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New records of *Chondracanthus saundersii* and *Schottera koreana* (Gigartinales, Rhodophyta) from Japan based on molecular and morphological analyses

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SUMMARY

We report two red algal species, *Chondracanthus saundersii* C.W. Schneider & C.E. Lane (Gigartinaceae, Gigartinales) and *Schottera koreana* M.S. Calderon, T.H. Seo & S.M. Boo (Phyllophoraceae, Gigartinales), from Japan for the first time based on molecular and morphological analyses. A *C. saundersii* specimen was collected at a depth of 35 m offshore of Mageshima Island, Kagoshima Pref., Japan. The *rbc*L and COI-5P (*cox*1) sequences of *C. saundersii* form a clade with the type specimen from Bermuda and additional specimens from Cuba and Brazil. Morphologically, *C. saundersii* is characterised by the presence of secondary attachments, compressed to flattened axes up to 1 mm in width, and a looser medulla. Two specimens of *S. koreana* were collected in lower intertidal to subtidal waters at Ohara, Chiba Pref., and Matsuyama, Ehime Pref., Japan. The *rbc*L sequences of *S. koreana* were closely related to reported sequences of specimens from South Korea including the type specimens. Morphologically, *S. koreana* is characterised by the presence of unicellular colourless hair developed from cortical cells.

Key words: *Chondracanthus saundersii*, Gigartinales, Rhodophyta, *Schottera koreana*, taxonomy

INTRODUCTION

Our molecular, and morphological analyses of benthic marine algae sampled along Japanese coasts revealed two red algal species that had not been previously reported from Japan: *Chondracanthus saundersii* C.W. Schneider & C.E. Lane (Gigartinaceae, Gigartinales) and *Schottera koreana* M.S. Calderon, T.H. Seo & S.M. Boo (Phyllophoraceae, Gigartinales). The genus *Chondracanthus* was originally described by Kützing (1843) based on *C. chauvinii* (Bory) Kützing. Twenty-eight species have been described in this genus to date (Guiry & Guiry 2020), five of which (*C. chamissoi* (C. Agardh) Kützing, *C. cincinnus* M.Y. Yang & M.S. Kim, *C. intermedius* (Suringar) Hommersand, *C. okamurae* I.A. Abbott and *C. tenellus* (Harvey) Hommersand) are known to occur in Japan (Yoshida *et al*. 2015; Yang & Kim 2016). The genus *Schottera* was originally described by Guiry & Hollenberg (1975) based on *S. nicaeensis* (J.V. Lamouroux ex Duby) Guiry & Hommersand. To date, three species have been described (Guiry & Guiry 2020). *Schottera koreana* is the only species in the genus reported from the northwest Pacific, and is considered endemic to South Korea (Calderon *et al*. 2016).

MATERIALS AND METHODS

A specimen on *C. saundersii* was collected from the seafloor at a depth of 35 m offshore of Mageshima Island, Kagoshima Pref., by dredging (T/S Nansei-Maru, Faculty of Fisheries, Kagoshima University). Two specimens of *S. koreana* were collected from lower intertidal to subtidal waters off Matsuyama, Ehime Pref., and Ohara, Chiba Pref. (Table S1). For molecular analyses, specimens were quickly dried in silica gel. For anatomical observations, specimens were preserved in 5% formalin; their voucher herbarium specimens were deposited at the National Museum of Nature and Science, Japan (TNS-AL 209432, 207074, 209799).

For molecular phylogenetic analyses, partial *rbc*L gene and COI-5P region were sequenced. Genomic DNA was extracted from silica gel-dried algal tissue from field-collected specimens. DNA extraction and sequencing procedures were performed as described previously (Suzuki *et al*. 2016). The *rbc*L and COI-5P sequences of a *C. saundersii* specimen and the *rbc*L sequences of two *S. koreana* specimens were sequenced (Table S1). We compiled sequence data available from GenBank for 18 *Chondracanthus* species and two *Schottera* species. The *rbc*L and COI-5P sequences were aligned using the ClustalW software (Larkin *et al*. 2007). Samples with identical nucleotide sequences were treated as a single operational taxonomic unit (OTU). As *Chondracanthus* has been resolved as a monophyletic group (Hommersand *et al*. 1999), three other genera belonging to Gigartinaceae were designated as outgroups in all analyses of *Chondracanthus*. As *Schottera* has been resolved as a monophyletic group (Calderon *et al*. 2016), two other genera belonging to Phyllophoraceae were designated as outgroups in all analyses of *Schottera*.

Phylogenetic analyses of three datasets (*rbc*L for *Chondracanthus*, COI-5P for *Chondracanthus*, and *rbc*L for *Schottera*) were subjected to maximum likelihood (ML) and Bayesian inference (BI) analyses. The data matrix included 1,227 base pairs (bp) for *rbc*L for *Chondarcanthus*, 564 bp for COI-5P for *Chondracanthus* and 1,278 bp for *rbc*L for *Schottera*. For both ML and BI analyses, alignment was partitioned by region and codon for *rbc*L gene and COI-5P region, and distinct models were applied to each partition. ML analysis was performed using the RAxML GUI v.1.31 software (Silvestro & Michalak 2012). The GTR + I + G model was applied to each partition in the analysis. Bootstrap values (BP) for the ML analysis were calculated based on 1,000 pseudoreplicates. The substitution models for BI are summarised in Table S2. BI analysis was performed using the MrBayes 3.2.7a software (Ronquist *et al*. 2012) as described previously (Suzuki *et al*. 2012). Four chains of Markov chain Monte Carlo (MCMC) iterations were performed for 2,000,000 generations, keeping one tree for every 500 generations. A burn-in sample of 5,000 trees was removed before constructing the majority rule consensus tree; the remaining trees were used to calculate a 50% majority rule tree and to determine posterior probabilities (PP) of the individual branches. The *p* distances for each pair of *Chondracanthus* species were calculated using PAUP 4.0b10 software (Swofford 2002).

Four DNA-based methods were applied to the *rbc*L dataset to delimit the *Chondracanthus* species: Poisson Tree Processes (PTP; Zhang *et al*. 2013), Automatic Barcode Gap Discovery (ABGD; Puillandre *et al*. 2012), and single and multiple threshold Generalized Mixed Yule Coalescent (GMYC; Pons *et al*. 2006; Reid & Carstens 2012). The PTP analysis was conducted on the web server (https://species.h-its.org/ptp/) using a RAxML input tree, calculated under a GTR + I + G model. The ABGD analysis was conducted on the web server (https://bioinfo.mnhn.fr/abi/public/abgd/abgdweb.html) selecting default parameters. The distance matrix was built under JC69 model. For the GMYC analysis, *rbc*L ultrametric tree was constructed using BI analyses in BEAST v2.6.2 software (Bouckaert et al. 2019), under a GTR + I + G model with divergence times estimated under an uncorrelated lognormal relaxed molecular clock model (Drummond *et al*. 2006) and the constant population size coalescent as the tree prior. MCMC analyses were run separately four times for 2,000,000 generations, keeping one tree for every 500 generations. The output was diagnosed for convergence using Tracer v.1.7.1 software (Rambaut *et al*. 2018) for acceptable effective sample sizes (ESS >200), and summary statistics and trees were generated using the last 1,500,000 generations with TreeAnnotator v2.6.3 software (included in BEAST package). GMYC analyses were performed on the Bayesian majority-rule consensus tree under the single and multiple threshold models, using the web server (https://species.h-its.org/gmyc/).

Prior to anatomical observations, specimens were sectioned by hand or using a freezing microtome (MA-101, Komatsu Electronics, Komatsu, Japan). Sections were stained with 1% cotton blue, acidified with 1% HCl, and mounted in 50% aqueous Karo syrup with 3% formalin to prevent microbial growth. Photomicrographs were taken using a BX51 microscope (Olympus, Tokyo, Japan) with an ATZ digital camera (Kenis, Tokyo, Japan). Drawings were made with the aid of a camera lucida.

RESULTS AND DISCUSSION

Chondracanthus saundersii **C.W. Schneider & C.E. Lane**

The ML tree based on *rbc*L gene sequences is shown in Fig. 1. The phylogenetic trees generated by ML and BI analyses showed similar topologies. The phylogenetic position of *C. acicularis* (Roth) Fredericq was different, but with low statistical support (45% BP; PP < 0.5). *C. saundersii*, *C. cincinnus*, *C. intermedius*, *C. okamurae*, and *C. tenellus* formed a clade with medium to high statistical support (85% BP; 1.00 PP). The Japanese specimen (LC538291) was closely related to reported sequences of *C. saundersii* from Bermuda (type, AY698062), Cuba (FJ513458), and Brazil (MH648764-MH648766), with statistical full support. Interspecific divergence among *Chondracanthus* species for which molecular data were available was 0.3–7.2% (Table S3), whereas divergence between Japanese and other reported *C. saundersii* specimens was 0.3%. The ML tree based on COI-5P sequences is shown in Fig. 2. Phylogenetic trees generated by ML and BI showed the similar topologies. *C. saundersii*, *C. cincinnus*, *C. intermedius*, *C. okamurae*, and *C. tenellus* formed a clade with low statistical support (52% BP; 0.58 PP). Interspecific divergence among *Chondracanthus* species for which molecular data were available was 1.0–11.7% (Table S4). The COI-5P sequence of the Japanese specimen (LC538298) was identical to the COI-5P sequences of *C. saundersii* specimen from Brazil (MH648738-MH648757).

Although the intraspecific divergence of *C. saundersii* between the specimen from Japan and other specimens was relatively high (0.3%) according to the *rbc*L data, DNA-based species delimitation methods suggested that the *C. saundersii* specimens belonged to a single species (Fig. S1). Furthermore, no sequence divergence was detected in COI-5P data between the specimens from Japan and those from Brazil. The *rbc*L sequences from Brazil (MH648764–MH648766), which belong to the same collection as the COI-5P sequences (MH648738, MH648739, and MH648742), were identical to those of the type (AY698062). Therefore, we provisionally identified the *Chondracanthus* specimen from Mageshima as *C. saundersii*.

The erect thallus arises from small discoid holdfasts, gives rise to many axes, is rose-red in colour and 2.0–3.5 cm in height (Fig. 3a, b). Some axes are curved and secondarily attached by adventitious rhizoidal pads. The axes are narrowly linear, exhibit a compressed to flattened appearance, approach 1.0 mm in width, and are alternately or irregularly branched. The branches are flattened, approach 0.6 mm in width, and taper to acute apices (Fig. 3b). The erect thallus is multiaxial, comprising a cortex and inner medullary filaments. The outer cortex is composed of three to four rows of small ellipsoidal cells. The inner cortex is composed of three to four loosely arranged cells. The medulla is composed of loosely entangled longitudinal filaments (Figs. 3c, d and S2). No reproductive structures were observed.

