Nonmarine Ostracoda (Crustacea) from Jeju Island, South Korea, including descriptions of two new species
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Collections of brackish and freshwater ostracods on Jeju Island, South Korea, yielded 26 species, including two new species belonging to the genera Cyclocypris and Cypretta, and nine new records for the Korean fauna: Bradleytriebella tuberculata (Hartmann, 1964), Strandesia flavescens Klie, 1932, Potamocypris variegata (Brady & Norman, 1889), Heterocypris salina (Brady, 1868), Stenocypris hirutai Smith and Kamiya, 2006, Ishizakiiella miurensis (Hanai, 1957), Terrestricythere ivanovae Schornikov, 1969, Limnocythere sp. and Tanycypris alfonsi Nagler, Geist and Matzke-Karasz, 2014. Tanycypris alfonsi is also known from Germany, where it is considered to be an alien species. The Limnocythere species belongs to the stationis group, which consists of another eight species, and is probably undescribed. A lack of males hinders its description, but its presence in Korea is significant; including the record herein, seven of the group inhabit North-East Asia, indicating the group may have originated in this region.

http://zoobank.org/urn:lsid:zoobank.org:pub:74FA8742-D301-4EC0-B058-021EE1CDFCB0

Keywords: brackish; freshwater; Cyclocypris; Cypretta; ostracods; South Korea

Introduction
Jeju Island, the largest island in South Korea, lies approximately 80 km south of the Korean peninsula. The island is about 73 km across east to west and 31 km north to south, and covers an area of 1847 km². It is a shield volcano, which started to form approximately two million years ago, and is dominated by Mount Halla, reaching 1950 m above sea level. The island mainly consists of basaltic and trachytic lavas, and underlying volcaniclastic deposits around the coasts. Natural surface waterbodies are not common on the island because rainwater readily percolates through the underlying volcanic geology; streams are usually dry except after heavy rainfall. The island has a humid subtropical climate, and is warmer than the rest of Korea.

Only six species of freshwater ostracods have been previously reported from Jeju Island: Heterocypris incongruens (Ramdohr, 1808), Dolerocypris fasciata (O.F. Müller, 1776), Dolerocypris sinensis Sars, 1903, Cypretta seurati Gauthier, 1929, Potamocypris mastigophora (Meuthuen, 1910) [as Potamocypris producta (Sars, 1924)], and Ilyocypris dentifera Sars, 1903 (Kim and Min 1991a, 1991b). These species, collected from rice fields, ponds and bogs, represent a small fraction of ostracod diversity that would be
expected from an area as large as Jeju Island. The aim of this study was to sample a wide variety of habitats, especially rivers, springs and seeps, to complement the data previously reported of the island’s nonmarine ostracod fauna.

**Material and methods**

Specimens were collected from 35 localities (43 samples) (Figure 1, Table 1) by sieving sediment from various habitats through a 125 μm sieve, or by scooping and filtering sediment through a net (mesh size 64). The resulting sediment was transferred to sample pots and preserved using ethanol. Appendages were dissected and mounted in glycerol and drawn with the aid of a camera lucida. Carapaces are stored dry in micropalaeontological cavity slides. Carapaces used for SEM investigation were

![Figure 1. Map of Jeju Island. Localities 1–24, northern side of Mount Halla, Jeju city area: 1, Suwolbong cave, Gosan-ri, Hangyeong-myeon; 2, Yonguncheon, Gosan-ri; 3, swamp, Yongdang-ri; 4, Cheongsu-gotjawal marsh; 5, Eoum-ri, Aewol-eup (pond); 6, Bilremot Pond, Eoeum-ri; 7, Dombaemul Pond, Eoeum-ri; 8, Geumseong-cheon estuary; 9, Gwakji-ri (coastal spring); 10, Sangga-ri (pond); 11, Sowangcheon spring, Goseong-ri; 12, Gisimil spring, Goseong-ri; 13, Cheonwangs Temple, Seogwipo-dong; 14, Bonggae-dong (streamlet); 15, Halla Eco-forest, Bonggae-dong; 16, Joelm Forest, Bonggae-dong; 17, Gyora-ri (streamlet); 18, Sinchon-ri, Jocheon-eup (salt marsh); 19, Keunmul spring, Sinchon-ri; 20, Jocheon Port (coast spring); 21, Dongbaek park, Seonheul-ri; 22, Banmup Pond, Seonheul-ri; 23, Jongdal-ri, Gujwa-eup (reed marsh); 24, Udo islet (spring). Localities 25–35, southern side of Mount Halla, Seogwipo city area: 25, Wolrangji, Nansan-ri, Seongsan-eup; 26, Samdal-ri (pond); 27, Taechung-ri, Namwon-eup (salt marsh); 28, Hannam-ri (reservoir); 29, Jeongbang Fall, Seogwipo-dong; 30, Saeseom islet; 31, Geolmae Eco-Park, Seoheung-dong; 32, Yeongcheoncheon stream, Sanghyo-ri; 33, Dosuncheon stream, Hawon-dong; 34, 1100-Hill Swamp; 35, Yeraechen stream, Haye-dong.](image-url)
Table 1. Localities and ostracod materials examined.

| Map locality no. | Locality | Habitat | Date | Latitude and longitude | Species (number of specimens) | f = female, m = male, juv = juvenile |
|------------------|----------|---------|------|-------------------------|--------------------------------|-----------------------------------|
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon | Puddle, seep in artificial cave | 5 October 2011 | 33° 17′ 55.9″ N, 126° 10′ 04.0″ E | Terresticythere ivanovae (1m, 1juv) Scottia pseudobrowniana (1) |
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon | Rock pool at coast | 13 May 2012 | 33° 17′ 55.9″ N, 126° 10′ 04.4″ E | Heterocypris salina (1f) |
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon | Small ditch leading from cave | 13 May 2012 | 33° 17′ 55.9″ N, 126° 10′ 04.4″ E | Heterocypris salina (1f) |
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon, Jeju-si | Seeps in the crevices of cave walls (natural cave) | 6 September 2013 | 33° 17′ 55.9″ N, 126°10′ 04.0″ E | Scottia pseudobrowniana (2f, 2m) Cyclocypris anacola n. sp. (2f) |
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon, Jeju-si | Seeps in the crevices of cave walls (artificial cave) | 6 September 2013 | 33° 17′ 55.9″ N, 126°10′ 04.0″ E | Scottia pseudobrowniana (1f) Cyclocypris anacola n. sp. (1f) |
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon, Jeju-si | Seeps in the crevices of artificial cave walls | 6 September 2013 | 33° 17′ 55.9″ N, 126° 10′ 04.1″ E | Physocypris nipponica(1) Cyclocypris anacola n. sp. (1m) Terrestricythere ivanovae (1juv. Empty carapace) |
| 1                | Suwolbong, Gosan-ri, Hangyeong-myeon, Jeju-si | Coastal small spring, seeps and ditch from spring | 6 September 2013 | 33° 18′ 00.54″ N, 126° 10′ 03.56″ E | Scottia pseudobrowniana (1m) |

(Continued)
| Map locality no. | Locality | Habitat | Date           | Latitude and longitude | Species (number of specimens) |
|------------------|----------|---------|----------------|------------------------|-------------------------------|
| 2                | Yonguncheon, Gosan-ri, Hangyeong-myeon | Spring, seep | 5 October 2011 | 33° 18’ 00.3” N, 126° 10’ 13.5” E | Dolerocypris ikeyai (2f) Scottia pseudobrowniana (6) |
| 3                | Yongdang-ri, Hangyeong-myeon, Jeju-si | Marsh | 26 June 2004 | 33° 19’ 38.6” N, 126° 10’ 34.3” E | Fabaeformiscandona subacuta (2f) Physocypria nipponica (5) |
| 4                | Cheongsu-gotjawal, Hangyeong-myeon, Jeju-si | Natural swamp in mountain lowlands, about 1 m deep | 7 September 2013 | 33° 18’ 21.78” N, 126° 15’ 42.36” E | Physocypria nipponica (12) Dolerocypris sinensis (1f) Fabaeformiscandona subacuta (6m, 1f) Cypretta seurati (1f) Tanycypris alfonsi (2f) |
| 5                | Eoum-ri, Aewol-eup, Jeju-si | Small pond for irrigation beside road, around 1 m deep | 7 September 2013 | 33° 24’ 44.54” N, 126° 19’ 57.65” E | Physocypria nipponica (89) Strandesia flavescens (1f) Physocypria nipponica (2) |
| 6                | Bilremot, Eoeum-ri, Aewol-eup | Lotus pond | 5 October 2011 | 33° 24’ 13.6” N, 126° 21’ 03.1” E | Physocypria nipponica |
| 7                | Dombaemul, Eoeum-ri, Aewol-eup | Old reservoir | 5 October 2011 | 33° 24’ 14.2” N, 126° 20’ 21.2” E | Physocypria nipponica |
| 7                | Dombaemul, Eoeum-ri, Aewol-eup, Jeju-si | Old pond for irrigation in the village, maximum 1.5 m in depth | 7 September 2013 | 33° 24’ 14.2” N, 126° 20’ 21.2” E | Tanycypris alfonsi (1f) |
| 8                | Geumseong-ri, Aewol-eup, Jeju-si | Estuary | 7 September 2013 | 33° 26’ 48.09” N, 126° 17’ 57.07” E | Dolerocypria mukaishimensis (8) |

