, and the genus *Bryceella* is new to Korea. Noticeable is the appearance of *Habrotrocha collaris*, which has never been reported from Asia before.

Here we describe five Korean new records with illustrations.

Dicranophorus forcipatus (O.F. Müller, 1786) (Fig. 1: a~c)

Cercaria forcipata O.F. Müller, 1786, p. 134, pl. 20, figs 21~23 (cited from Harring, 1913).

Dicranophorus remanei Wulfert, 1936, p. 405, Abb. 1a~i.

Dicranophorus forcipatus: Bartoš, 1959, p. 716, Obr. 124C~E; 126F, CH, J, K; Donner, 1964, p. 281, figs 17a~e; Koste, 1978, p. 469, Abb. 52, pl. 169, figs 10, 13a~i; pl. 170, figs 6, 12a~b.

Material examined: 2 specimens, June 13 1999.

Description: Two eyes present below rostrum. Integument very thin, smooth and transparent, but body outline rather fairly constant. Body elongate, sub-cylindrical, rather flat ventrally and slightly gibbous posterodorsally; integument divided longitudinally by distinct lateral sulci into dorsal and ventral plates, limited by anterior and posterior transverse folds, which defining body into head, abdomen and foot; head long, about 2/5 of body length, and defined by well marked neck; corona ventral; rostrum short, narrow and rounded anteriorly; abdomen rather abruptly tapering to prominent tail; tail reaching 2/3 of foot length; foot short, stout and conical. Toes two times as long as foot; ventral margin slightly concave and dorsal margin convex in lateral view; base with oblique septum. Trophi forcipate type; distal end of manubrium knobby; rami tips bifurcate; 5 teeth on

Table 1. List of species.

Phylum Rotifera Cuvier, 1817
Class Monogononta Plate, 1889
Order Ploimida Hudson and Gosse, 1886
Family Colurellidae Bartoš, 1959
Genus <i>Lepadella</i> Bory de St. Vincent, 1826
<i>Lepadella acuminata</i> (Ehrenberg, 1834) (J)
Genus <i>Colurella</i> Bory de St. Vincent, 1824
<i>Colurella adriatica</i> Ehrenberg, 1831 (O)
Family Dicranophoridae Remane, 1933
Genus <i>Dicranophorus</i> (O.F. Müller, 1773)
* <i>Dicranophorus forcipatus</i> (O.F. Müller, 1786) (J)
Family Euchlanidae Bartoš, 1959
Genus <i>Euchlanis</i> Ehrenberg, 1832
<i>Euchlanis dilatata</i> Ehrenberg, 1832 (J)
Family Lecanidae Bartoš, 1959
Genus <i>Lecane</i> Nitzsch, 1827
<i>Lecane bulla bulla</i> Gosse, 1851 (J)
<i>Lecane closteroerca</i> (Schmarda, 1859) (J)
<i>Lecane luna</i> (O.F. Müller, 1776) (J)
<i>Lecane lunaris</i> (Ehrenberg, 1832) (J)
Family Notommatidae Remane, 1933
Genus <i>Cephalodella</i> Bory de St. Vincent, 1826
* <i>Cephalodella forficula</i> (Ehrenberg, 1832) (J, O)
<i>Cephalodella gibba</i> (Ehrenberg, 1838) (J)
Genus <i>Notommata</i> Bartsch, 1870
* <i>Notommata glyphura</i> Wulfert, 1935 (J)
Family Proalidae Bartoš, 1959
Genus <i>Bryceella</i> Remane, 1929
* <i>Bryceella tenella</i> (Bryce, 1897) (J)
Family Trichotriidae Bartoš, 1959
Genus <i>Trichotria</i> Bory de St. Vincent, 1827
<i>Trichotria pocillum</i> (O.F. Müller, 1776) (J)
<i>Trichotria tetractis</i> (Ehrenberg, 1830) (J)
Family Scaridiidae Manfredi, 1927
Genus <i>Scaridium</i> Ehrenberg, 1830
<i>Scaridium longicaudum</i> (O.F. Müller, 1786) (J)
Class Digononta Plate, 1889
Order Bdelloidea Hudson and Gosse, 1886
Family Philodinidae Bryce, 1910
Genus <i>Macrotrachela</i> Milne, 1886
<i>Macrotrachela quadricornifera quadricornifera</i> Milne, 1886 (J)
Genus <i>Philodina</i> Ehrenberg, 1830
<i>Philodina acuticornis odiosa</i> Milne, 1916 (J)
Genus <i>Pleuretra</i> Bryce, 1910
<i>Pleuretra brycei</i> (Weber, 1898) (O)
Family Habrotrochidae Bryce, 1910
Genus <i>Habrotrocha</i> Bryce, 1910
** <i>Habrotrocha collaris</i> (Ehrenberg, 1832) (O)