Chondracanthus saundersii was originally described from Bermuda and has also been recorded from Florida, USA, Cuba, Haiti, and Brazil (Schneider & Lane 2005; Littler *et al*. 2008; Cabrera *et al*. 2009; Rocha-Jorge *et al*. 2018). This species is characterised by the presence of secondary attachments, which are compressed to flattened axes approaching 1 mm in width, and a looser medulla (Schneider & Lane 2005; Roch-Jorge *et al*. 2018). A comparison of morphological features among *C. saundersii* populations is shown in Table 1. Our morphological observations of the new specimen collected from Mageshima agreed well with those of Schneider & Lane (2005) and Rocha-Jorge *et al*. (2018). The outer cortex of the Japanese specimen is composed of three to four cells, whereas the outer cortex of *C. saundersii* comprises one to two cells (Schneider & Lane 2005; Roch-Jorge *et al*. 2018). The 0.3% *rbc*L divergence and morphological difference observed in the cortex may suggest that Japanese *C. saundersii* is a new species. Further investigations, which include more specimens from Japan and other regions, are required to clarify the molecular and morphological gaps among specimens.

***Schottera koreana* M.S. Calderon, T.H. Seo & S.M. Boo**

The ML tree based on *rbc*L gene sequences is shown in Fig. 4. The phylogenetic trees generated by ML and BI showed the same topologies. The Japanese specimens were closely related to *S. koreana*, including the holotype (KU749563) and isotype (KU749564), with full support. The divergence between Japanese and other reported *S. koreana* specimens was 0–0.08%. Therefore, we identified the *Schottera* specimens from Japan as *S. koreana*.

The erect thallus arises from small discoid holdfasts, is rose-red in colour, approaches 5.5 cm in height, and forms branched stolons (Fig. 3e, f). The blades arise from the stolon, are spatulate, flattened, simple, or subdichotomously branched, and are 2.0–7.0 mm in width (Fig. 3e, f). The erect thallus is multiaxial, solid, and composed of a thin outer cortex and inner medullary layers. The cortex at the stolon is composed of three to four continuous cell layers. The medulla at the stolon is 8 to 10 cells thick (Figs. 3g and S3a). The cortex at the blade is composed of one to two continuous cell layers. The medulla at the blade is composed of three to five incomplete layers of large cells (Figs. 3h and S3b). Unicellular colourless hairs are produced from the outermost cortical cell. No reproductive structures were observed.

Schottera koreana was originally described by Calderon *et al*. (2016) from Daegueulbido, South Korea. The species is characterised by the presence of unicellular colourless hairs developed from cortical cells (Calderon *et al*. 2016). Our morphological observations of the new specimens collected from Japan agreed well with those of the original description by Calderon *et al*. (2016). This is the first *Schottera* species to be reported from Japan.

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REFERENCES

Bouckaert, R., Vaughan, T.G., Barido-Sottani, J. *et al*. 2019. BEAST 2.5: An advanced software platform for Bayesian evolutionary analysis. *PLoS Comput*. *Biol*. **15**: e1006650.

Cabrera, R., O'Shields, B. and López-Bautista, J. M. 2009. Confirmación molecular de *Chondracanthus saundersii* C.W. Schneider et C.E. Lane para Cuba. *Rev*. *Invest*. *Mar*. **30**: 85–9.

Calderon, M. S., Miller, K. A., Seo, T. H. and Boo, S. M. 2016 Transfer of selected *Ahnfeltiopsis* (Phyllophoraceae, Rhodophyta) species to the genus Besa and description of *Schottera koreana* sp. nov. *Eur*. *J*. *Phycol*. **51**: 431–43.

Drummond, A. J., Ho, S. Y. W., Phillips, M. J. and Rambaut, A. 2006. Relaxed phylogenetics and dating with confidence. *PLoS Biol*. **4**: e88.

Guiry, M. D. and Guiry, G. M. 2020. *AlgaeBase*. World-wide electronic publication, National University of Ireland, Galway. [cited on 5 Jun 2020]. Available from:

https://www.algaebase.org

Guiry, M. D. and Hollenberg, G. J. 1975. *Schottera* gen. nov. and *Schottera nicaeensis* (Lamour. ex Duby) comb. nov. (=*Petroglossum nicaeense* (Lamour. ex Duby) Schotter) in the British Isles. *Br. Phycol. J.* **10**: 149-64

Hommersand, M. H., Fredericq, S., Freshwater, D. W. and Hughey, J. 1999. Recent developments in the systematics of the Gigartinaceae (Gigartinales, Rhodophyta) based on *rbc*L sequence analysis and morphological evidence. *Phycol. Res.* **47**: 139–51.

Kützing, F. T. 1843. *Phycologia generalis oder Anatomie, Physiologie und Systemkunde der Tange*. F.A. Brockhaus, Leipzig, xxxii + 458 pp.

Larkin, M. A., Blackshields, G., Brown, N. P. *et al*. 2007. ClustalW and Clustal X version 2.0. *Bioinformatics* **23**: 2947–8.

Littler, D. S, Littler, M. M. and Hanisak, M. D. 2008. *Submersed plants of the Indian River Lagoon*. Offshore Graphics, Inc, Washington, D.C. 286 pp.

Pons, J., Barraclough, T.G., Gomez-Zurita, J. *et al*. 2006. Sequence-based species delimitation for the DNA taxonomy of undescribed insects. *Syst. biol.* **55**: 595–609.

Puillandre, N., Lambert, A., Brouillet, S. and Achaz, G. 2012. ABGD, Automatic Barcode Gap Discovery for primary species delimitation. *Mol. Ecol.* **21**: 1864–77.

Rambaut, A., Drummond, A. J., Xie, D., Baele, G. and Suchard, M. A. 2018. Posterior summarisation in Bayesian phylogenetics using Tracer 1.7. *Syst. Biol.* **67**: 901-4.

Reid, N. M. and Carstens, B. C. 2012. Phylogenetic estimation error can decrease the accuracy of species delimitation: a Bayesian implementation of the general mixed Yule-coalescent model. *BMC Evol. Biol.* **12**: 196.

Rocha-Jorge, R., Nauer, F., Silva, I. B., Fujii, M. T., Necchi Jr., O., Le Gall, L. and Oliveira, M. C. 2018. Diversity of *Chondracanthus* (Gigartinaceae, Rhodophyta) on the Brazilian coast based on molecular and morphological evidences. *Braz. J. Bot.* **41**: 889–900.

Ronquist, F., Teslenko, M., van der Mark, P. *et al*. 2012. MrBayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. *Syst. Biol.* **61**: 539–42.

Schneider, C.W. and Lane, C.E. 2005. Notes on the marine algae of the Bermudas. 7. Additions to the flora, including *Chondracanthus saundersii* sp. nov. (Rhodophyta, Gigartinaceae) based on *rbc*L sequence analysis. *Phycologia* **44**: 72–83.

Silvestro, D. and Michalak, I. 2012. raxmlGUI: a graphical front-end for RAxML. *Org. Divers. Evol.* **12**: 335–7.

Suzuki, M., Nozaki, H., Terada, R., Kitayama, T., Hashimoto, T., Yoshizaki, M. 2012. Morphology and molecular relationships of *Leptofauchea leptophylla* comb. nov. (Rhodymeniales, Rhodophyta) from Japan. *Phycologia* **51**: 479–88

Suzuki, M., Segawa, T., Mori, H. *et al*. 2016. Next-generation sequencing of an 88-year-old specimen of the poorly known species *Liagora japonica* (Nemaliales, Rhodophyta) supports the recognition of *Otohimella* gen. nov. *PLOS ONE* **11**: e0158944.

Swofford, D. L. 2002. *PAUP*. Phylogenetic Analysis Using Parsimony (* and Other Methods). Version 4*. Sinauer Associates, Sunderland, MA.

Yang, M. Y. and Kim, M. S. 2016. Molecular phylogeny of the genus *Chondracanthus* (Rhodophyta), focusing on the resurrection of *C. okamurae* and the description of *C.*

cincinnus sp. nov. *Ocean Sci*. *J*. **51**: 517-29.

Yoshida, T., Suzuki, M. and Yoshinaga, K. 2015. Checklist of marine algae of Japan (Revised in 2015). *Jpn*. *J*. *Phycol*. **63**: 129-89.

Zhang, J., Kapli, P., Pavlidis, P. and Stamatakis, A. 2013. A general species delimitation method with applications to phylogenetic placements. *Bioinformatics* **29**: 2869-76

Figure legends

Fig. 1. Maximum Likelihood (ML) molecular phylogeny based on *rbc*L gene sequences. Numbers below the branches indicate the bootstrap values (BP, left) and Bayesian posterior probabilities (PP, right). Only the BP (≥ 50%) and PP (≥ 0.95) are shown. Asterisk (*) means 100% BP and 1.00 PP in ML and Bayesian analyses.

Fig. 2. Maximum Likelihood (ML) molecular phylogeny based on COI-5P sequences. Numbers below the branches indicate the bootstrap values (BP, left) and Bayesian posterior probabilities (PP, right). Only the BP (≥ 50%) and PP (≥ 0.95) are shown. Asterisk (*) means 100% BP and 1.00 PP in ML and Bayesian analyses.

Fig. 3. *Chondracanthus saundersii* C.W. Schneider & C.E. Lane. (a, b) Plant collected from offshore of Mageshima Island, Kagoshima Pref., Japan. (c) Transverse section of axis. (d) Longitudinal section of axis. Specimens: TNS-AL 209799 (b-d). *Schottera koreana* M.S. Calderon, T.H. Seo & S.M. Boo. (e) Plant collected from Matsuyama, Ehime Pref., Japan. (f) Plant collected from Ohara, Chiba Pref., Japan. (g) Transverse

section of stipe. (h) Transverse section of blade. Arrowheads indicate unicellular colourless hairs. Specimens: TNS-AL 207074 (e, g, h); TNS-AL 209432 (f).

Fig. 4. Maximum Likelihood (ML) molecular phylogeny based on *rbc*L gene sequences. Numbers below the branches indicate the bootstrap values (BP, right) and Bayesian posterior probabilities (PP, left). Asterisk (*) means 100% BP and 1.00 PP in ML and Bayesian analyses.

Table 1. Comparison of morphological features among the populations of *Chondracanthus saundersii* from three regions.

Supporting Information

Fig. S1. Results of the species delimitation analysis plotted on the ultrametric tree based on *rbc*L gene sequences. Numbers below the branches indicate the Bayesian posterior probabilities (PP). Only the PP (≥ 0.95) are shown. Bars represent results from the Poisson Tree Processes method (PTP), Automatic Barcode Gap Discovery (ABGD), Generalized Mixed Yule Coalescent (GMYC) method using a single threshold (GMYC single), and GMYC method with multiple thresholds (GMYC multiple).

Fig. S2. *Chondracanthus saundersii* C.W. Schneider & C.E. Lane. (a) Transverse section of axis. (b) Longitudinal section of axis. Specimen: TNS-AL 209799.