(Continued)
|   | Location                                    | Description            | Date          | Latitude, Longitude   | Species                        |
|---|--------------------------------------------|------------------------|---------------|-----------------------|--------------------------------|
|9  | Gwakji, Aewol-eup, Jeju-si                 | Run-off from a coastal spring, brackish water | 7 September 2013 | 33° 27' 00.06" N, 126° 18' 12.98" E | *Ishizakiella miurensis* (1m) |
|10 | Sangga-ri, Aewol-eup                       | Pond for irrigation    | 5 October 2011 | 33° 25' 53.9" N, 126° 20' 59.6" E | *Cypretta seurati* (12f) *Physocypria nipponica* (23) |
|11 | Sowangcheon, Goseong-ri, Aewol-eup         | Stream                 | 5 October 2011 | 33° 27' 18.4" N, 126° 24' 07.1" E | *Cavernocypris coreana elongata* (14f) |
|12 | Gusimul, Goseong-ri, Aewol-eup             | Spring, seep           | 5 October 2011 | 33° 27' 23.8" N, 126° 24' 34.6" E | *Cavernocypris coreana elongata* (15f) *Eucypris pigra* (5f) |
|13 | Cheonwangsa Temple, Nohyeong-dong, Jeju-si | Spring, seep           | 26 January 2003 | 33° 24' 29.6" N, 126° 29' 42.2" E | *Candona quasiakaina* (14m, 1f) *Cypretta seurati* (1f) *Bradleycypris vittata* (2f) |
|14 | Bongge-dong, Jeju-si                       | Seep in dried streamlet| 27 October 2011 | 33° 25' 21.3" N, 126° 36' 35.2" E | *Candona quasiakaina* (14m, 1f) *Cypretta seurati* (1f) *Bradleycypris vittata* (2f) |
|15 | Halla Eco-forest, Bongge-dong, Jeju-si     | Pond                   | 27 October 2011 | 33° 25' 53.8" N, 126° 35' 51.3" E | *Cavernocypris coreana elongata* (4f) *Bradleytriebella tuberculata* (7f) *Cypretta seurati* (3f) |
|16 | Jeolmul Forest, Bonggae, Jeju-si           | Around spring          | 14 May 2012    | 33° 26' 16.4" N, 126° 37' 46.5" E | *Cavernocypris coreana elongata* (4f) *Bradleytriebella tuberculata* (7f) *Cypretta seurati* (3f) |
|17 | Gyorae-ri, Jocheon-eup, Jeju-si            | Stream side seep       | 8 September 2013 | 33° 26' 09.98" N, 126° 40' 50.81" E | *Candona quasiakaina* (14m, 1f) *Cypretta seurati* (1f) *Bradleycypris vittata* (2f) |
Table 1. (Continued).

| Map locality no. | Locality                          | Habitat                          | Date            | Latitude and longitude | Species (number of specimens) |
|------------------|-----------------------------------|-----------------------------------|-----------------|------------------------|------------------------------|
| 18               | Sinchon-ri, Jocheon-eup, Jeju-si | Salt marsh                        | 6 September 2013| 33° 32' 08.79" N, 126° 37' 45.21" E | Dolerocypria mukaishimensis (1f, 1m) Ishizakiella supralittoralis (1f, 1m) |
|                  |                                   | Seaside spring                    | 28 October 2011 | 33° 32' 15.9" N, 126° 37' 05.9" E | Ishizakiella miurensis (2m) |
| 19               | Sinchon-ri, Jocheon-eup, Jeju-si | Coastal spring (used for fishermen’s bath), sandy bottom, draining to sea | 5 September 2013 | 33° 32' 16.27" N, 126° 37' 04.94" E | Dolerocypria mukaishimensis (16) |
|                  |                                   | Coastal spring                    | 13 May 2012     | 33° 32' 28.1" N, 126° 38' 11.2" E | Dolerocypria mukaishimensis (2f) |
| 20               | Jocheon-ri, Jocheon-eup, Jeju-si | Marsh (pond)                      | 28 October 2011 | 33° 30' 32.1" N, 126° 43' 02.2" E | Bradleycypris vittata (4f) |
| 21               | Dongbaek park, Seonhol-ri, Jocheon-eup, Jeju-si |                          | 12 May 2012     | 33° 30' 30.6" N, 126° 43' 02.8" E | Bradleycypris vittata (10f) |
| 22               | Banmot Pond, Seonheul-ri, Jocheon, Jeju-si |                          | 25 January 2003 | 33° 30' 42.48" N, 126° 53' 52.6" E | Dolerocypria mukaishimensis (2) |
|                  | Jongdal-ri, Gujwa-eup, Jeju-si   | Reed marsh                        | 18 November 2003| 33° 30' 42.1" N, 126° 57' 54.9" E | Stenocypris hirutai (2f) |

(Continued)
| Location | Habitat | Date | Coordinates | Species |
|----------|---------|------|-------------|---------|
| Wolrangji, Nansan-ri, Seongsan-eup, Seogwipo-si | Marsh (natural) | 8 September 2013 | 33° 24' 42.54" N, 126° 49' 32.29" E | Cypretta seurati (5f) Vestalenula cylindrica (6f) Limnocythere sp. (1f) |
| Samdal-ri, Seongsan-eup, Seogwipo-si | Pond for irrigation, about 1 m deep | 8 September 2013 | 33° 23' 01.07" N, 126° 50' 15.33" E | Cypretta seurati (23f) Physocypria nipponica (1) Tanycypris centa (5f) Bradleytriebella tuberculata (1f) Limnocythere sp. (1f) Fabaeformixandona subacuta (1m, 1f) Cypretta karanovicae n. sp. (11f) Dolerocypria mukaishimensis (5) |
| Taeheung-ri, Namwon-eup, Seogwipo-si | Salt marsh | 8 September 2013 | 33° 17' 22.67" N, 126° 45' 09.30" E | Dolerocypria mukaishimensis (5) |
| Hannam-ri, Namwon-eup, Seogwipo-si | Pond or reservoir at the entrance of horse farm, about 1–1.5 m deep | 8 September 2013 | 33° 17' 55.9" N, 126° 10' 04.0" E | Physocypria nipponica (6) Cypretta seurati (11f) Bradleycypris vittata (58f) Dolerocypria sinensis (48f) Cypretta seurati (9f) Dolerocypria mukaishimensis (1) |
| Jeongbang Fall, Seogwipo-dong, Seogwipo-si | Water fall | 6 October 2011 | 33° 14' 43.6" N, 126° 34' 18.5" E | |
| Saeseom islet, Seogwi-dong, Seogwipo-si | Salt marsh | 5 June 2004 | 33° 14' 12.2" N, 126° 33' 35.8" E | |
| Map locality no. | Locality                                      | Habitat                      | Date          | Latitude and longitude | Species (number of specimens) | **f** = female, **m** = male, **juv** = juvenile |
|------------------|-----------------------------------------------|------------------------------|---------------|------------------------|--------------------------------|-----------------------------------------------|
| 31               | Geolmae Eco-Park, Seoheung-dong, Seogwipo-si | Marsh                        | 13 January 2007 | 33° 14' 55.9" N, 126° 33' 17.6" E | *Physocypria nipponica* (13)   |
| 32               | Yeongcheoncheon, Sanghyo-dong, Seogwipo-si   | River (stream)               | 6 October 2011 | 33° 17' 54.2" N, 126° 33' 22.1" E | *Cypretta seurati* (1f) *Bradleycypris vittata* (1f) |
| 33               | Dosuncheon, Hawon-dong, Seogwipo-si          | Seep in dried streamlet      | 7 October 2011 | 33° 21' 10.4" N, 126° 29' 48.7" E | *Eucypris pigra* (c.80f) *Dolerocypris ikeyai* (1f) |
| 34               | 1100 Hill, Jeju-si                           | Wetland                      | 15 May 2012    | 33° 21' 27.2" N, 126° 27' 48.2" E | *Fabaeformiscandona subacuta* (5m, 12f) |
| 35               | Yeraecheon, Hayedong, Seogwipo-si            | Riverside sand, lower reaches | 7 October 2011 | 33° 14' 30.2" N, 126° 23' 46.7" E | *Potamocypris variegata* (4f) *Cypridopsis vidua* (5f) *Cypretta seurati* (1f) |

Note: Sex determination of some species is not possible without dissection, and so for some samples the number of individuals of each sex is not given.
coated with gold before being photographed with a JEOL 5800 LV scanning electron microscope (JEOL, Tokyo, Japan). Carapaces of *Cypretta seurati* used for measurements were first photographed using SEM, and the digital images then measured using the software ImageJ (Research Services Branch, National Institute of Mental Health, Bethesda, MD, USA; http://imagej.nih.gov/ij/).