* Species new to Korea;

** Species new to Asia.

Abbreviations: J, collected on June 13, 1999; O, collected on October 17, 1999.

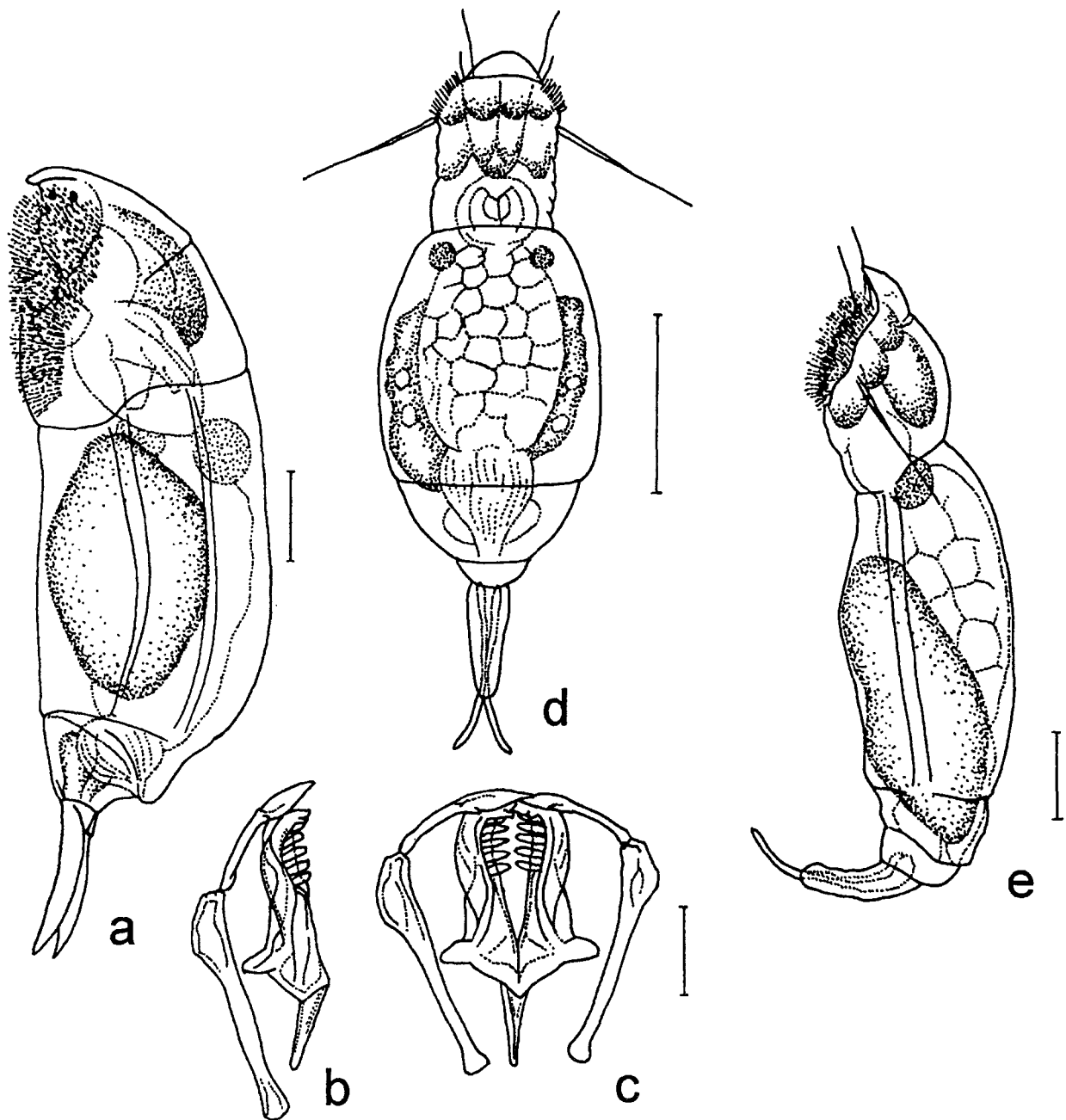


Fig. 1. a~c, *Dicranophorus forcipatus* (O.F. Müller, 1786): a, lateral view; b, trophi, lateral view; c, trophi, ventral view (scale bars: 1=50 μm ; 3=25 μm). d~e, *Bryceella tenella* (Bryce): d, dorsal view (after Koste & Shiel, 1990); e, lateral view (scale bars: 25 μm).

each inner margins of rami; unci single toothed; fulcrum rod-shaped in ventral view and triangular in lateral view; alulae short and pointing rather posteriorly.

Measurements (in μm): Body length 399, spur length 76.

Remarks: This species is littoral in habitat and

feeds on ciliates, other rotifers and nematodes (Koste, 1978).

Cephalodella forficula (Ehrenberg, 1832) (Fig. 2: c)

Distemma forficula Ehrenberg, 1832, p. 139 (cited from Koste and Shiel, 1991).