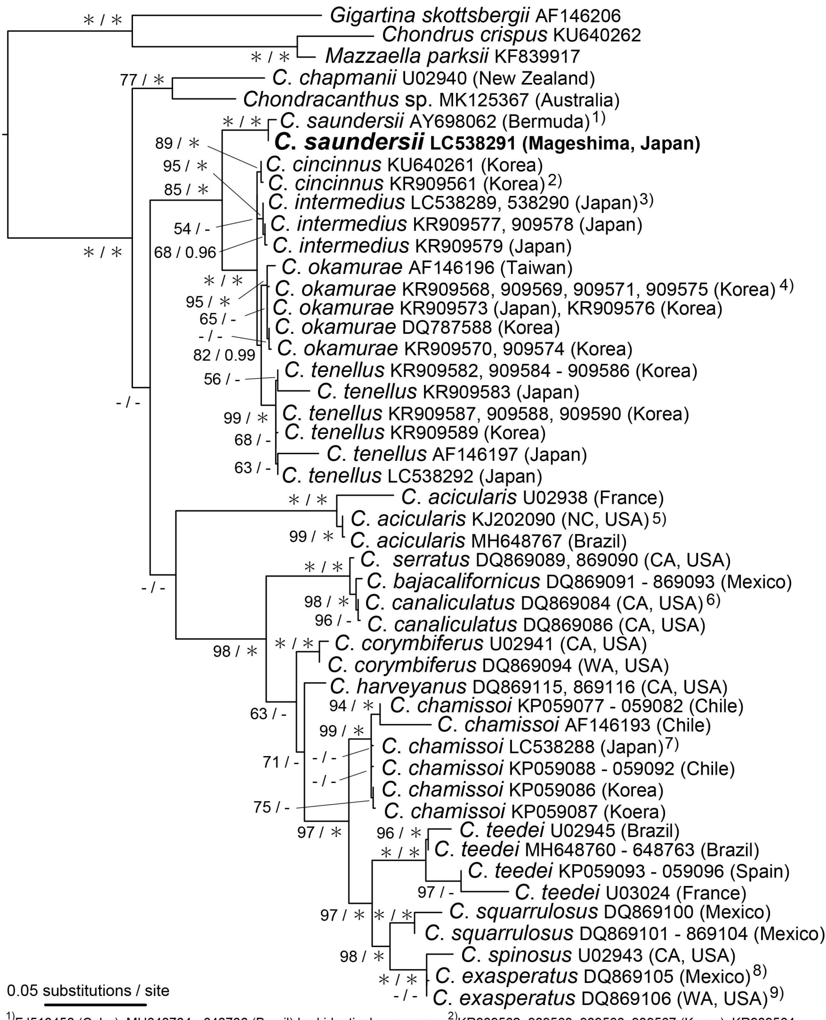
Fig. S3. *Schottera koreana* M.S. Calderon, T.H. Seo & S.M. Boo. (a) Transverse section of stipe. (b) Transverse section of blade. Specimen: TNS-AL 207074.

Table S1. Collection locations and details, and INSD accession numbers of samples used in the *rbc*L and COI-5P sequence analyses. Accession numbers in bold were determined for this study.

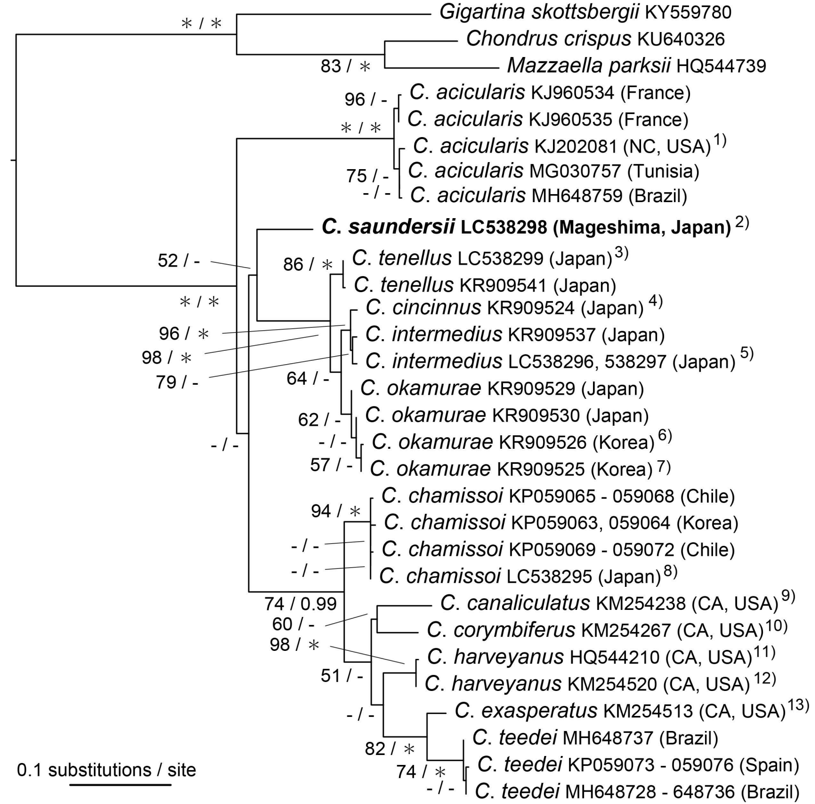
Table S2. Summary for the Bayesian analyses on the basis of three datasets (*rbc*L for *Chondracanthus*, COI-5P for *Chondracanthus*, and *rbc*L for *Schottera*).

Table S3. Matrix of *p* distances among the species of *Chondracanthus* used in the *rbc*L analysis.

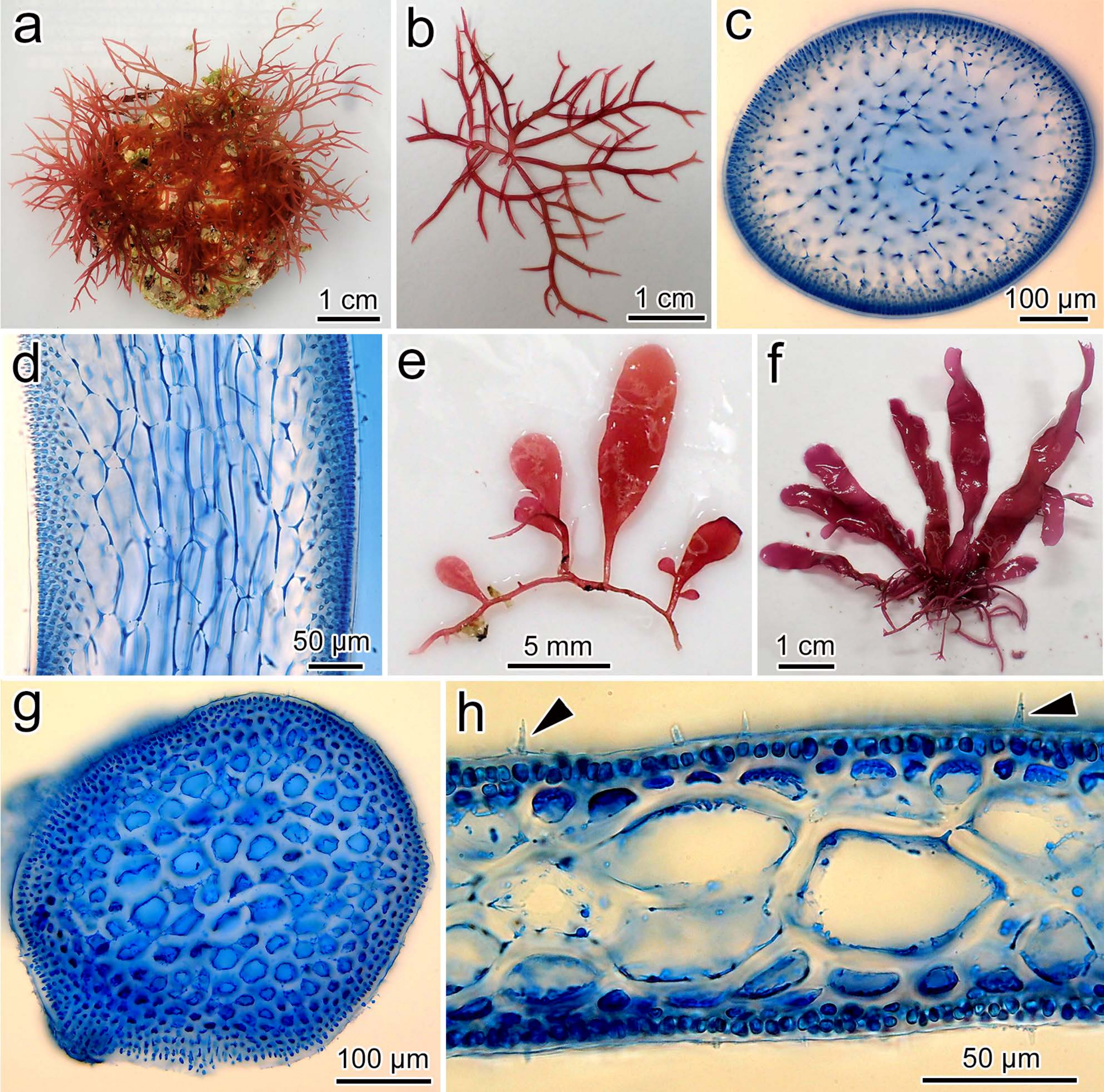
Table S4. Matrix of *p* distances among the species of *Chondracanthus* used in the COI-5P analysis.



1) FJ513458 (Cuba), MH648764 - 648766 (Brazil) had identical sequences. 2) KR909562, 909563, 909566, 909567 (Korea), KR909564, 909565 (Japan) had identical sequences. 3) KR909580, 909581, U02942 (Japan) had identical sequences. 4) KR909572 (Japan) had identical sequences. 5) KP059097 (Spain), KP909058 - 909560 (FL, USA) had identical sequences. 6) DQ869085, 869087, 869088 (CA, USA) had identical sequences. 7) JQ405738 (France), KP059083 - 059085 (Japan) had identical sequences. 8) DQ869109, 869113 (CA, USA), DQ869110 (Mexico) had identical sequences. 9) AF146194, DQ869106, 869107 (WA, USA), DQ869108, 869111, 869112, 869114 (CA, USA), JN403073 (BC, Canada) had identical sequences.