The type and figured material is deposited in the National Institute of Biological Resources (NIBR), Korea (numbers with prefix NIBRIV), and in the Department of Biological Science, Daegu University, Korea (numbers with prefix DB).

Terminology of the appendage chaetotaxy follows that of Broodbakker and Danielopol (1982), Martens (1987), and Meisch (2000).

**Results**

Twenty-six species of brackish and freshwater ostracods were recovered, representing four superfamilies, and six families (*Tables 1, 2*). Two species are new and described herein.

**Order** **PODOCOPIDA** Sars, 1866  
**Suborder** **CYPRIDOCOPINA** Jones in Chapman, 1901  
**Superfamily** **CYPRIDOIDEA** Baird, 1845  
**Family** **CANDONIDAE** Kaufmann, 1900  
**Subfamily** **CANDONINAE** Kaufmann, 1900  
**Genus** *Candona* Baird, 1845  
*Candona quasiakaina* Karanovic and Lee, 2012  
(Figure 2A, B)

**Remarks**

*Candona quasiakaina* was described from a mountain stream near Seoul, approximately 440 km to the north of Jeju Island (Karanovic and Lee 2012). This species was found in small numbers (14 males, one female) from only one locality during our survey, a seep in a dried streamlet (locality 14).

**Genus** *Fabaeformiscandona* Krstić, 1972  
*Fabaeformiscandona subacuta* (Yang in Hou et al. 1982)

*Candona subacuta* Yang in Hou et al. 1982  
*Candona japonica* Okubo, 1990b  
*Fabaeformiscandona japonica* (Okubo, 1990) nov. comb. Schornikov and Trebukhova 2001

**Remarks**

This species has a widespread but patchy known distribution, including Spain, Japan, Korea, China, Thailand, Far-East Russia, Columbia, Australia, and New Zealand (see review of distribution in Escrivà et al. 2012). Escrivà et al. (2012) postulated that *F. subacuta* is invasive in Spain, with its origin probably centred in East Asia. Korean
Table 2. List of nonmarine ostracods collected from Jeju Island, South Korea during our surveys.

| Superfamily         | Family          | Subfamily         | Species                                                                 |
|---------------------|-----------------|-------------------|-------------------------------------------------------------------------|
| Cypridoidea         | Candonidae      | Candonininae      | *Candona quasiakaina* Karanovic and Lee, 2012                           |
|                     |                 |                   | *Fabaeformiscandona subacuta* (Yang in Hou et al. 1982)                   |
|                     |                 | Cyclocypridae     | *Physocypris nipponica* Okubo, 1990                                     |
|                     |                 | Paracypridae      | *Dolerocypris mukaishimensis* Okubo, 1980                                |
| Cyprididae          | Cyprettae      | Cypridae          | *Cypretta karanovicae* n. sp.                                          |
|                     |                 |                   | *Cypretta seurati* Gauthier, 1929                                       |
|                     |                 | Cypricercinae     | *Bradleycypris vittata* (Sars, 1903)                                    |
|                     |                 |                   | *Bradleytriebella tuberculata* (Hartmann, 1964)                          |
|                     |                 |                   | *Strandesia flavescens* Klie, 1932                                       |
|                     |                 |                   | *Tanycypris alonsi* Nagler, Geist and Matzke-Karasz, 2014                |
|                     |                 |                   | *Tanycypris centa* Chang, Lee and Smith, 2012                            |
|                     |                 | Cypridopsinae     | *Cavernocypis coreana elongata* (McKenzie, 1972)                        |
|                     |                 |                   | *Cypridopsis vidua* (O. F. Müller, 1776)                                |
|                     |                 |                   | *Potamocypris variegata* (Brady and Norman, 1889)                       |
|                     |                 | Cypinotinae       | *Heterocypris salina* (Brady, 1868)                                     |
|                     |                 | Dolerocypridae    | *Dolerocypris ikeyai* Smith and Kamiya, 2006                            |
|                     |                 |                   | *Dolerocypris sinensis* Sars, 1903                                      |
|                     |                 | Eucypridae        | *Eucypris pigra* (Fischer, 1851)                                        |
|                     |                 | Herpetocypridae   | *Stenocypris hirutai* Smith and Kamiya, 2006                            |
|                     |                 | Scottinae         | *Scottia pseudobrowniana* Kempf, 1971                                  |
| Cytheroidea         | Leptocytheridae | Leptocytherinae   | *Ishizakiella miurensis* (Hanai, 1957)                                  |
|                     |                 |                   | *Ishizakiella supralitoralis* Schornikov, 1974                          |
|                     |                 | Limnocytheridae   | *Limnothere sp.*                                                        |
| Darwinuloidea       | Darwinulidae    |                   | *Vestakanela cylindrica* Straub, 1952                                   |
| Terrestricytheroidea| Terrestricytheridae |               | *Terrestricyther eivanovae* Schornikov, 1969                         |
Figure 2. (A, B) *Candona quasiakaina*: (A) right view of male carapace (DB40033); (B) dorsal view of male carapace, anterior to right (DB40033). (C–F) *Cyclocypris anacola* n. sp.: (C) left view of female carapace (paratype, DB40035); (D) dorsal view of female carapace, anterior to right (paratype, DB40035); (E) internal view of female left valve (allotype, NIBRIV0000297034); (F) internal view of right valve (allotype, NIBRIV0000297034). (G–J) *Bradleytriebella tuberculata*: (G) left view of female carapace (DB40036); (H) dorsal view of female carapace, anterior to right (white triangles mark the areas where tubercles are weakly expressed) (DB40036); (I) internal view of female left valve (DB40037); (J) internal view of female right valve (DB40037). Scale bar = 587 µm for A, B; 209 µm for C–E; 269 µm for G–J.
specimens have previously been recovered from a river, rice field, lotus field, wetland and springs (Chang et al. 2012; Escrivà et al. 2012). Four localities (3, 4, 26 and 34) yielded this species during our surveys, in a swamp, marsh, irrigation pond and wetland.

Subfamily CYCLOCYPRIDINAE Kaufmann, 1900
Genus Cyclocypris Brady and Norman, 1889
Cyclocypris anacola n. sp.
(Figures 2C–F, 3, 4)

Type locality
Seeps and crevices of the walls in the entrance of a natural cave in volcaniclastic deposits at the coast of Suwolbong, Gosan-ri, Hangyeong-myeon, Jeju-si, Jeju Island, South Korea (33° 17′ 55.9′′ N, 126° 10′ 4.1′′ E) (locality 1 on Figure 1).

Type material
Holotype – dissected male (NIBRIV0000297033). Allotype – dissected female (NIBRIV0000297034). Paratypes – dissected female (DB40034), and whole, dried female (DB40035).

Material examined
One male from the type locality, 6 September 2013. Three females from seeps and crevices of the walls in the entrance of a nearby man-made cave (33° 17′ 55.9′′ N, 126° 10′ 4′′ E) (locality 1 on Figure 1), 6 September 2013.

Derivation of name
From the Greek, anakolos, meaning shortened or stunted, referring to the strongly reduced natatory setae of the antennae.