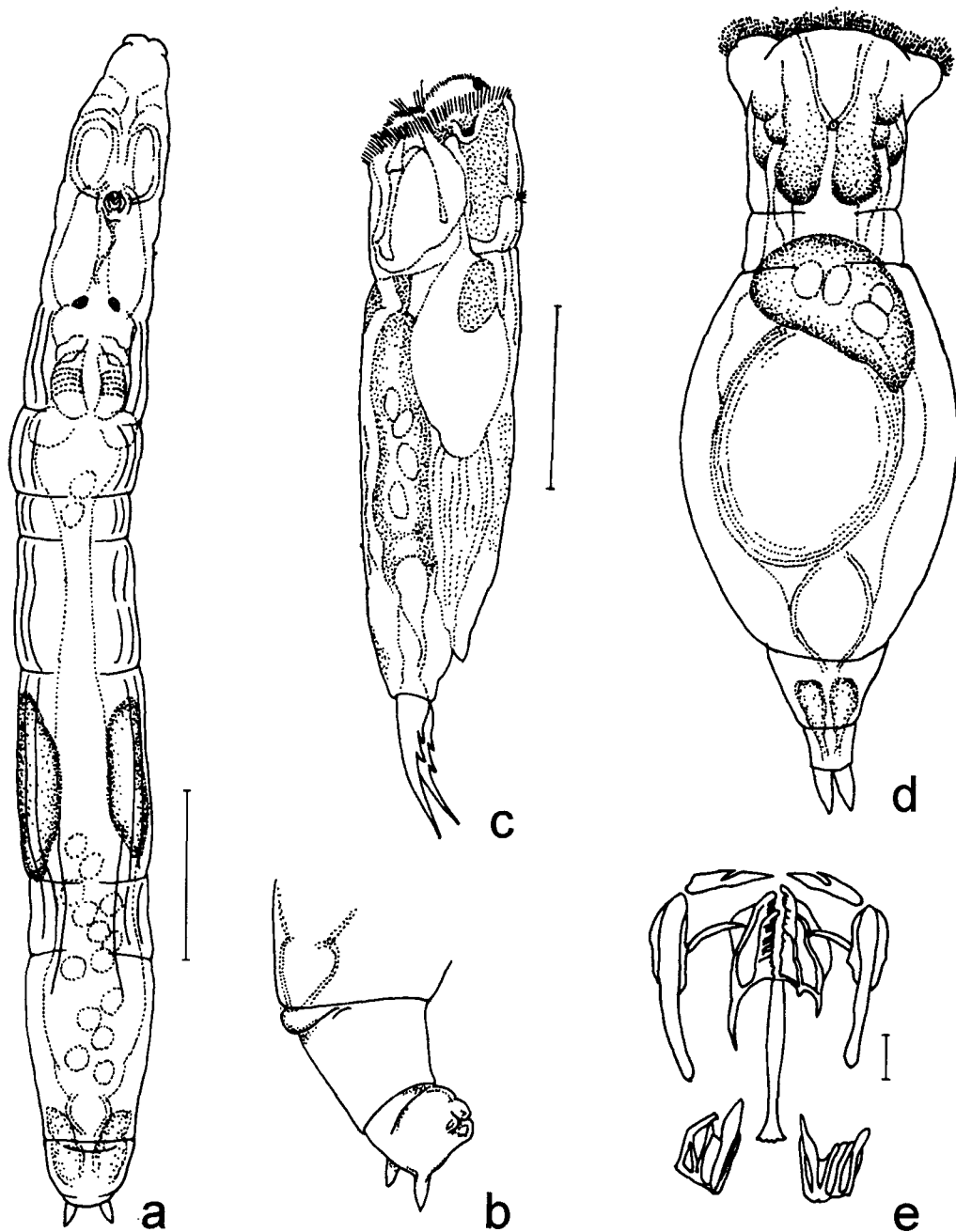


Fig. 2. a~b, *Habrotrocha collaris* (Ehrenberg, 1832): a, creeping, dorsal view (scale bar: 50 μm); b, foot, spurs and toes, ventrolateral view. c, *Cephalodella forficula* (Ehrenberg), lateral view (after Koste & Shiel, 1991, scale bar: 50 μm). d~e, *Notommata glyphura* Wulfert: d, dorsal view; e, trophi (after Koste & Shiel, 1991) (scale bars: 9=50 μm ; 10=10 μm).

Cephalodella forficula: Harring, 1913, p. 25; Harring and Myers, 1924, p. 476, pl. 34, figs 1~3; Bartoš, 1959, p. 592, Obr. 102B-D, H; Donner, 1950, p. 322, Abb. 20; Wang, 1961, p. 189, pl. 18, fig. 165; Koste, 1978, p. 358, pl. 129, figs 6a~i; 7a~b; Koste and Shiel, 1991, p. 122,

fig. 9: 5; Mizuno and Takahashi, 1991, p. 272, fig. 230; Nogrady *et al.*, 1995, p. 77, fig. 106.

Material examined: 5 specimens, June 13 1999; 3 specimens, Oct. 17 1999.

Description: Single eyespot present frontally. Retrocerebral organ absent. Integument thin and

flexible; lorica plate absent. Body elongate, spindle-shaped, and with a slight constriction at neck; abdomen gradually tapering to foot; foot ill-defined; toes longer than foot, stout, recurved, and with two spicules dorsomedially. Trophi type D (Koste & Shiel, 1991, p. 117, fig. 6); manubria dilated distally, but not crooked, with distinctive oval basal plate.

Remarks: This species is pancontinental and feeds on diatoms (Koste, 1978). It prefers 12~25°C in temperature (Nogrady *et al.*, 1995).