1)KR909519 - 909521 (FL, USA) had identical sequences. 2)MH648738 - 648757 (Brazil) had identical sequences. 3)KR909540, 909542 - 909545, 909547 - 909552, 909554 - 909557 (Korea), 909546, 909553 (Japan) had identical sequences. 4)KR909522, 909523, 909525, KU640325 (Korea) had identical sequences. 5)KR909534 - 909536, 909538, 909539 (Japan) had identical sequences. 6)KR909532, 909533 (Korea) had identical sequences. 7)KR909527, 909528, 909531 (Korea) had identical sequences. 8)KP059060 - 059062 (Japan) had identical sequences. 9)HQ544186, KM254287, 254319, 254787, 254793, 254878, 254892 (CA, USA) had identical sequences. 10)GQ398090 (BC, Canada), HQ544218 (WA, USA), KM254376, 254441, 254448, 254457, 254575, 254942 (CA, USA) had identical sequences. 11)HM915561, 915570, HQ544688, 544692, 544697, 544707, 544896, 544906, 544930, 544979, 544982, 544996, 545003, 919433, 919434, 919442, KM254253, 254277, 254461, 254530, 254564, 254811, 254817, 254899, 254919, 254979 (BC, Canada), 254231, 254341, 254374, 254421, 254447, 254626, 254650, 254690, 254711, 254744, 254862, 254931 (CA, USA) had identical sequences. 12)KM254718, 254915 (CA, USA) had identical sequences. 13)GQ398091 (BC, Canada), KM254593, 254607, 254733, 254927, 254953 (CA, USA), KX281899 (WA, USA) had identical sequences.


a
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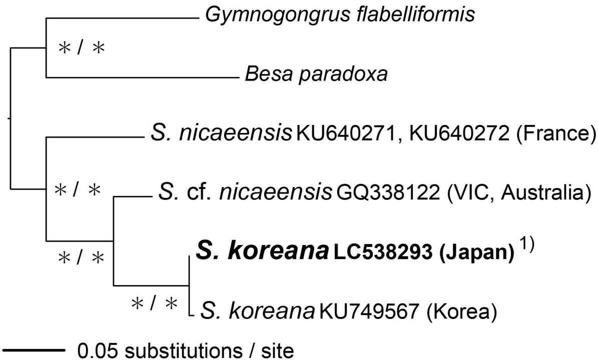
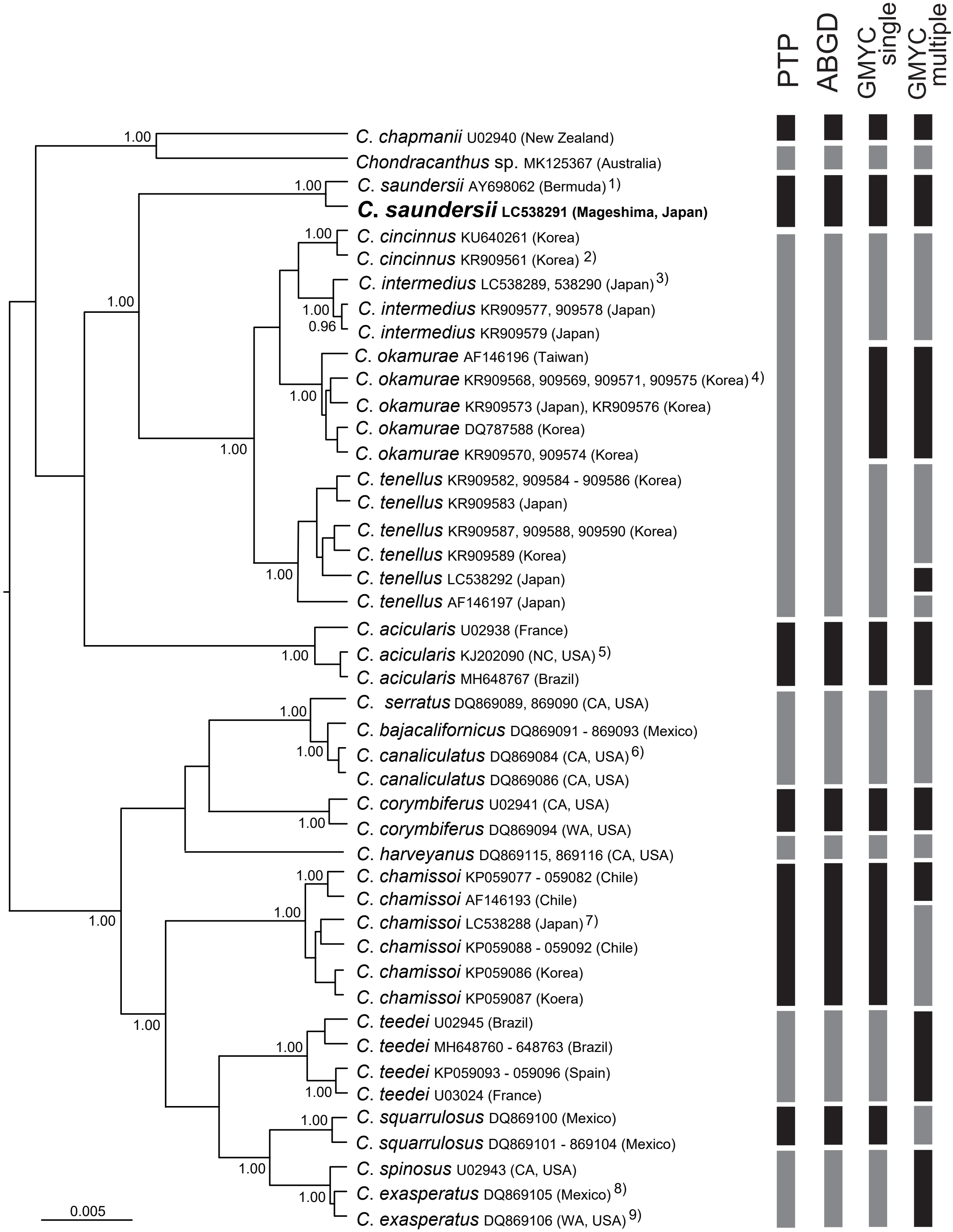


1) LC538294 (Japan), KU749562 - 749566, 749568 - 749570 (Korea) had identical sequences.

Table 1. Comparison of morphological features among the populations of *Chondracanthus saundersii* from three regions.

	Japan	Bermuda	Brazil
Habitat	The seafloor at a depth of 35 m	The depth 3 – 6 m on shaded rock	Intertidal and turf associations in the subtidal
Habit	Erect thallus gives rise to many axes	Erect thallus gives rise to one or more axes.	Forming spreading, entangled mats
Height	2.0-3.5 cm	4.5 cm	9.0 cm
Axes	Curved, compressed to flattened	Curved, flattened	Cylindrical in basal and distal portions of the branches, normally becoming flattened on medium portions
Width of axes	1.0 mm	1.0 mm	1.0 mm
Secondarily attachment	Present	Present	Present
Branching pattern	Alternately or irregularly	Alternately or irregularly	Irregularly
Apices of branches	Acute	Acute	Acute
Outer cortex	Three to four rows of small ellipsoidal cells	One to two globose to ovoid cells bearing ultimate paired narrowly elongate to obclaviform cells	One to two layers of globose to cylindrical cells
Inner cortex	Three to four loosely arranged cells	Anastomosing, elongate stellate cells	Three to four layers of stellate, anastomosing elongate cells
Medulla	Loosely entangled longitudinal filaments	Loosely entangled longitudinal filaments	Loosely entangled longitudinal filaments
References	This study	Schneider & Lane (2005)	Rocha-Jorge *et al*. (2018)



1)FJ513458 (Cuba), MH648764 - 648766 (Brazil) had identical sequences. 2)KR909562, 909563, 909566, 909567 (Korea), KR909564, 909565 (Japan) had identical sequences. 3)KR909580, 909581, U02942 (Japan) had identical sequences. 4)KR909572 (Japan) had identical sequences. 5)KP059097 (Spain), KP909058 - 909560 (FL, USA) had identical sequences. 6)DQ869085, 869087, 869088 (CA, USA) had identical sequences. 7)JQ405738 (France), KP059083 - 059085 (Japan) had identical sequences. 8)DQ869109, 869113 (CA, USA), DQ869110 (Mexico) had identical sequences. 9)AF146194, DQ869106, 869107 (WA, USA), DQ869108, 869111, 869112, 869114 (CA, USA), JN403073 (BC, Canada) had identical sequences.

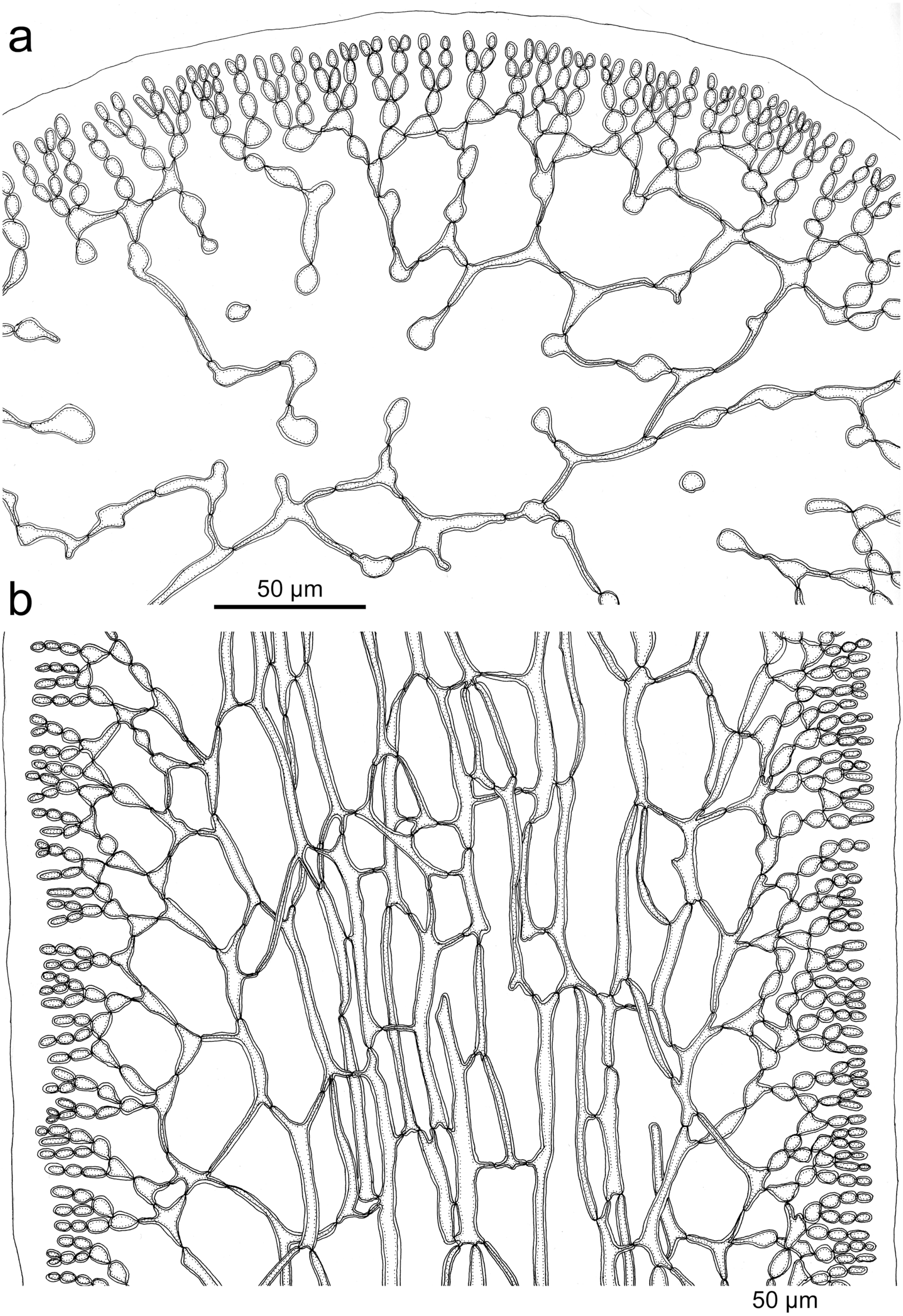


Fig. S2. *Chondracanthus saundersii* C.W. Schneider & C.E. Lane. (a) Transverse section of thallus. (b) Longitudinal section of thallus. Specimen: TNS-AL 209799.