Diagnosis
Right valve overlaps left, greatest height anterior of adductor muscle scars, apex of curvature of anterior and posterior margins below mid-height, dorsal view ovoid, but relatively narrow, with anterior more pointed than posterior. Antenna with very reduced natatory setae, not reaching to end of next segment. Claw G2 of female antenna relatively short, approximately 80% length of claw G1. Seventh limb with relatively long g seta, approximately as long as final segment, and with relatively long, straight h2 seta. Claw Gp of caudal ramus slightly shorter than claw Ga, setae sa and sp approximately equal in length. Lobe b of hemipenes triangular in shape with narrowly rounded apex, lobe a with quadrate end, projecting beyond lobe b.
Figure 3. *Cyclocypris anacola* n. sp. (A) internal view of female right valve (allotype, NIBRIV0000297034); (B) female antennule (allotype, NIBRIV0000297034); (C) male antenna (holotype, NIBRIV0000297033); (D) distal section of female antenna (allotype, NIBRIV0000297034); (E) palp and endites of male maxillula (setae on endites not drawn) (holotype, NIBRIV0000297033); (F) left and right male fifth limb palps (holotype, NIBRIV0000297033).
Figure 4. *Cyclocypris anacola* n. sp. (A) male mandibular palp (holotype, NIBRIV0000297033); (B) alpha and beta setae of mandibular palp (holotype, NIBRIV0000297033); (C) male sixth limb (holotype, NIBRIV0000297033); (D) male seventh limb (holotype, NIBRIV0000297033); (E) male caudal ramus (holotype, NIBRIV0000297033); (F) hemipenis (holotype, NIBRIV0000297033).
Description

Carapace (Figures 2C–F, 3A) length 524–536 µm, height 304–320 µm. Right valve overlaps left along all margins. Ventral margin almost straight. Dorsal margin straight, slightly sloping towards posterior. Greatest height anterior of adductor muscle scars. Inner calcified lamella wider anteriorly than posteriorly. Right valve with list on anterior calcified lamella. Dorsal view ovoid, greatest width behind mid-length. Anterior more pointed than posterior. Carapace colour chestnut brown. Surface generally smooth, but with small area of very shallow, ill-defined pits in central-ventral area (only observable with SEM).

Antennule (Figure 3B) with seven articulated segments. First segment with one dorsal seta and two long ventral setae. Second segment with tiny Rome organ and one short dorsoapical seta. Third segment with one medium-length dorsoapical seta. Fourth segment with two long dorsoapical setae and two short ventroapical setae. Fifth segment with two long dorsoapical setae, and one short and one long ventroapical seta. Sixth segment with four long apical setae. Seventh segment with three long setae and aesthetasc ya.

Antennal (Figure 3C) natatory setae on third segment strongly reduced, not reaching to fifth segment. Male antenna with sub-divided fourth segment. Seta z3 very short, claw z2 well-developed, seta z1 medium-length. Claw G1 short, similar in length to z1. Seta G3 very small. Claw Gm short, less than half length of claw GM.

Female antenna (Figure 3D) with claw G2 approximately 80% length of claw G1. Setae z2 and z3 short to medium-length, seta z1 long, approximately reaching to end of claw G2. Claw Gm longer than in male, approximately 70% length of GM.

Mandible palp (Figure 4A, B) large with four segments. Alpha seta very short and slender. Beta seta very short and stout, with stiff setules. Final segment supporting three claws and two setae.

Maxillula (Figure 3E) with two-segmented palp. First segment with three setae on outer apical edge and one seta in sub-apical position near outer edge. Final segment quadrate with three robust setae and three shorter and more slender setae.

Fifth limb male palps (Figure 3F) asymmetrical. Left palp slightly widens distally with wide, bluntly rounded terminal hook. Right palp with tightly curved, finger-like terminal hook.

Sixth limb (Figure 4C) five-segmented, first segment with d1 seta. Second segment with long e seta, extending beyond end of third segment. Third segment with f seta reaching to about end of fourth segment. Fourth segment with two g setae, both extending just beyond fifth segment. Fifth segment with h1 and h3 setae of similar length, and with well-developed, robust, long claw h2.

Seventh limb with four segments (Figure 4D), first segment with d1, d2 and dp setae present. Second segment with e seta reaching beyond mid point of next segment. Third segment with long f seta, extending beyond end of third segment and g seta extending to end of fourth segment. Fifth segment with long, reflexed h3 setae, relatively long h1 and h2 setae.

Caudal ramus (Figure 4E) relatively robust, claw Gp slightly shorter than Ga. Seta sp almost reaching to base of claw Gp. Seta sa approximately one-third the length of claw Ga.
Hemipenes (Figure 4F) with strongly rounded outer margin and slightly curved inner margin, lobe a with quadrate shape distally. Lobe b triangular, with rounded apex, not reaching to end of lobe a.

Remarks
Three previously described *Cyclocypris* species have natatory setae not reaching beyond the claws of the antennae: *Cyclocypris breviseptosa* (Bronshtein, 1925), *C. mediosetosa* Meisch, 1987, and *C. diebeli* Absolon, 1973. *Cyclocypris breviseptosa* is known from only one site in north-east Russia, near the Arctic Circle (Bronshtein 1988). Compared with *C. anacola* n. sp., *C. breviseptosa* has longer natatory setae on the antennae, a wider a-lobe on the hemipenis, and is much more inflated in dorsal view (width/length = 0.71, compared with 0.55 for *C. anacola* n. sp.). *Cyclocypris mediosetosa* is known from France and Italy (Meisch 1987; Pieri et al. 2009). The overall carapace shape of *C. mediosetosa* is similar to that of *C. anacola* n. sp., although in dorsal view *C. mediosetosa* is slightly wider (width/length = 0.6), and the carapace has a vertical band of shallow pits mid-length. Additionally, *C. mediosetosa* has longer natatory setae, a S-shaped h2 seta on the seventh limb (straight with a small hook distally in *C. anacola* n. sp.) and considerably differently shaped hemipenes. Extant *C. diebeli* are only known from Hokkaido, Japan, although fossils are known from Europe (Matzke-Karasz et al. 2004). The carapace of *C. diebeli* is much more globular than that of *C. anacola* n. sp., has a series of small platelets along the anterior margin of the right valve, and opposite valve overlap (left valve overlaps right). The natatory setae of the antennae are much longer than those of *C. anacola* n. sp., reaching to almost the ends of the claws, and the hemipenes are shaped differently, especially the outer margins.

The strongly reduced natatory setae on the antennae indicate that this species cannot swim. The presence of an eye and dark coloration of the carapace suggest that this species may not be restricted to subterranean habitats.

Genus *Physocypria* Vávra, 1897

*Physocypria nipponica* Okubo, 1990

Remarks
Previously this species has been reported from various localities on the Korean Peninsula and Japan (Okubo 1990a, 2004; Smith and Janz 2008; Chang et al. 2012). *Physocypria kraepelini* Muller, 1903 has also been reported from Korea (Lee et al. 2000), and as Smith and Janz (2008) noted, the two species may be synonyms, although further work is required to confirm this. During our surveys, this species was recovered from nine localities (1, 3, 4, 6, 7, 10, 26, 28 and 31) from a range of habitats, including marshes, swamps, a lotus pond, irrigation ponds and a cave.

Subfamily PARACYPRIDINAE Sars, 1923

Genus *Dolerocypria* Tressler, 1937

*Dolerocypria mukaishimensis* Okubo, 1980
Remarks

*Dolerocypria mukaishimensis* is a relatively common species found in brackish water habitats around Japan (Okubo 1980; Nakao and Tsukagoshi 2002; Smith and Kamiya 2003), Korea (Lee et al. 2000; Karanovic and Lee 2012) and China (Dai et al. 1995). Karanovic and Lee (2012) figured a Korean specimen of *D. mukaishimensis* with three setae on the first segment of the sixth limb. Japanese specimens have two setae on this segment (Okubo 1980; Nakao and Tsukagoshi 2002), and all Korean material checked by us also has two setae, suggesting that Karanovic and Lee’s (2012) specimen is aberrant. This species was found in seven brackish water localities (8, 18, 19, 20, 23, 27 and 30) during our surveys.

**Family** CYPRIDIDAE Baird, 1845  
**Subfamily** CYPRETTINAE Hartmann, 1963  
**Genus** Cypretta Vávra, 1895  
*Cypretta karanovicae* n. sp.  
(Figures 5A–E, 6, 7)

*Type locality*
An irrigation pond about 1 m deep in Samdal-ri, Seongsan-eup, Seogwipo-si, Jeju Island, South Korea (33° 23′ 1.07″ N, 126° 50′ 15.33″ E) (locality 26 on Figure 1).

*Type material*
Holotype – dissected female (NIBRIV0000297035). Paratypes – three dissected females (NIBRIV0000297036, DB40041, DB40042) and one whole, dried female (DB40043).

*Material examined*
Eleven females (including type material) collected from the type locality, 8 September 2013.

*Derivation of name*
Named after Dr. Ivana Karanovic, Hanyang University, South Korea, in recognition of her contribution to Korean ostracod studies.