Notommata glyphura Wulfert, 1935 (Fig. 2: d~e)

Notommata glyphura Wulfert, 1935, p. 590, Abb.

7a~e (cited from Koste, 1978); Bartoš, 1959, p. 560, Obr. 97K, L, N, O, P; Koste, 1978, p. 330, pl. 108, figs 1a~g; pl. 110, figs 3a~g, 4a~g; Koste and Shiel, 1991, p. 148, fig. 23: 4; Mizuno and Takahashi, 1991, p. 268, fig. 219; Nogrady *et al.*, 1995, p. 188, fig. 237.

Material examined: 3 specimens, June 13 1999.

Description: Body spindle-shaped; corona extending ventrally to form chin; auricle rather big and retractable; head and neck clearly defined; neck cylindrical; tail rounded distally; foot about 1/5 of total length, with 2 segments, and covered by tail except distal end of second segment; toes with rather parallel sides and abruptly tapering to blunt tips. Subcerebral glands long and wide. Mastax large. Trophi asymmetric; rami with inner margin teeth; alulae all hook-shaped and left one much longer than right ones; unci plates with a thick main and three thin secondary teeth, which fused at bases forming rectangular plate; manubria dilated distally.

Measurements (in μm): Body length 391, spur length 21.

Remarks: This species is found in fresh to brackish water, in littoral standing and flowing waters. It eats algae and rotifers, and scavenges dead microcrustacea (Koste and Shiel, 1991). It is common and eurytopic in Europe (Nogrady *et al.*, 1995), also reported from West Africa (De Ridder, 1986) and Asia (Mizuno and Takahashi, 1991).

Bryceella tenella (Bryce, 1897) (Fig. 1: d~e)

Stephanops tenellus Bryce, 1897, p. 798.

Squatinella tenella: Haring, 1913, p. 97.

Bryceella tenella: Bartoš, 1959, p. 539, Obr. 94C, K;

Koste, 1978, p. 264, pl. 87, figs 9a~c; pl. 88, figs 1a~e; Koste and Shiel, 1990, p. 131, fig. 1: 2.

Material examined: 1 specimen, June 13 1999.

Description: Corona oblique. Head cylindrical with rostrum; rostrum triangular with blunt tip in ventral view. Three pairs of stout cirri present; two pairs present at end of head and pointing forward; one pair present at each lateral corners of head and pointing posterolaterally. Abdomen oval. Foot much narrower than abdomen, about 1/2 of abdomen length, and with two segments; second segment about three times as long as first one. Toes blunt, very slender and curved ventrally.

Measurements (in μm): Body length 230, spur length 21.

Remarks: The present species has been known from acid waters of North and South America, Europe, Asia and New Zealand. Genus *Bryceella* is isolated systematically by the possession of peculiar cirri assemblages on the corona (Koste & Shiel, 1990).

Habrotrocha collaris (Ehrenberg, 1832) (Fig. 2: a~b)

Philodina collaris Ehrenberg, 1832, p. 148 (cited from Haring, 1913).

Habrotrocha collaris (Ehrenberg) Bryce, 1910, p. 75; Bartoš, 1951, p. 290, figs 8A, B; Donner, 1965, p. 25, fig. 4; Donner, 1970, p. 235, fig. 19; Koste and Shiel, 1986, p. 770, figs 5: 2, 3.

Material examined: 2 specimens, Oct. 17 1999.

Description: Rostrum rather short and small. Head much shorter than neck. Corona a little wider than cingulum pad. Sulcus narrow anteriorly and with wide and concave base. Disc retractor bilobed and with median notch in ventral view. Antenna long and a little longer than antenna segment width. Esophagus longer than trophi and with loops in creeping. Two cerebral eyes present and pale orange in color. Trunk cylindrical and almost as wide as neck during creeping; preanal and anal segment somewhat plump; a transverse bulge present between anal and first foot segment dorsally. Foot short, stout and with 4 segments; first segment very gibbous dorsally. Spurs conical, short and with interspace as wide as spur base. Three toes very short and near to toe-like papillae.