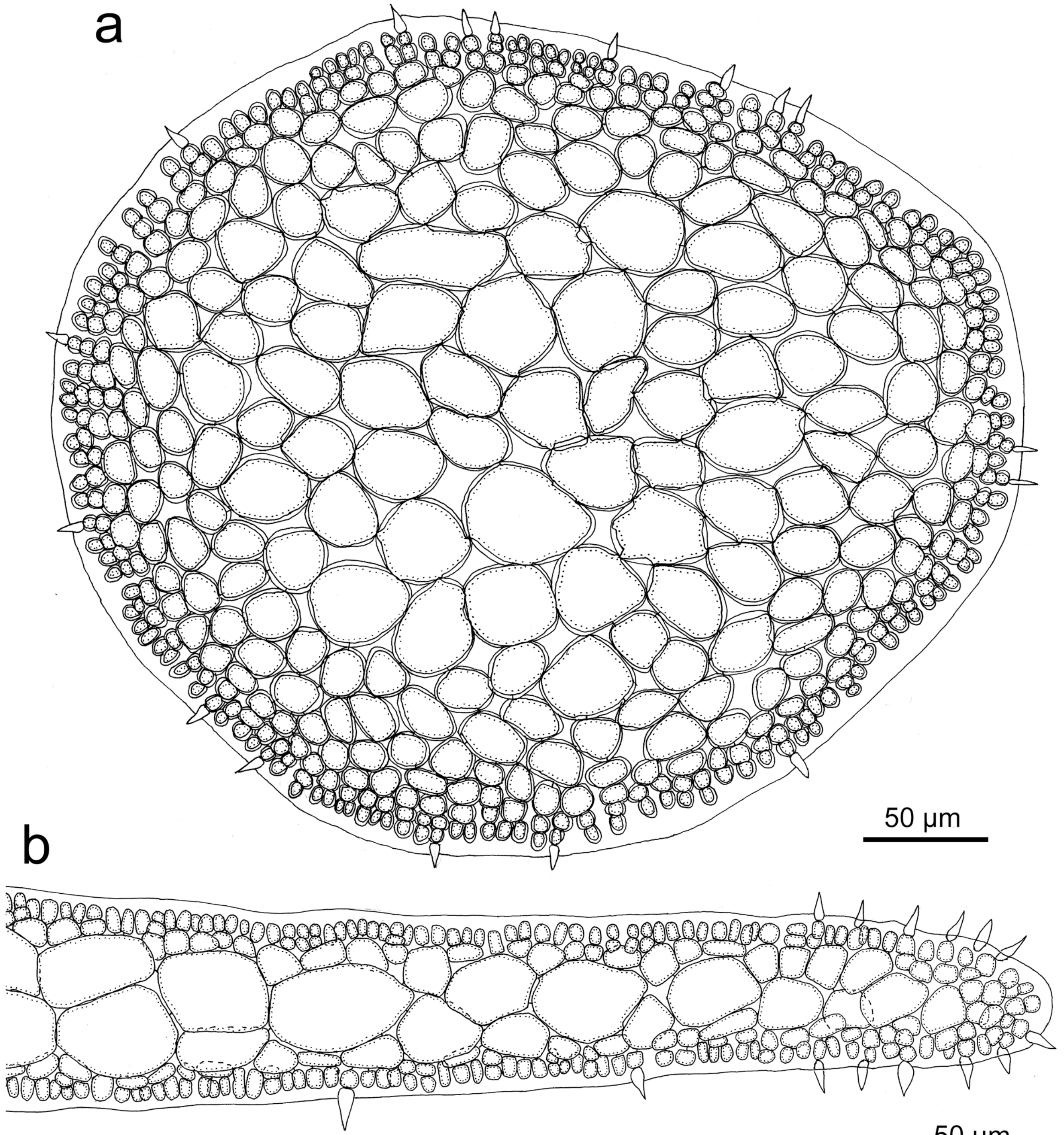


Fig. S3. *Schottera koreana* M.S. Calderon, T.H. Seo & S.M. Boo. (a) Transverse section of stipe. (b) Transverse section of blade. Specimen: TNS-AL 207074.

Table S1. Collection locations and details, and INSD accession numbers of samples used in the *rbc*L and COI-5P sequence analyses. Accession numbers in bold were determined for this study.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
Gigartinaceae			
Chondracanthus acicularis (Roth) Fredericq	Masonboro Inlet, Masonboro Inlet South Jetty, New Hanover Co., North Carolina, USA; 26 Mar. 2013; Marine Botany Class; Freshwater *et al*. (unpublished)	KJ202090	KJ202081
	Roche, Cádiz, Andalucía, Spain; 29 Apr. 2014; Yang *et al*. (2015)	KP059097	
	Klosenn Malaga, Brittany, France; 15 Mar. 2011; L. Le Gall & S. Bregeon; RMAR1001; Robuchon *et al*. (2015)		KJ960534
	Le Loup, Brittany, France; 23 Mar. 2011; L. Couceiro & M. Robuchon; RMAR2559; Robuchon *et al*. (2015)		KJ960535
	Sebastian Inlet, Florida, USA; 3 Aug. 2013; Gigar404; Yang & Kim (2016)	KR909558	KR909519
	Sebastian Inlet, Florida, USA; 3 Aug. 2013; Gigar405; Yang & Kim (2016)	KR909559	KR909520
	Sebastian Inlet, Florida, USA; 3 Aug. 2013; Gigar406; Yang & Kim (2016)	KR909560	KR909521
	Korbous, Tunisia; 8 Apr. 2015; RM0233; Manghisi *et al*. (2019)		MG030757
	Ponta da Fortaleza, Ubatuba, São Paulo, Brazil; 2008; E.C. Oliveira; SPF58214; Rocha-Jorge *et al*. (2018)	MH648767	
	Sambaqui, Florianópolis, Santa Catarina, Brazil; 2008; E.C. Oliveira; SPF58213; Rocha-Jorge *et al*. (2018)		MH648759
	Île Verte, Roscoff, Brittany, France, 9 Mar. 1993; J. Cabioch; Hommersand *et al*. (1994)	U02938	
Chondracanthus bajacalifornicus Hughey & Hommersand	San Miguel Beach, Baja California, Mexico; 27 Mar. 1989; C.K. Kjeldsen; #8293; Hughey & Hommersand (2008)	DQ869091	
	Punta Baja, Baja California, Mexico; 3 Dec. 1996; J.R. Hughey; Hughey & Hommersand (2008)	DQ869092	
	Punta San Tomás, Baja California, Mexico; 2 Jul. 1996; Hughey & Hommersand (2008)	DQ869093	
Chondracanthus canaliculatus (Harvey) Guiry	North and West Cove, San Clemente Is., Los Angeles Co., California, USA; 22 Feb. 1997; S. Murray; Hughey & Hommersand (2008); as *C. kjeldsenii*.	DQ869084	
	Mission Bay Jetty, San Diego, San Diego Co., California, USA; 17 Mar. 1999; J.R. Hughey, P.A. Hughey & D.R. Hughey; Hughey & Hommersand (2008); as *C. kjeldsenii*.	DQ869085	
	Pescadero Pt., Monterey, Monterey Co., California, USA; 12 Aug. 1995; J.R. Hughey; Hughey & Hommersand (2008)	DQ869086	

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Carmel Beach, Carmel, Monterey Co., California, USA; 13 Jul. 1996; J.R. Hughey; Hughey & Hommersand (2008)	DQ869087	
	S. end of La Jolla shores, San Diego Co., California, USA; 24 Dec. 1995; J.R. Hughey, P.A. Hughey & D.R. Hughey; Hughey & Hommersand (2008)	DQ869088	
	Santa Cruz, California, USA; 19 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022076; Saunders (2014)		HQ544186
	Santa Cruz, California, USA; 19 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022046; Saunders (2014)		KM254238
	Santa Cruz, California, USA; 19 May 2010; B. Clarkston, K. Hind & S. Toews; GWS021889; Saunders (2014)		KM254287
	Santa Cruz, California, USA; 19 May 2010; B. Clarkston, K. Hind & S. Toews; GWS021894; Saunders (2014)		KM254319
	Pigeon Point, Lighthouse, California, USA; 15 May 2010; B. Clarkston & K. Hind; GWS021257; Saunders (2014)		KM254787
	Sea Lion Point North (backside), Point Lobos State Reserve, California, USA; 16 May 2010; B. Clarkston, K. Hind & S. Toews; GWS021453; Saunders (2014)		KM254793
	Santa Cruz, California, USA; 19 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022052; Saunders (2014)		KM254878
	Pigeon Point, Lighthouse, California, USA; 15 May 2010; B. Clarkston & K. Hind; GWS021244; Saunders (2014)		KM254892
Chondracanthus chamissoi (C. Agardh) Kützing	Tanoshiro Beach (34°34’57’’N, 135°01’24’’E), Iwaya, Awaji City, Hyogo Pref., Japan; 12 Jul. 2018; M. Suzuki; TNS-AL 209790; this study	**LC538288**	**LC538295**
	Lechagua, Chiloé, Chile; 23 Feb. 1993; S. Fredericq & M. E. Ramírez; Hommersand *et al*. (1999)	AF146193	
	Cocholgüe, Biobío Region, Chile; 13 Feb. 2012; Yang *et al*. (2015)	KP059077	
	Chonchi, Los Lagos Region, Chile; 26 Feb. 2012; Yang *et al*. (2015)	KP059078	
	Lebu, Biobío Region, Chile; 15 Feb. 2012; Yang *et al*. (2015)	KP059079	KP059065
	Huayquique, Tarapacá Region, Chile; 21 Nov. 2013; Yang *et al*. (2015)	KP059080	KP059067
	Iquique, Tarapacá Region, Chile; 21 Nov. 2013; Yang *et al*. (2015)	KP059081	