*Diagnosis*
Carapace relatively compressed in lateral view (H/L = 0.6), and sub-triangular in shape. Anterior margin slightly more inflated than posterior margin. Right valve overlaps left. Septa well developed along anterior margins of both valves. Dorsal view with maximum width posterior of mid-length. Surface of valves strongly pitted in central area; shallower pits towards margins of valves. Carapace with distinctive dark green patches. Claw G2 of antenna with robust serration, and approximately 85% length of claw G1, claw Gm very slender, approximately 80% length of claw GM.
Figure 5. (A–E) Cypretta karanovicae n. sp.: (A) left view of female carapace (paratype, DB40043); (B) internal view of female left valve (holotype, NIBRIV0000297035); (C) internal view of female right valve (holotype, NIBRIV0000297035); (D) dorsal view of female carapace, anterior to right (paratype, DB40043); (E) ventral view of female carapace, anterior to right (paratype, DB40043). (F–J) Cypretta seurati: (F) left view of female carapace (DB40038); (G) internal view of female left valve (DB40039); (H) internal view of female right valve (DB40039); (I) dorsal view of female carapace, anterior to right (DB40038); (J) dorsal view of female carapace, anterior to right (DB40040). Scale bar = 300 µm.
Figure 6. *Cypretta karanovicae* n. sp. (A) internal view of female right valve (holotype, NIBRIV0000297035); (B) female antennule (paratype, NIBRIV0000297036); (C) female antenna (holotype, NIBRIV0000297035); (D) female mandibular palp (paratype, DB40042); (E) detail of alpha and beta setae of mandibular palp (paratype, DB40042).
Alpha seta of mandibular palp with wide base, tapering distally and sporting one long, fine setule, and beta seta stout with numerous stiff setules. Sixth limb with short d1 seta, much shorter than d2 seta, and long f seta, reaching well beyond end of fifth segment. Caudal ramus with no sa seta, long Ga claw, and very small Gp claw and sp seta; seta sp longer than claw Gp.

Figure 7. *Cypretta karanovicae* n. sp. (A) female palp and endites of maxillula (setae on endites not drawn) (paratypes, DB40042); (B) female fifth limb (paratype, DB40042); (C) female sixth limb (holotype, NIBRIV0000297035); (D) female seventh limb (paratype, DB40041); (E) female caudal ramus (holotype, NIBRIV0000297035); (F) dorsal view of whole carapace showing coloration pattern.
Description

Carapace (Figures 5A–E, 6A) length 635–649 µm, height 366–376 µm. Right valve overlaps left along all margins. Lateral view sub-triangular, dorsal margin unevenly curved with clear hump at mid-length, very gently curved either side of hump. Anterior margin slightly more inflated than posterior margin, maximum curvature below mid-height. Ventral margin sinuous. Both valves with well-developed outer lists along ventral margins. Dorsal view egg-shaped with maximum width posterior of mid-length, posterior margin evenly rounded and more inflated than anterior margin; anterior margin slightly angular either side of valve margins. Internally, calcified inner lamella wider anteriorly than posteriorly, and right valve with well-developed groove running near free margin. Septa well developed along anterior margins of both valves. Surface of valves strongly pitted in central area, with shallower and smaller pits towards valve margins. Dorsal areas of valves almost smooth. Colour yellowish with dark green patches (Figure 7F).

Antennule (Figure 6B) with seven articulated segments. First segment with one dorsal seta and two long ventral setae. Second segment with tiny Rome organ and one short dorsoapical seta. Third segment with one short dorsoapical seta and one short ventroapical seta. Fourth and fifth segments each with two long dorsoapical setae and two short ventroapical setae. Sixth segment with four long and one tiny apical setae. Seventh segment with two long and one medium-length setae, and aesthetasc ya.

Antennal (Figure 6C) natatory setae on third segment long, extending to just beyond ends of claws. Shorter seta accompanying long natatory setae relatively very long, extending well beyond end of segment. Claw Gm very slender, approximately 80% length of claw GM. Claw G2 approximately 85% length of claw G1, and with serration more robust than other claws. Seta z3 stout, almost as long as claw G2.

Mandibular palp with four segments (Figure 6D). Alpha seta of mandibular palp with wide base, tapering distally and sporting one long, fine setule. Beta seta stout with numerous stiff setules (Figure 6E).

Maxillula (Figure 7A) with two-segmented palp. First segment with four setae on outer apical edge and one seta in sub-apical position near outer edge. Final segment elongate with one robust, claw-like seta and four more slender setae. Third endite with two smooth Zahnborsten.

Fifth limb (Figure 7B) endite with approximately 12 setae distally, and slender d seta on inner edge. Palp elongate and very lightly sclerotized, terminating with one long and two shorter setae.

Sixth limb (Figure 7C) five-segmented, first segment with short d1 seta and longer d2 seta. Second segment with long e seta, extending to end of fourth segment. Third segment with long f seta reaching well beyond end of fifth segment. Fourth segment with short g seta, reaching to approximately end of fifth segment. Fifth segment with tiny h3 seta, longer h1 seta and well-developed, robust claw h2.

Seventh limb (Figure 7D) first segment with d1, d2 and dp setae. Second segment with relatively short e seta. Third segment with short f seta at approximately mid-length. Pincer with short h3 seta and short, stout h2 seta.

Caudal ramus (Figure 7E) with delicate and short ramus. Claw Ga long, more than half length of ramus. Claw Gp very short, shorter than adjacent Sp seta. Sa seta absent.
Remarks

Three previously described species of *Cypretta* have a similar low lateral view to *C. karanovicae* n. sp.: *C. baylyi* McKenzie, 1966, *C. lutea* McKenzie, 1966 and *C. patialaensis* Battish, 1982. *Cypretta baylyi* is known from north-western Australia (McKenzie 1966; De Deckker 1981; Bayly 1997) and differs from *C. karanovicae* n. sp. in that the dorsal margin is more evenly curved, the anterior margin is more inflated and the dorsal view is slightly less globular with maximum width further towards the anterior. Additionally, *C. baylyi* is strongly pitted over the entire carapace surface and the caudal ramus has a much longer Gp claw compared with *C. karanovicae* n. sp. *Cypretta lutea* is another species known from north-western Australia (McKenzie 1966) and in addition to the low lateral view of the carapace, has a similar dorsal view to *C. karanovicae* n. sp. It differs from *C. karanovicae* n. sp. in that the surface is smooth with scattered pits, the dorsal margin is more evenly rounded, it lacks green patches, and the Gp claw of the caudal ramus is considerably longer at over half the length of claw Ga. *Cypretta patialaensis* is an Indian species (Battish 1982), which is distinguished by a noticeable asymmetry in dorsal view. Additionally, the carapace lacks green patches, and the Gp claw of the caudal ramus is much longer than that of *C. karanovicae* n. sp.

The caudal ramus of *C. karanovicae* n. sp. is unusual in that seta sp is larger than claw Gp, in contrast to most other species where Gp is larger than sp (some species lack sp). However, even though the taxonomy of the genus relies very heavily on the morphology of the caudal ramus, this appendage is partially reduced in *Cypretta* species, and thus the lengths of claws and setae could be relatively plastic. Further work is required to determine whether this appendage is a robust taxonomic character for species discrimination in this genus. So far this species is only known from the type locality (locality 26).

*Cypretta seurati* Gauthier, 1929
(Figure 5F–J)

Remarks

Adult females collected from Jeju Island showed a large size range from 620 through to 709 μm in length (Appendix 1). The dorsal view was noticeably variable in shape, with a width/length ratio ranging from 0.74 through to 0.81 (Figure 5I, J), and with the position of maximum width ranging from a position 38 to 43% of the length from the posterior margin (Appendix 1). This large variation may indicate that cryptic species exist within this widespread parthenogenetic form.

*Cypretta seurati* is widespread in circum-tropical regions and warmer areas of temperate zones (Meisch et al. 2007). It has previously been reported from Korea, including Jeju Island, by Kim and Min (1991a). In our surveys, it was collected from 10 localities (4, 10, 14, 17, 25, 26, 28, 29, 32 and 35) from a wide range of habitats, including marshes, seeps, irrigation ponds, natural pools, and rivers.

Genus *Bradleycypris* McKenzie, 1982
*Bradleycypris vittata* (Sars, 1903)
Remarks

This widespread Asian species has previously been reported from four localities on the Korean Peninsula (Chang et al. 2012). For an outline of its known distribution, see Chang et al. (2012). The specimens collected from Jeju Island were all females, and so the population from Thailand remains the only known occurrence of males (Savatenalinton and Martens 2010). *Bradleycypris vittata* was found at five localities (15, 21, 22, 29 and 32) during our surveys, in ponds, pools and the lower reaches of a river.