Measurements (in μm): Body length 352, spur

length 8.

Remarks: This species is rather similar to *H. gracilis gracilis* Montet, 1915 with respect to the general body structure, but, it is distinguished from the latter by the following characteristics: (1) *H. collaris* has two cerebral eyes, while *H. gracilis gracilis* has not, (2) The transverse bulge right under anus is always single in *H. collaris*, while single or triple in *H. gracilis gracilis*, and (3) *H. collaris* does not have nest, while *H. gracilis gracilis* inhabits irregularly shaped house made of mucus, detritus and extruded food pellets.

This species is probably cosmopolitan, but has been reported only from North America, Europe and New Zealand (Donner, 1965; Bateman and Davis, 1980; Bērziņš and Pejler, 1989; Schmid-Arāya, 1998).

Conclusion

According to Pontin (1978), among 14 genera identified during this study, only genus *Euchlanis* is with planktonic or semiplanktonic species, 4 genera such as *Lepadella*, *Colurella*, *Lecane* and *Cephalodella* are with species sometimes collected in plankton, and all the other genera are with littoral, periphytic or benthic species (Table 2). That means, of 19 species/subspecies, only *Euchlanis dilatata* is planktonic or semiplanktonic, and 10 species are rarely or never in plankton, which can be expected in this stream community.

Table 2. Classification of genera identified during this study, according to their habitats. (modified from Pontin, 1978)

Genera with some planktonic or semi-planktonic members	Littoral or periphytic genera, sometimes collected in plankton	Littoral, periphytic or benthic genera rarely or never in plankton
<i>Euchlanis</i>	<i>Lepadella</i> , <i>Colurella</i> , <i>Lecane</i> , <i>Cephalodella</i>	<i>Dicranophorus</i> , <i>Notommata</i> , <i>Bryceella</i> , <i>Trichotria</i> , <i>Scaridium</i> , <i>Macrotrachela</i> , <i>Philodina</i> , <i>Pleuretra</i> , <i>Habrotrocha</i>

Though most of the species recorded from this study are common, cosmopolitan or pancontinental, we found 5 species, *Cephalodella forficula*, *Dicranophorus forcipatus*, *Notommata glyphura*, *Bryceella tenella*, *Habrotrocha collaris* are new to the Korean fauna. Among these Korean new records, *Habrotrocha collaris* is also new to Asia. Our result suggests that the distribution range of *Habrotrocha collaris* might be wider than expected before, and it is probably cosmopolitan or pancontinental.

The present study is the first taxonomic work on rotifers of natal streams of chum salmon. Further studies on microinvertebrates, including rotifers, are required at both Oshipcheon and the other natal streams.

References

- Baek, K.K. 1998. Growth and temporary stay of young salmon released in river. Proceedings of East Coastal Region Research Institute of Kangnung National University Symposium, 4(1)~4(15). (in Korean)
- Bartoš, E. 1951. The Czechoslovak Rotatoria of the order Bdelloidea. Věstník čsl. zool. spol., 15, 241~500.
- Bartoš, E. 1959. Viřnici-Rotatoria. Fauna ČSR, 15, 1~969.
- Bateman, L.E. and C.C. Davis. 1980. The Rotifera of hummock-hollow formations in a poor (mesotrophic) fen in Newfoundland. Int. Revue ges. Hydrobiol., 65, 1, 127~153.
- Bērziņš, B. and B. Pejler. 1989. Rotifer occurrence and trophic degree. Hydrobiologia, 182, 171~180.
- Bryce, D. 1897. Contributions to the non-marine fauna of Spitsbergen. Part II. Report on the Rotifera. Proc. zool. Soc., London, 793~799.
- Bryce, D. 1910. On a new classification of the bdelloid Rotifera. J. Quekett Microsc. Club, ser. 2, 11, 61~92.
- De Ridder, M. 1986. Annotated checklist of non-marine rotifers (Rotifera) from African inland waters. Zool. Docum., 21, 13~18.
- Donner, J. 1950. Rädertiere der Gattung *Cephalodella* aus Südmähren. Arch. Hydrobiol., 42, 3, 304~328.
- Donner, J. 1964. Die Rotatorien-Synusien submerser Makrophyten der Donau bei Wien und mehrere Alpenbäche. Arch. Hydrobiol./Suppl., 27, 1, 3, 227~324.
- Donner, J. 1965. Ordnung Bdelloidea. Bestimmungsbücher zur Bodenfauna Europas 6. Akademie Verlag, Berlin, 267 pp.
- Donner, J. 1970. Die Rädertierbestände submerser Moose der Salzach und anderer Wasser-Biotope des Flußgebietes. Arch. Hydrobiol. Suppl., 36, 2/3, 109~254.
- Harring, H.K. 1913. Synopsis of the Rotatoria. US. Nat. Mus. Bull., 81, 1~226.