Table S1. Continued

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Iquique, Tarapacá Region, Chile; 21 Nov. 2013; Yang *et al*. (2015)		KP059068
	Puerto Aldea, Coquimbo Region, Chile; 4 Jan. 2013; Yang *et al*. (2015)	KP059082	KP059069
	Enoshima, Fujisawa City, Kanagawa Pref., Japan; 28 Mar. 2014; Yang *et al*. (2015)	KP059083	KP059062
	Enoshima, Fujisawa City, Kanagawa Pref., Japan; 28 Mar. 2014; Yang *et al*. (2015)	KP059084	KP059060
	Misaki, Miura City, Kanagawa Pref., Japan; 10 Apr. 2013; Yang *et al*. (2015)	KP059085	KP059061
	Gwangan-ri, Busan, South Korea; 20 Dec. 2012; Yang *et al*. (2015)	KP059086	KP059063
	Gwangan-ri, Busan, South Korea; 20 Dec. 2012; Yang *et al*. (2015)	KP059087	KP059064
	Cocholgüe, Biobío Region, Chile; 13 Feb. 2012; Yang *et al*. (2015)	KP059088	KP059070
	Cocholgüe, Biobío Region, Chile; 13 Feb. 2012; Yang *et al*. (2015)	KP059089	
	Chonchi, Los Lagos Region, Chile; 26 Feb. 2012; Yang *et al*. (2015)		KP059071
	Chonchi, Los Lagos Region, Chile; 26 Feb. 2012; Yang *et al*. (2015)	KP059090	KP059072
	Cocholgüe, Biobío Region, Chile; 13 Feb. 2012; Yang *et al*. (2015)	KP059091	KP059066
	Puerto Aldea, Coquimbo Region, Chile; 4 Jan. 2013; Yang *et al*. (2015)	KP059092	
	Puerto Aldea, Coquimbo Region, Chile; 4 Jan. 2013; Yang *et al*. (2015)		KP059069
	Toulindac, Gulf of Morbihan, France; 25 May 2009; A. Le Roux; H8170; Mineur *et al*. (2012); as *Chondracanthus* sp.	JQ407738	
Chondracanthus chapmanii (J.D. Hooker & Harvey) Fredericq	Island Bay, Wellington, New Zealand; 23 May 1993; W.A. Nelson; Hommersand *et al*. (1994)	U02940	
Chondracanthus cincinnus M.Y. Yang & M.S. Kim	Jakdo, Yeosu, South Korea; 26 Jul. 2012; Gigar031; Yang & Kim (2016)	KR909561	
	Daesambudo, Yeosu, South Korea; 25 Jul. 2012; Gigar032; Yang & Kim (2016)	KR909562	KR909522
	Chujado, Jeju, South Korea; 1 Oct. 2013; Gigar213; Yang & Kim (2016)	KR909563	KR909523
	Otaru, Hokkaido, Japan; 23 Feb. 2014; Gigar320; Yang & Kim (2016)	KR909564	
	Otaru, Hokkaido, Japan; 23 Feb. 2014; Gigar320; Yang & Kim (2016)	KR909565	
	Otaru, Hokkaido, Japan; 23 Feb. 2014; Gigar320; Yang & Kim (2016)		KR909524
	Gapado, Jeju, South Korea; 20 Mar. 2015; Gigar412; Yang & Kim (2016)	KR909566	
	Gapado, Jeju, South Korea; 20 Mar. 2015; Gigar414; Yang & Kim (2016)	KR909567	
	Taean, South Korea; 22 Jul. 2006; S.M. Boo; CNU042987; Calderon & Boo (2016b); as *C. intermedius*.	KU640261	KU640325

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
Chondracanthus corymbiferus (Kützing) Guiry	Wizard Islet, Vancouver Is., British Columbia, Canada; GWS002830		GQ398090
	Indian Is., Kitsap Co., Washington, USA; 10 June 1994; M.H. Hommersand; Hughey & Hommersand (2008)	DQ869094	
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022215; Saunders (2014)		HQ544218
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022250; Saunders (2014)		HQ544221
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston; GWS022113; Saunders (2014)		KM254267
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B.E. Clarkston; GWS022183; Saunders (2014)		KM254376
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston; GWS022122; Saunders (2014)		KM254441
	Pigeon Point Lighthouse, California, USA; 15 May 2010; B. Clarkston; GWS021319; Saunders (2014)		KM254448
	Aquarium Reef, Monterey Bay, California, USA; 21 May 2010; B. Clarkston; GWS022386; Saunders (2014)		KM254457
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022253; Saunders (2014)		KM254575
	Pigeon Point, San Mateo Co., California, USA; 21 Dec. 1992; M.H. Hommersand; Hommersand *et al*. (1994)	U02941	
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022112; Saunders (2014)		KM254942
Chondracanthus exasperatus (Harvey & Bailey) Hughey	Tacoma Narrows, Tacoma Co., Washington, USA; 4 May 1997; J.R. Hughey, 4.v.1997; Hommersand *et al*. (1999); as *C. corymbiferus*.	AF146194	
	drift, Bahia Colnett, Baja California, Mexico; 2 Jul. 1996; J.R. Hughey; Hughey & Hommersand (2008)	DQ869105	

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Tacoma Narrows, Tacoma Co., Washington, USA; 4 May 1997; J.R. Hughey, P.A. Hughey & D.R. Hughey; Hughey & Hommersand (2008)	DQ869106	
	Neah Bay, Clallam Co., Washington, USA; 6 Jun. 1994; M.H. Hommersand; Hughey & Hommersand (2008)	DQ869107	
	Drift, Leadbetter Beach, Santa Barbara, Santa Barbara Co., California, USA; 27 May 1995; J.R. Hughey; Hughey & Hommersand (2008)	DQ869108	
	Drift, Beach at Almar Ave., Santa Cruz, Santa Cruz Co., California, USA; 11 Jul. 1995; J.R. Hughey; Hughey & Hommersand (2008)	DQ869109	
	Punta Maria, Baja California, Mexico, 4 Dec. 1996; J.R. Hughey; Hughey & Hommersand (2008)	DQ869110	
	Nick's Cove, Tomales Bay, Marin Co., California, USA; 21 Feb. 1994; J.R. Hughey; Hughey & Hommersand (2008)	DQ869111	
	Crissie Field, Fort Pt., San Francisco Co., California, USA; 23 Jul. 1992; M.H. Hommersand; Hughey & Hommersand (2008)	DQ869112	
	Pacific Grove, Monterey Co., California, USA; 22 Aug. 1994; J.R. Hughey; Hughey & Hommersand (2008)	DQ869113	
	Marshall, Tomales Bay, Marin Co., California, USA; 19 Oct. 1994; J.R. Hughey; Hughey & Hommersand (2008)	DQ869114	
	Bamfield, Wizard Is., British Columbia, Canada; G.W. Saunders; GWS002829; Schneider *et al.* (2011)	JN403073	
	Wizard Islet, Vancouver Is., British Columbia, Canada; GWS002829		GQ398091
	Soberanes Point, California, USA; 17 May 2010; B. Clarkston, K. Hind & S. Toews; GWS021634; Saunders (2014)		KM254513
	Pigeon Point Lighthouse, California, USA; 15 May 2010; B. Clarkston & K. Hind; GWS021238; Saunders (2014)		KM254593
	Sea Lion Point North (frontside), Point Lobos State Reserve, California, USA; 16 May 2010; B. Clarkston & K. Hind; GWS021509; Saunders (2014)		KM254607
	Soberanes Point, California, USA; 17 May 2010; B. Clarkston, K. Hind & S. Toews; GWS021662; Saunders (2014)		KM254733

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Sea Lion Point North (frontside), Point Lobos State Reserve, California, USA; 16 May 2010; B. Clarkston & K. Hind; GWS021464; Saunders (2014)		KM254927
	Sea Lion Point North (frontside), Point Lobos State Reserve, California, USA; 16 May 2010; B. Clarkston & K. Hind; GWS021494; Saunders (2014)		KM254953
	Washington, USA; 1 Aug. 2014; J. Colt; GWS036289; Gadberry *et al*. (2018)		KX281899
Chondracanthus harveyanus (Kützing) Guiry	S. end of Carmel Beach, Monterey Co., California, USA; 27 Dec. 1998; J.R. Hughey & M.F. Perez; Hughey & Hommersand (2008)	DQ869115	
	Horseshoe Cove, Bodega Head, Sonoma Co., California, USA; 30 Dec. 1994; J.R. Hughey; Hughey & Hommersand (2008)	DQ869116	
	Hot Spring Is. at Watchmen Station (in hot water seepage), Gwaii Haanas, British Columbia, Canada; 21 Jun. 2009; G.W. Saunders & D. McDevit; GWS013232; Saunders (2014)		HM915561
	Hot Spring Is. at Watchmen Station (in hot water seepage), Gwaii Haanas, British Columbia, Canada; 21 Jun. 2009; G.W. Saunders & D. McDevit; GWS013233; Saunders (2014)		HM915570
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022169; Saunders (2014)		HQ544210
	Warden Station Huxley Is., Gwaii Haanas, British Columbia, Canada; 12 Jun. 2010; G.W. Saunders & K. Dixon; GWS019965; Saunders (2014)		HQ544688
	Warden Station Huxley Is., Gwaii Haanas, British Columbia, Canada; 12 Jun. 2010; G.W. Saunders & K. Dixon; GWS019972; Saunders (2014)		HQ544692
	Warden Station Huxley Is., Gwaii Haanas, British Columbia, Canada; 12 Jun. 2010; G.W. Saunders & K. Dixon; GWS019978; Saunders (2014)		HQ544697
	Warden Station Huxley Is., Gwaii Haanas, British Columbia, Canada; 12 Jun. 2010; G.W. Saunders & K. Dixon; GWS019993; Saunders (2014)		HQ544707
	Hot Spring Is. (east 'back' side), Gwaii Haanas, British Columbia, Canada; 15 Jun. 2010; G.W. Saunders & K. Dixon; GWS020404; Saunders (2014)		HQ544896
	Hot Spring Is. (east 'back' side), Gwaii Haanas, British Columbia, Canada; 15 Jun. 2010; G.W. Saunders & K. Dixon; GWS020421; Saunders (2014)		HQ544906

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Hot Spring Is. (east 'back' side), Gwaii Haanas, British Columbia, Canada; 15 Jun. 2010; G.W. Saunders & K. Dixon; GWS020472; Saunders (2014)		HQ544930
	Tanuu Is. (Watchmen Station), Haida Gwaii, British Columbia, Canada; 16 Jun. 2010; G.W. Saunders & K. Dixon; GWS020561; Saunders (2014)		HQ544979
	Tanuu Is. (Watchmen Station), Haida Gwaii, British Columbia, Canada; 16 Jun. 2010; G.W. Saunders & K. Dixon; GWS020568; Saunders (2014)		HQ544982
	Tanuu Is. (Watchmen Station), Haida Gwaii, British Columbia, Canada; 16 Jun. 2010; G.W. Saunders & K. Dixon; GWS020582; Saunders (2014)		HQ544996
	Tanuu Is. (Watchmen Station), Haida Gwaii, British Columbia, Canada; 16 Jun. 2010; G.W. Saunders & K. Dixon; GWS020594; Saunders (2014)		HQ545003
	Alder Is., Gwaii Haanas, British Columbia, Canada; 11 Jun. 2010; G.W. Saunders & K. Dixon; GWS021163; Saunders (2014)		HQ919433
	Alder Is., Gwaii Haanas, British Columbia, Canada; 11 Jun. 2010; G.W. Saunders & K. Dixon; GWS021164; Saunders (2014)		HQ919434
	Alder Is., Gwaii Haanas, British Columbia, Canada; 11 Jun. 2010; G.W. Saunders & K. Dixon; GWS021181; Saunders (2014)		HQ919442
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022181; Saunders (2014)		KM254231
	Tanuu Is. (Watchmen Station), Haida Gwaii, British Columbia, Canada; 16 Jun. 2010; G.W. Saunders & K. Dixon; GWS020559; Saunders (2014)		KM254253
	Murchison Is., Northwest Beach, Gwaii Haanas, British Columbia, Canada; 7 Jul. 2011; G.W. Saunders & K. Dixon; GWS028186; Saunders (2014)		KM254277
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022114; Saunders (2014)		KM254341
	Santa Cruz (Four Mile), California, USA; 19 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022001 Saunders (2014)		KM254374
	Stillwater Cove, Pebble Beach, California, USA; 20 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022116; Saunders (2014)		KM254421