Genus *Bradleytriebella* Savatenalinton and Martens, 2009a

*Bradleytriebella tuberculata* (Hartmann, 1964) (Figure 2G–J)

*Strandesia tuberculata* Hartmann, 1964

*Strandesia decorata* (Sars, 1903) – Okubo 1990b, 2004. Synonymy herein.

*Bradleystrandesia tuberculata* (Hartmann, 1964) nov. comb. Savatenalinton and Martens 2009b

*Bradleytriebella tuberculata* (Hartmann, 1964) nov. comb. Savatenalinton and Martens 2009a

Remarks

The Korean specimens closely match the redescription provided by Savatenalinton and Martens (2009a), with the exception that the two small sub-marginal tubercles at approximately mid-height on the anterior part of the carapace (one on each valve) are very weakly developed or absent in the Korean material. In one specimen, there are very small tubercles on the carapace seen in dorsal view (marked with triangles on Figure 2H), which correspond to the areas where tubercules are present in specimens from other areas. Within the superfamily Cypridoidea, some species have ornamentation present in some specimens while it is lacking in others. For example, *Ilyocypris gibba* (Ramdohr, 1808), *Ilyocypris decipiens* Masi, 1905, *Prionocypris zenkeri* (Chyzer and Toth in Chyzer, 1858), *Heterocypris incongruens* (Ramdohr, 1808), and *Heterocypris salina* (Brady, 1868) typically have tubercles or denticles on the carapace, but such ornamentation can be lacking in some specimens/populations (Meisch 2000). In the superfamily Cytheroidea, the presence or absence of tubercles of *Cyprideis torosa* is ecophenotypically induced (e.g. Keyser 2005), although it is not known what causes differences in surface ornamentation in the Cypridoidea. As the appendages and other carapace features of the Korean specimens are identical to the redescription of *B. tuberculata* from Thailand, we conclude that the Korean specimens represent a form of *B. tuberculata* with very weakly developed or absent tubercules.
In Japan, both *Strandesia tuberculata* and *Strandesia decorata* (Sars, 1903) have been reported (Okubo 1990b), but later the Japanese specimens were considered to all be *S. decorata* (Okubo, 2004). However, *S. decorata* has a smooth carapace (Sars 1903; Savatenalinton and Martens 2010), whereas the Japanese specimens are clearly striated. We consider that the Japanese and Korean specimens are conspecific, and specimens with weak or no tubercles attributed to *S. decorata* by Okubo (1990b, 2000, 2004) are *B. tuberculata*. The Thai specimens figured by Savatenalinton and Martens (2009a) also appear to have two weakly developed posterior tubercles in addition to the two anterior tubercles, similar to *Strandesia spinulosa* Bronshtein in Akatova, 1958. Further investigation is required to determine whether these two species are synonyms.

*Bradleytriebella tuberculata* is known from India (Hartmann 1964 as *S. tuberculata*), Thailand (Savatenalinton and Martens 2009a), Japan (Okubo 1990b as *S. tuberculata* and *S. decorata*; Okubo 2000 as *S. tuberculata* and *S. decorata*; Okubo 2004 as *S. decorata*), and Taiwan (Yu et al. 2009, as *Bradleystrandesia tuberculata*, citing grey literature). From Japan and Thailand it is known from rice fields, whereas the Korean specimens were recovered from a streamside seep (locality 17) and an irrigation pond (locality 26).

**Genus Strandesia** Stuhlmann, 1888

*Strandesia flavescens* Klie, 1932

(Figures 8A, B, 9A, B)

**Remarks**

Since Klie’s (1932) original description of this large (length approximately 2 mm), conspicuous species from Indonesia, it has only been reported twice more, from India (Victor and Fernando 1979b) and Taiwan (Yu et al. 2009, citing grey literature). Victor and Fernando (1979a) were of the opinion that *S. flavescens* is a junior synonym of *Strandesia odiosa* (Moniez 1892), after they redescribed the types of *S. odiosa*, although this was not followed by later authors (e.g. Savatenalinton and Martens 2010). The slightly lower lateral view of the carapace and the list on the anterior calcified inner lamella of the left valve (marked by black triangle 1 on Figure 9A) of *S. flavescens* discriminate the two species. Additionally, *S. flavescens* has a series of septa-like structures in the internal part of the margins of the left valve (marked with black triangle 2 of Figure 9A), which are not mentioned or figured in Victor and Fernando’s redescriptions of *S. odiosa*. Because Victor and Fernando (1979a) considered the two species as synonyms, is not clear whether the previous Indian report is of *S. flavescens* or *S. odiosa*. Only one specimen of this species was collected during our surveys, from a lotus pond (locality 6).

**Genus Tanycypris** Triebel, 1959

*Tanycypris alfonsi* Nagler, Geist and Matzke-Karasz, 2014

(Figures 8C–F, 9C)

*Strandesia camaguinensis* Tressler, 1937 – Okubo 1972. Synonymy herein.

*Tanycypris pellucida* (Klie, 1932) – Okubo and Ida 1989; Okubo 2000, 2004. Synonymy herein.
Figure 8. (A, B) *Strandesia flavescens*: (A) internal view of female left valve (DB40044); (B) internal view of female right valve (DB40044). (C–F), *Tanycypris alfonsi*: (C) internal view of female left valve (DB40045); (D) internal view of female right valve (DB40045); (E) lateral view of posterior inner lamella of female left valve (DB40045); (F) external view of female right valve (DB40045). (G, H) *Potamocypris variegata*: (G) left view of female carapace (DB40046); (H) dorsal view of female carapace, anterior to right (DB40046). (I, J) *Heterocypris salina*: (I) left view of female carapace (DB40047); (J) dorsal view of female carapace, anterior to right (DB40047). Scale bar = 725 µm for A, B; 495 µm for C, D, F; 164 µm for E; 207 µm for G, H; 409 µm for I, J.
Remarks

*Tanycypris alfonsi* was described using specimens collected from the Munich Botanical Gardens, Germany (Nagler et al. 2014). The German specimens were collected from containers with hydrophytes in glasshouses of the botanical gardens, together with *T. centa*, another Korean species, and they are considered to be an artificial introduction, unwittingly transported with plants to the botanical gardens. The Korean specimens were collected from two ponds and are most probably a natural occurrence.

*Tanycypris pellucida* (Klie 1932) has been reported from Japan (Okubo 1972, as *Strandesia camaguinensis*; 2000, 2004; Okubo and Ida 1989), but Chang et al. (2012) noted that the Japanese specimens are different from Klie’s original description, and more similar to *Tanycypris siamensis* Savatenalinton and Martens, 2009a. For this study, the specimen figured by Okubo (2004) (labelled ‘Tany 30’) was investigated. The specimen lacks the groove along the posterior and anterior margins of the left valve, and so is not *T. siamensis*, which does have a groove running along these margins (Savatenalinton and Martens 2009a). Okubo’s (2004) specimen is, however, very similar to *Tanycypris alfonsi*, which also lacks the groove along the anterior and posterior margins. The specimen’s accompanying appendages are incomplete (missing the antennae and caudal rami) and embedded in an unknown matrix (together with the valves) that makes detailed observation difficult. However, it is probable that the Japanese *Tanycypris* species is conspecific with the Korean and Germany species. During our surveys, *Tanycypris alfonsi* was found in two irrigation ponds (localities 5 and 7).

Figure 9. (A, B) *Strandesia flavescens*: (A) internal view of female left valve (DB40044); (B) internal view of female right valve (DB40044). (C) *Tanycypris alfonsi*: internal view of female left valve, specimen figured in Okubo (2004) (Tany 30). (D) *Stenocypris hirutai*: internal view of female right valve (DB40048).
**Tanycypris centa** Chang, Lee and Smith, 2012

**Remarks**
Previously, this species was reported from one locality in the lower reaches of the Hyeongsan River on the south-east of the Korean Peninsula (Chang et al. 2012). The specimens found on Jeju Island were collected from a pond, and indicate that the species may be relatively widespread in southern Korea. It has also been collected from the Munich Botanical Gardens, Germany (Renate Matzke-Karasz pers. comm.), where it is probably an alien species (see above under *Tanycypris alfonsi*). This species was recovered from only one locality (26), an irrigation pond.