- Harring, H.K. and F.J. Myers. 1924. The rotifer fauna of Wisconsin. II. A revision of the notommatid rotifers, exclusive of the Dicranophorinae. *Trans. Wisconsin Acad. Sci., Arts and Letters*, 21, 415~549, pls. 16~43.
- Koste, W. 1978. Die Rädertiere Mitteleuropas. *Überordnung Monogononta. Begründet von M. Voigt. I. Textbd.* viii+673 pp.; *II. Tafelbd.* ii+476 pp. mit 234 Tafeln, Stuttgart.
- Koste, W. and R.J. Shiel. 1986. Rotifera from Australian inland waters. I. Bdelloidea (Rotifera: Digononta). *Aust. J. Mar. Freshw. Res.*, 37, 765~792.
- Koste, W. and R.J. Shiel. 1990. Rotifera from Australian inland waters. VI. Proalidae, Lindiidae (Rotifera: Monogononta). *Trans. Roy. Soc. S. Aust.*, 114, 3, 129~143.
- Koste, W. and R.J. Shiel. 1991. Rotifera from Australian inland waters. VII. Notommatidae (Rotifera: Monogononta). *Trans. Roy. Soc. S. Aust.*, 115, 3, 111~159.
- Mizuno, T. and E. Takahashi. 1991. An illustrated guide to freshwater zooplankton in Japan. *Tokai Univ. Publ.*, xix+532 pp. (In Japanese)
- Nogrady, T., R. Pourriot and H. Segers. 1995. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World. 8. Rotifera. Vol. 3: The Notommatidae and the Scaridiidae. SPB Academic Publishing bv, 248 pp.
- Nogrady, T., R.L. Wallace and T.W. Snell. 1993. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World. 4. Rotifera. Vol. 1: Biology, Ecology and Systematics. SPB Academic Publishing bv, vii+142 pp.
- Pontin, R.M. 1978. A key to the freshwater planktonic and semi-planktonic Rotifera of the British Isles. *FBA Scientific Publication*, no. 38, 178 pp.
- Schmid-Araya, J.M. 1998. Small-sized invertebrates in a gravel stream: community structure and variability of benthic rotifers. *Freshwater Biology*, 39, 25~39.
- Song, M.O. 1999. Systematic study on Korean bdelloid Rotifera. Ph.D. thesis, SNU, iii+200 pp.
- Stemberger, R.S. 1979. A Guide to Rotifers of the Laurentian Great Lakes. US Environmental Protection Agency, Cincinnati, Ohio, 185 pp.
- Wang, C.C. 1961. Freshwater Rotifers of China. *Inst. Freshw. Hydrobiol. AN KNR, Peking*, 288 pp.
- Wulfert, K. 1936. Beiträge zur Kenntnis der Rädertierfauna Deutschlands. *Arch. Hydrobiol.*, 30, 405~407.