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Sea Lion Point North (backside), Point Lobos State Reserve, California, USA; 16 May 2010; B. Clarkston & K. Hind; GWS021446; Saunders (2014)		KM254447
	Northeast corner of Kunga Island, Gwaii Haanas, British Columbia, Canada; 14 Jun. 2012; G.W. Saunders & K. Dixon; GWS030963; Saunders (2014)		KM254461
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022201; Saunders (2014)		KM254520
	Burnaby Narrows (S opening, in Macrocystic bed), Gwaii Haanas, British Columbia, Canada; 16 Aug. 2013; G.W. Saunders & K. Dixon; GWS035674; Saunders (2014)		KM254530
	Northeast corner of Kunga Island, Gwaii Haanas, British Columbia, Canada; 14 Jun. 2012; G.W. Saunders & K. Dixon; GWS030968; Saunders (2014)		KM254564
	Bird Rock, Pacific Grove, California, USA; 22 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022319; Saunders (2014)		KM254626
	Sea Lion Point North (backside), Point Lobos State Reserve, California, USA; 16 May 2010; B. Clarkston & K. Hind; GWS021447; Saunders (2014)		KM254650
	Bird Rock, Pacific Grove, California, USA; 22 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022321; Saunders (2014)		KM254690
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022245; Saunders (2014)		KM254711
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022238; Saunders (2014)		KM254718
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022255; Saunders (2014)		KM254744
	Northeast corner of Kunga Island, Gwaii Haanas, British Columbia, Canada; 14 Jun. 2012; G.W. Saunders & K. Dixon; GWS030972; Saunders (2014)		KM254811
	East corner of entrance to Slim Inlet, Gwaii Haanas, British Columbia, Canada; 10 Jun. 2012; G.W. Saunders & K. Dixon; GWS030719; Saunders (2014)		KM254817
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022193; Saunders (2014)		KM254862

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Warden Station Huxley Is., Gwaii Haanas, British Columbia, Canada; 25 Jun. 2009; G.W. Saunders & D. McDevit; GWS013646; Saunders (2014)		KM254899
	Lover's Point, Pacific Grove, California, USA; 22 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022289; Saunders (2014)		KM254915
	Burnaby Narrows (S opening, in Macrocystic bed), Gwaii Haanas, British Columbia, Canada; 16 Aug. 2013; G.W. Saunders & K. Dixon; GWS035673; Saunders (2014)		KM254919
	McAbee Beach, Monterey Co., California, USA; 21 May 2010; B. Clarkston, K. Hind & S. Toews; GWS022256; Saunders (2014)		KM254931
	Tanuu Is. (Watchmen Station), Haida Gwaii, British Columbia, Canada; 16 Jun. 2010; G.W. Saunders & K. Dixon; GWS020549; Saunders (2014)		KM254979
Chondracanthus intermedius (Suringar) Hommersand	Tangaura (35°14’56’’N, 140°24’17’’E), Ohara, Isumi City, Chiba Pref., Japan; 27 Apr. 2016; M. Suzuki; TNS-AL 207094; this study	**LC538289**	**LC538296**
	Ashikajima (35°43’06’’N, 140°52’16’’E), Choshi City, Chiba Pref., Japan; 26 Apr. 2016; M. Suzuki; TNS-AL 209798; this study	**LC538290**	**LC538297**
	Misaki, Miura City, Kanagawa Pref., Japan; 10 Apr. 2013; Gigar125; Yang & Kim (2016)	KR909577	KR909534
	Shimoda, Shizuoka Pref., Japan; 12 Apr. 2013; Gigar128; Yang & Kim (2016)	KR909578	KR909535
	Katsuura, Chiba Pref., Japan; 23 Mar. 2014; Gigar246; Yang & Kim (2016)	KR909579	KR909536
	Shimoda, Shizuoka Pref., Japan; 27 Mar. 2014; Gigar324; Yang & Kim (2016)		KR909537
	Shimoda, Shizuoka Pref., Japan; 28 Mar. 2014; Gigar325; Yang & Kim (2016)	KR909580	KR909538
	Shimoda, Shizuoka Pref., Japan; 28 Mar. 2014; Gigar326; Yang & Kim (2016)	KR909581	KR909539
	Tokawa, Choshi City, Chiba Pref., Japan; 22 May 1993; M. Yoshizaki; Hommersand *et al*. (1994)	U02942	
Chondracanthus okamurae I.A. Abbott	Wang Hai Xiang, Taiwan; 8 Jul. 1994; S. Fredericq & S-M. Lin; Hommersand *et al*. (1999); as *C. tenellus*.	AF146196	
	Gamdo, South Korea; 18 Jul. 2001; Yang & Boo (unpublished); as *C. intermedius*.	DQ787588	
	Ieodo, Jeju, South Korea; 18 Jun. 2013; Gigar166; Yang & Kim (2016)	KR909568	KR909525
	Wando, South Korea; 9 Jan. 2013; Gigar170; Yang & Kim (2016)	KR909569	KR909526
	Hamduck, Jeju, South Korea; 9 Jan. 2013; Gigar215; Yang & Kim (2016)	KR909570	KR909527
	Ieodo, Jeju, South Korea; 18 Jun. 2013; Gigar216; Yang & Kim (2016)	KR909571	KR909528

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Katsuura, Chiba Pref., Japan; 23 Mar. 2014; Gigar247; Yang & Kim (2016)	KR909572	KR909529
	Katsuura, Chiba Pref., Japan; 23 Mar. 2014; Gigar323; Yang & Kim (2016)	KR909573	KR909530
	Sinyang, Jeju, South Korea; 23 Dec. 2014; Gigar409; Yang & Kim (2016)	KR909574	KR909531
	Gapado, Jeju, South Korea; 20 Mar. 2015; Gigar413; Yang & Kim (2016)	KR909575	KR909532
	Gapado, Jeju, South Korea; 20 Mar. 2015; Gigar415; Yang & Kim (2016)	KR909576	KR909533
Chondracanthus saundersii C.W. Schneider & C.E. Lane	Offshore of Mageshima Is. (30°43’28’’N, 130°49’21’’E), Kagoshima Pref., Japan; 20 Jul. 2017; R. Terada; TNS-AL 209799; this study	**LC538291**	**LC538298**
	Walsingham Pond, Hamilton Parish, Bermuda; 31 Mar. 2003; Type collection; Schneider & Lane (2005)	AY698062	
	Playa el Chivo, N de la Habana; Cuba; 24 Apr. 2008; R. Cabrera; 3 005 MNHN; Cabrera *et al*. (2009)	FJ513458	
	Praia da Lagoinha, Ubatuba, São Paulo, Brazil; 2010; F. Nauer; SPF58221; Rocha-Jorge *et al*. (2018)	MH648764	MH648738
	Praia das Cigarras, São Sebastião, Ubatuba, São Paulo, Brazil; 2010; E.C. Oliveira; SPF58220; Rocha-Jorge *et al*. (2018)	MH648765	MH648742
	Praia Brava, Ubatuba, São Paulo, Brazil; 2009; S.M.P.B. Guimarães; SPF58216; Rocha-Jorge *et al*. (2018)	MH648766	MH648739
	Praia da Lagoinha, Ubatuba, São Paulo, Brazil; 2009; F. Nauer; SPF58215; Rocha-Jorge *et al*. (2018)		MH648740
	Praia Brava, Ubatuba, São Paulo, Brazil; 2007; E.C. Oliveira; SPF58218; Rocha-Jorge *et al*. (2018)		MH648741
	Praia Brava, Ubatuba, São Paulo, Brazil; 2008; E.C. Oliveira; SPF58219; Rocha-Jorge *et al*. (2018)		MH648743
	Praia da Lagoinha, Ubatuba, São Paulo, Brazil; 2010; F. Nauer; SPF58221; Rocha-Jorge *et al*. (2018)		MH648744
	Picinguaba, Ubatuba, São Paulo, Brazil; 2010; M.T. Fujii; SPF58222; Rocha-Jorge *et al*. (2018)		MH648745
	Praia das Cigarras, São Sebastião, São Paulo, Brazil; 2010; S.M.P.B. Guimarães; SPF58223; Rocha-Jorge *et al*. (2018)		MH648746

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Praia das Cigarras, São Sebastião, São Paulo, Brazil; 2010; M.T. Fujii; SPF58224; Rocha-Jorge *et al*. (2018)		MH648747
	Praia das Cigarras, São Sebastião, São Paulo, Brazil; 2010; M.T. Fujii; SPF58225; Rocha-Jorge *et al*. (2018)		MH648748
	Ponta dos Anéis, Maracajú, Rio Grande do Norte, Brazil; 2009; I.B. Silva; SPF58226; Rocha-Jorge *et al*. (2018)		MH648749
	Praia de Guajirú, Trairi, Ceará, Brazil; 2012; F. Nauer; SPF58229; Rocha-Jorge *et al*. (2018)		MH648750
	Praia de Guajirú, Trairi, Ceará, Brazil; 2012; F. Nauer; SPF58231; Rocha-Jorge *et al*. (2018)		MH648751
	Praia do Sambaqui, Florianópolis, Santa Catarina, Brazil; 2012; F. Nauer; SPF58232; Rocha-Jorge *et al*. (2018)		MH648752
	Praia do Forno, Arraial do Cabo, Rio de Janeiro, Brazil; 2011; F. Nauer; SPF58228; Rocha-Jorge *et al*. (2018)		MH648753
	Ilha das Couves, Ubatuba, São Paulo, Brazil; 2009; M.C. Oliveira; SPF58235; Rocha-Jorge *et al*. (2018); as *C. teedei*.		MH648754
	Ilha das Couves, Ubatuba, São Paulo, Brazil; 2009; M.C. Oliveira; SPF58235; Rocha-Jorge *et al*. (2018); as *C. teedei*.		MH648755
	Praia do Sambaqui, Florianópolis, Santa Catarina, Brazil; 2012; F. Nauer; SPF58233; Rocha-Jorge *et al*. (2018)		MH648756
	Ponta da Fortaleza, Ubatuba, São Paulo, Brazil; 2008; E.C. Oliveira; SPF58214; Rocha-Jorge *et al*. (2018) *as *C. acicularis*		MH648757
Chondracanthus serratus (N.L. Gardner) Hughey & Hommersand	S. end of beach, La Jolla, San Diego Co., California, USA; 24 Dec. 1995; J.R. Hughey, P.A. Hughey & D.R. Hughey; Hughey & Hommersand (2008)	DQ869089	
	Mission Bay Jetty, San Diego,San Diego Co., California, USA; 17 Mar. 1999; J.R. Hughey, P.A. Hughey & D.R. Hughey; Hughey & Hommersand (2008)	DQ869090	
Chondracanthus spinosus (Kützing) Guiry	Ramp, Crissie Field, Fort Point, San Francisco Co., California, USA; 23 Dec. 1992; M.H. Hommersand; Hommersand *et al*. (1994)	U02943	
Chondracanthus squarrulosus (Setchell & N.L. Gardner) Hughey, P.C. Silva & Hommersand	Bahía de los Angeles, Gulf of California, Mexico; 5 Jul. 1996; J.R. Hughey; Hughey & Hommersand (2008)	DQ869100	