Subfamily **CYPRIDOPSINAE** Kaufmann, 1900  
Genus **Cavernocypris** Hartmann, 1964  
*Cavernocypris coreana elongata* (McKenzie, 1972)

**Cypridopsis coreana elongata** McKenzie, 1972  
*Cavernocypris coreana* (McKenzie, 1972) nov. comb. Marmonier et al. 1989

**Remarks**
This species has been previously reported from Korea, usually associated with groundwater discharge at the surface, or from caves (McKenzie 1972; Chang et al. 2012). On Jeju Island we recovered this species from around springs and a stream (localities 11, 12 and 16).

Genus **Cypridopsis** Brady, 1867  
*Cypridopsis vidua* (O.F. Müller, 1776)

**Cypris vidua** Müller, 1776  
**Cypris pincta** Straus, 1821  
**Cypridopsis obesa** Brady and Robertson, 1869  
**Cypridopsis helvetica** Kaufmann, 1900  
**Cypridopsella tumida** Kaufmann, 1900  
**Cypridopsis parva** G.W. Müller, 1900  
**Cypridopsis mariae** Rome, 1943  
**Cypridopsis parvoides** J.M. Martens, 1977  
**Cypridopsis biwaensis** Okubo, 1990a

**Remarks**
This widespread species was previously reported from the Korean Peninsula (Chang et al. 2012). Similar to the previous Korean report, the longest seta of the antennal exopodite is long, reaching beyond the distal end of the second endopodal segment. On Jeju Island this species was encountered only once, from the lower reaches of a river (locality 35).
Genus *Potamocypris* Brady, 1870

*Potamocypris variegata* (Brady and Norman, 1889)
(Figure 8G, H)

*Cypridopsis variegata* Brady and Norman, 1889

*Potamocypris variegata* (Brady and Norman, 1889) ** nov. comb. ** Daday 1900

**Remarks**

This species has a wide, probably Holarctic distribution (see review of distribution in Meisch 2000), but this is the first report from north-east Asia. It is often found in stagnant and slow flowing waters with dense vegetation (Meisch 2000). During our surveys, *Potamocypris variegata* was found at only one locality (locality 35), in the lower reaches of a river.

Previously, Kim and Min (1991a) reported *Potamocypris mastigophora* (Meuthuen, 1910) (as *Potamocypris producta* (Sars, 1924)) from Jeju Island. Their specimens were ‘severely damaged’ by formalin, and they noted that they were unable to illustrate their specimens in detail (Kim and Min 1991a). Their species determination therefore remains questionable, but as their specimens have five spine-like setae on the final segment of the maxillula (in contrast to four in *P. variegata*), they are clearly a different species.

Subfamily *CYPRINOTINAE* Bronshtein, 1947

Genus *Heterocypris* Claus, 1892

*Heterocypris salina* (Brady, 1868)
(Figure 8I, J)

*Cypris salina* Brady, 1868

*Cypris fretensis* Brady and Robertson, 1870

*Cyprinotus inaequalvis* Bronshtein, 1928

*Heterocypris salina* (Brady, 1868) ** nov. comb. ** Klie in Stammer 1932

**Remarks**

*Heterocypris salina* has a Holarctic distribution often found in fresh to slightly brackish waters (Meisch 2000). Its presence along the coast in Korea is thus not unexpected, but this is the first record from the country. It was found at one locality (locality 1) from a freshwater water rock pool and in a small ditch leading from a cave, both of which were overlooking the sea.

Subfamily *DOLEROCYPRIDINAE* Triebel, 1961

Genus *Dolerocypris* Kaufmann, 1900

*Dolerocypris ikeyai* Smith and Kamiya, 2006
Remarks
This species is currently known from Japan and Korea. It is a typical inhabitant of groundwater discharge at the surface, usually in small springs and seeps with a muddy substrate (Smith and Kamiya 2006; Smith 2011; Chang et al. 2012; this study). A total of three specimens were found at two localities (localities 2 and 33) in springs and seeps during our surveys. Currently, males are only known from two small Japanese islands (Smith and Kamiya 2006; Smith 2011); the specimens from Jeju Island are all females, but the three specimens collected are not sufficient in number to determine the reproductive mode of the population.

*Dolerocypris sinensis* Sars, 1903

Remarks
Kim and Min (1991b) previously reported this widespread Eurasian species from Jeju island. A pool below a waterfall, and a swamp (localities 4 and 29) both yielded this species during our surveys.

Subfamily **EUCYPRIDINAE** Bronshtein, 1947
Genus *Eucypris* Vávra, 1891
*Eucypris pigra* (Fischer, 1851)

Remarks
Previously, this widespread Palaearctic species was reported from Korea by Chang et al. (2012). It was found at two localities (localities 13 and 33) during our surveys, in springs and seeps, a typical habitat for this species.

Subfamily **HERPETOCYPRIDINAE** Kaufmann, 1900
Genus *Stenocypris* Sars, 1889
*Stenocypris hirutai* Smith and Kamiya, 2006
(Figure 9D)

Remarks
This species has previously been reported from the island of Yakushima in Kagoshima Prefecture (Smith and Kamiya 2006), and in Shiga Prefecture (Smith 2011), Japan. The significantly reduced natatory setae on the antennae clearly distinguish this species from *Stenocypris hislopi*, which has previously been reported from Korea (Kim and Min 1991a). The Jeju Island specimens came from a spring (locality 24), a similar habitat to the Japanese specimens (springs and river gravels).
Subfamily SCOTTINAE Bronshtein, 1947
Genus Scottia Brady and Norman, 1889
Scottia pseudobrowniana Kempf, 1971

Cypris browniana Jones, 1850
Scottia browniana nov. comb. Brady and Norman, 1889
Scottia pseudobrowniana Kempf, 1971

Remarks
Scottia pseudobrowniana was previously reported from Korea by Chang et al. (2012). The specimens from Jeju Island were collected from a man-made cave, and seeps and springs (localities 1 and 2), types of habitat that are typical for this species.

Superfamily CYTHEROIDEA Baird, 1850
Family LEPTOCYTHERIDAE Hanai, 1957
Subfamily LEPTOCYTHERINAE Hanai, 1957
Genus Ishizakiella McKenzie and Sudijono, 1981
Ishizakiella miurensis (Hanai, 1957)
(Tanella miurensis Hanai, 1957)
Tanella pacifica Hanai, 1957 (postscript)
Ishizakiella pacifica (Hanai, 1957) nov. comb. Tsukagoshi 1992

Remarks
Ishizakiella miurensis has previously been reported from brackish habitats along the Pacific and Sea of Japan sides of the island of Honshu, and the western and eastern sides of the island of Kyushu, Japan (Tsukagoshi 1994; Yamaguchi 2000). The specimens from Jeju Island are the first outside of Japan, but occur less than 300 km west of the westernmost locality in Kyushu, and thus are not unexpected. On Jeju Island it was found at two localities (localities 9 and 19), both in the run-off of springs at the coast in brackish water.

Ishizakiella supralittoralis (Schornikov, 1974)

Tanella supralittoralis Schornikov, 1974
Ishizakiella supralittoralis (Schornikov, 1974) nov. comb. Tsukagoshi 1994

Remarks
This species was recently reported from coastal rockpools near Busan, South Korea (Yoo et al. 2012). Other localities include the Kuril Islands (Schornikov 1974) and Japan (Tsukagoshi 1994; Yamaguchi 2000; Smith and Kamiya 2003). It was collected from a salt marsh (locality 18) during our surveys.
Figure 10. (A, B) *Ishizakiella miurensis*: (A) external view of male right valve (DB40049); (B) internal view of male left valve (DB40049). (C, D) *Limnocythere* sp.: (C) right view of female carapace (DB40050); (D) dorsal view of female carapace, anterior to right (DB40050). (E–H) *Vestalenula cylindrica*: (E) internal view of female left valve (DB40051); (F) internal view of female right valve (DB40051); (G) ventral view of female right valve (DB40051); (H) dorsal view of female carapace, anterior to right (DB40052). Scale bar = 270 µm for A, B; 137 for C, D; 183 µm for E–H.
Family **LIMNOCYHERIDAE** Klie, 1938
Subfamily **LIMNOCYHERINAE** Klie, 1938
Genus *Limnocythere* Brady, 1867

*Limnocythere* sp. (Figure 10C, D)

**Remarks**
This species belongs to the *stationis* group of *Limnocythere*, characterized by a reduced seventh limb, which is significantly smaller than the sixth limb, and a similar carapace shape (Martens 1990). The lack of post-ventral alae on the carapace indicates that it is not the widespread *Limnocythere stationis* (Vávra, 1891), which has previously been reported from Korea (Lee et al. 2000). It is also sufficiently different from other species of the group to suggest that it is an undescribed species, but as no males were recovered, it is not described herein. On Jeju Island it was found at two localities (25 and 26), in a marsh and an irrigation pond.

Superfamily **DARWINULOIDEA** Brady and Norman, 1889
Family **DARWINULIDAE** Brady and Norman, 1889
Genus *Vestalenula* Rossetti and Martens, 1998

*Vestalenula cylindrica* Straub, 1952 (Figure 10E–H)

*Darwinula cylindrica* Straub, 1952
*Vestalenula cylindrica* (Straub, 1952) nov. comb. Janz et al. 2001
*Vestalenula* sp. – Smith and Kamiya, 2008

**Remarks**
With a height/length ratio of 0.45, and a Gm claw on the antenna that is about 50% the length of claw GM, this species most closely resembles *Vestalenula cylindrica*, which has previously been reported from Korea (Chang et al. 2012). However, the keel on the right valve is relatively short, at about 18% of the length of the valve (Figure 10G), more similar to the keel of *Vestalenula cornelia* (see Smith et al. 2006). This apparent overlapping of characters of two species could indicate that there are unrecognized cryptic species within the genus, or that these characters are more plastic than previously assumed. Without a detailed statistical analysis of the amount of variation of features within the genus (which requires additional material), this issue cannot be currently resolved. *Vestalenula cylindrica* was found in one sample during our surveys, collected from a marsh (locality 25).

Superfamily **TERRESTRICYTHEROIDEA** Schornikov, 1969
Family **TERRESTRICYTHERIDAE** Schornikov, 1969
Genus *Terrestriocythere* Schornikov, 1969

*Terrestriocythere ivanovae* Schornikov, 1969 (Figure 11A–C)
Remarks

The adult male and two juvenile specimens of *Terrestricythere ivanovae* recovered were all in a badly preserved state, indicating that they were probably deceased when collected. Although unlikely, we cannot rule out that they may have been transported into the cave by natural or artificial means after death.

The superfamily Terrestricytheroidea consists of only five described species, known from the Russian Far East (Schornikov 1969, 1980) the Black Sea (Schornikov and Syrtlanova 2008), the UK (Horne et al. 2004), France (Scharf and Keyser 1991) and Japan (Hiruta et al. 2007). The shape of the Korean adult male specimen’s carapace, seventh limb and hemipenis, although poorly preserved, closely match those of *T. ivanovae* (Figure 11A–C).

Three previous reports of *T. ivanovae* exist, from the far-east of Russia (two localities), and France (Schornikov 1969, 1980; Scharf and Keyser 1991). The Russian specimens were recovered from amongst small pebbles kept moist by mist, rain and sea spray, and supralittoral salt-tolerant plants and littoral filamentous algae. The French specimens were recovered from a freshwater lake. The Korean specimens were recovered from freshwater pools in two coastal caves (locality 1), which drain into the nearby seashore through a brooklet.

Figure 11. *Terrestricythere ivanovae*: (A) internal view of male left valve (DB40053); (B) male seventh limb (DB40053); (C) hemipenis (partially disarticulated due to poor preservation) (DB40053).
Discussion

Of the six ostracod species previously reported from Jeju Island by Kim and Min (1991a, 1994b), two species, namely *Cypretta seurati* and *Dolerocypris sinensis*, were also found during our study. This difference is probably a reflection of the different types of habitat targeted during the relevant surveys; with the exception of *Potamocypris mastigophora*, the species reported by Kim and Min (1991a, 1994b) are typical taxa of rice fields, a habitat targeted by them, but not during our surveys. There are now 28 named species of non-marine ostracods reported from Jeju Island, and the two new species and seven new records for Korea reported herein increase the known Korean non-marine ostracod fauna to about 50 named species/subspecies.

The most diverse ostracod subfamily on Jeju Island is the Cypricercinae, represented by five species. This subfamily is the most diverse of the family and is strongly represented in tropical to subtropical regions, but only *Strandesia flavescens* was previously known exclusively from tropical zones (Indonesia and possibly India; see above). The other four Cypricercinae species are known from slightly cooler areas, such as the Korean Peninsula, Japan and China.

The presence of a *Cyclocypris* species on the island is unusual as this genus is typically found in cooler regions of the northern hemisphere. For example, in Japan, *Cyclocypris* species are currently only known from Hokkaido, which has a much cooler climate compared with the rest of the Japanese archipelago. This may be why *Cyclocypris anacola* n. sp. was found in cooler cave habitats on Jeju Island and not in surface water bodies. The discovery of a *Terrestricythere* species on the island is also significant in that this is the first record of the superfamily from a cave, and in a subtropical climate. Previous records are from lakes, marine beaches, and supralittoral zones in temperate or sub-arctic climates. In our study, *Terrestricythere ivanovae* was found in the same cave system as *C. anacola* n. sp., which suggests that the caves or connecting groundwater may be a refuge for these two species.

The recovery of two specimens of an undescribed *Limnocythere* species increases the total of the *stationis* group to nine. *Limnocythere stationis* is known across the Palaearctic, including Japan and Korea (Lee et al. 2000; Smith and Janz 2009), *L. notodonta* Várvá, 1906 from Indonesia and the Seychelles (Várvá 1906; McKenzie 1971), and *L. dorsosicula* De Deckker, 1981 from Australia (De Deckker 1981). *Limnocythere cyphoma* Smith and Janz, 2009, *L. fude* Smith and Janz, 2009, *L. kamiyai* Smith and Janz, 2009, and *L. levigatus* Smith and Janz, 2009 are currently only known from Lake Biwa (Smith and Janz 2009), while *L. xinanensis* Zhao, 1987 has been reported from China (Zhao 1987). Including the record herein of *Limnocythere* sp., seven of the group inhabit North-East Asia, indicating the group may have originated in this region. The *stationis* group appears to be phylogenetically distinct within the genus, and a review of *Limnocythere* would probably conclude that a new genus should be erected to accommodate it.

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Appendix 1. Sizes of carapaces of *Cypretta seurati*

| Locality (see Figure 1) | Length (µm) | Width (µm) | Width/length | Maximum width position (from posterior) (µm) | Maximum width position from posterior (% of length) |
|-------------------------|-------------|------------|--------------|-------------------------------------------|-----------------------------------------------|
| 29 684                  | 505         | 0.74       | 286          | 42                                        |                                               |
| 29 672                  | 497         | 0.74       | 278          | 41                                        |                                               |
| 29 687                  | 509         | 0.74       | 283          | 41                                        |                                               |
| 10 705                  | 525         | 0.74       | 290          | 41                                        |                                               |
| 10 689                  | 517         | 0.75       | 283          | 41                                        |                                               |
| 10 701                  | 528         | 0.75       | 288          | 41                                        |                                               |
| 10 702                  | 529         | 0.75       | 299          | 43                                        |                                               |
| 10 692                  | 523         | 0.76       | 284          | 41                                        |                                               |
| 10 704                  | 534         | 0.76       | 287          | 41                                        |                                               |
| 10 672                  | 511         | 0.76       | 279          | 42                                        |                                               |
| 28 709                  | 544         | 0.77       | 289          | 41                                        |                                               |
| 26 669                  | 521         | 0.78       | 257          | 38                                        |                                               |
| 28 694                  | 541         | 0.78       | 289          | 42                                        |                                               |
| 26 672                  | 524         | 0.78       | 261          | 39                                        |                                               |
| 26 661                  | 517         | 0.78       | 266          | 40                                        |                                               |
| 29 626                  | 491         | 0.78       | 252          | 40                                        |                                               |
| 26 666                  | 523         | 0.79       | 260          | 39                                        |                                               |
| 26 673                  | 530         | 0.79       | 269          | 40                                        |                                               |
| 29 621                  | 490         | 0.79       | 253          | 41                                        |                                               |
| 29 633                  | 500         | 0.79       | 239          | 38                                        |                                               |
| 29 628                  | 500         | 0.80       | 261          | 42                                        |                                               |
| 29 641                  | 511         | 0.80       | 253          | 39                                        |                                               |
| 28 686                  | 547         | 0.80       | 282          | 41                                        |                                               |
| 26 658                  | 527         | 0.80       | 263          | 40                                        |                                               |
| 29 620                  | 498         | 0.80       | 254          | 41                                        |                                               |
| 17 682                  | 551         | 0.81       | 280          | 41                                        |                                               |
| 28 674                  | 546         | 0.81       | 268          | 40                                        |                                               |
| 17 642                  | 522         | 0.81       | 255          | 40                                        |                                               |