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Bahía de los Angeles, Gulf of California, Mexico; 1996; L. Aguilar; Hughey & Hommersand (2008)	DQ869101	
	Cholla Bay, Sonora, Mexico, 25 Feb. 1998; J.R. Hughey; Hughey & Hommersand (2008)	DQ869102	
	Cabo Lobos, Puerto Libertad, Sonora, Mexico, 1 Mar. 1998; J.R. Hughey; Hughey & Hommersand (2008)	DQ869103	
	Cholla Bay, Sonora, Mexico, 25 Feb. 1998; J.R. Hughey; Hughey & Hommersand (2008)	DQ869104	
Chondracanthus teedei (Mertens ex Roth) Kützing	San Fernando, Cádiz, Spain; 29 Apr. 2014; Yang *et al*. (2015)	KP059093	KP059074
	San Fernando, Cádiz, Spain; 29 Apr. 2014; Yang *et al*. (2015)	KP059094	KP059075
	San Fernando, Cádiz, Spain; 29 Apr. 2014; Yang *et al*. (2015)	KP059095	KP059073
	San Fernando, Cádiz, Spain; 29 Apr. 2014; Yang *et al*. (2015)	KP059096	KP059076
	Praia Vermelha do Sul, Ubatuba, São Paulo, Brazil; 2008; E.C. Oliveira; SPF58237; Rocha-Jorge *et al*. (2018)	MH648760	MH648729
	Praia Dura, Ubatuba, São Paulo, Brazil; 2008; E.C. Oliveira; SPF58234; Rocha-Jorge *et al*. (2018)	MH648761	MH648730
	Praia Dura, Ubatuba, São Paulo, Brazil; 2008; E.C. Oliveira; SPF58234; Rocha-Jorge *et al*. (2018)	MH648762	MH648728
	Praia da Lagoinha, Ubatuba, São Paulo, Brazil; 2009; E.C. Oliveira; SPF58236; Rocha-Jorge *et al*. (2018)	MH648763	MH648731
	Praia de Peruibe, Itanhaém, Estado de Sào Paulo, Brazil; Apr. 1993; Hommersand *et al*. (1994)	U02945	
	Île Verte, Roscoff, Brittany, France; 5 Mar. 1993; J. Cabioch; Hommersand *et al*. (1994)	U03024	
	Ilha das Couves, Ubatuba, São Paulo, Brazil; 2009; M.C. Oliveira; SPF58217; Rocha-Jorge *et al*. (2018); as *C. saundersii*.		MH648732
	Praia do Sambaqui, Florianópolis, Santa Catarina, Brazil; 2012; F. Nauer; SPF58239; Rocha-Jorge *et al*. (2018)		MH648733
	Praia do Sambaqui, Florianópolis, Santa Catarina, Brazil; 2012; F. Nauer; SPF58240; Rocha-Jorge *et al*. (2018)		MH648734
	Praia da Ferradura, Armacão de Búzios, Rio de Janeiro, Brazil; 2011; F. Nauer; SPF58227; Rocha-Jorge *et al*. (2018); as *C. saundersii*.		MH648735
	Praia do Éden, Guarujá, São Paulo, Brazil; 2011; F. Nauer; SPF58238; Rocha-Jorge *et al*. (2018)		MH648736

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
	Praia de Guajirú, Trairi, Ceará, Brazil; 2012; F. Nauer; SPF58230; Rocha-Jorge *et al*. (2018); as *C. saundersii*.		MH648737
Chondracanthus tenellus (Harvey) Hommersand	Yura (34°16’23’’N, 134°57’16’’E), Sumoto City, Hyogo Pref., Japan; 9 Aug. 2018; M. Suzuki; TNS-AL 209800; this study	**LC538292**	**LC538299**
	Okinoshima, Tateyama Bay, Chiba Pref. Japan; 18 Jun. 1993; M. Yoshizaki; Hughey & Hommersand (2008)	AF146197	
	Oedo, Namhaedo, South Korea; 19 May 2012; Gigar033; Yang & Kim (2016)	KR909582	KR909540
	Shimoda, Shizuoka Pref., Japan; 12 Apr. 2013; Gigar124; Yang & Kim (2016)	KR909583	KR909541
	Chujado, Jeju, South Korea; 17 Aug. 2012; Gigar202; Yang & Kim (2016)	KR909584	KR909544
	Jookbyeon, Uljin, South Korea; 28 Apr. 2012; Gigar212; Yang & Kim (2016)	KR909585	KR909552
	Chiba Pref., Japan; 9 Apr. 2013; Gigar399; Yang & Kim (2016)	KR909586	KR909553
	Gijang, Busan, South Korea; 20 Sep. 2013; Gigar401; Yang & Kim (2016)	KR909587	KR909554
	Guryoungpo, Pohang, South Korea; 29 Sep. 2012; Gigar402; Yang & Kim (2016)	KR909588	KR909555
	Haeundae, Busan, South Korea; 3 Nov. 2012; Gigar403; Yang & Kim (2016)	KR909589	KR909556
	Gapado, Jeju, South Korea; 20 Mar. 2015; Gigar416; Yang & Kim (2016)	KR909590	KR909557
	Seorim, Jeju, South Korea; 3 Jul. 2012; Gigar200; Yang & Kim (2016)		KR909542
	Seorim, Jeju, South Korea; 3 Jul. 2012; Gigar201; Yang & Kim (2016)		KR909543
	Sungsan, Jeju, South Korea; 8 May 2012; Gigar204; Yang & Kim (2016)		KR909545
	Chiba Pref., Japan; 9 Apr. 2013; Gigar205; Yang & Kim (2016)		KR909546
	Sungjeong, Busan, South Korea; 20 Dec. 2012; Gigar207; Yang & Kim (2016)		KR909547
	Wando, South Korea; 15 Jan. 2013; Gigar208; Yang & Kim (2016)		KR909548
	Wando, South Korea; 15 Jan. 2013; Gigar209; Yang & Kim (2016)		KR909549
	Wando, South Korea; 16 Jan. 2013; Gigar210; Yang & Kim (2016)		KR909550
	Jookbyeon, Uljin, South Korea; 28 Apr. 2012; Gigar211; Yang & Kim (2016)		KR909551
Chondracanthus sp.	Mallacoota, Victoria, Australia; H. Verbruggen & K. Dixon; HV06402; Verbruggen & Costa (unpublished)	MK125367	
Chondrus crispus Stackhouse	Cheyne Beach, Devon, England; 3 Apr. 2010; K.M. Kim & K.M. Lee; CNU034179; Calderon & Boo (2016a)	KU640262	KU640326

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
Gigartina skottsbergii Setchell & N.L. Gardner	Bahía Collins, King George Is., S. Shetland Is. Antarctic Pen.; 10 Feb. 1994; S. Fredericq & J. Rodriguez; Hommersand *et al*. (1999)	AF146206	
	Carvajal, Marguerite Bay, Antarctic Pen.; Guillemin *et al*. (2018)		KY559780
Mazzaella parksii (Setchell & N.L.Gardner) Hughey, P.C. Silva & Hommersand	Gwaii Haanas, Saw Reef, British Columbia, Canada; 13 Jun. 2010; GWS020061; Saunders & Millar (2014)	KF839917	HQ544739
Phyllophoraceae			
Besa paradoxa (Suringar) M.S. Calderon & S.M. Boo	Choshi City, Chiba Pref., Japan; 27 Jul. 2002; S.M. Boo; CNU047618; Calderon & Boo (2016b)	KU640225	
Gymnogongrus flabelliformis Harvey	Ebisujima (34°39’08” N, 138°57’55” E), Susaki, Shimoda City, Shizuoka Pref., Japan; 14 May 2014; M. Suzuki; TNS-AL 188599; this study	**LC473155**	
Schottera koreana M.S. Calderon, T.H. Seo & S.M. Boo	Tangaura (35°14’56” N, 140°24’17” E), Ohara, Isumi City, Chiba Pref., Japan; 27 Apr. 2016; M. Suzuki; TNS-AL 209432; this study	**LC538293**	
	Shiraishinohana (33°54’25” N, 132°42’37” E), Takahama Town, Matsuyama City, Ehime Pref., Japan; 9 Apr. 2016; M. Suzuki & K. Shibata; TNS-AL 207074; this study	**LC538294**	
	Deungdaeseom, Toyeong, South Korea; 23 Jul. 2011; T.H. Seo; CNU025315; Calderon *et al*. (2016)	KU749562	
	Daegueulbido, Tongyeong, South Korea; 25 Jul. 2011; T.H. Seo; CNU025311 (Holotype); Calderon *et al*. (2016)	KU749563	
	Daegueulbido, Tongyeong, South Korea; 25 Jul. 2011; T.H. Seo; CNU025312 (Isotype); Calderon *et al*. (2016)	KU749564	
	Jeolmyeongyeo, Chujado, South Korea; 4 Apr. 2013; T.H. Seo; CNU040701; Calderon *et al*. (2016)	KU749565	
	Jeolmyeong, Chujado, South Korea; 4 Apr. 2013; T.H. Seo; CNU025316; Calderon *et al*. (2016)	KU749566	
	Namyeodo, Geoje, South Korea; 24 Jul. 2011; T.H. Seo; CNU025314a; Calderon *et al*. (2016)	KU749567	
	Namyeodo, Geoje, South Korea; 24 Jul. 2011; T.H. Seo; CNU025314b; Calderon *et al*. (2016)	KU749568	
	Gyeokryeolbiyeoldo, Taean, South Korea; 20 Aug. 2015; T.H. Seo; CNU068737; Calderon *et al*. (2016)	KU749569	
	Gyeokryeolbiyeoldo, Taean, South Korea; 20 Aug. 2015; T.H. Seo; CNU068738; Calderon *et al*. (2016)	KU749570	

Table S1. Continued.

Species	Collection information (locality; date; collector, voucher; reference)	*rbc*L	COI-5P
Schottera nicaeensis (J.V. Lamouroux ex Duby) Guiry & Hollenberg	Cap d' Antibes, Antibes, Provence-Alpes-Code d' Azur, France; 4 Jun. 2007; S.M. Boo; CNU047652; Calderon & Boo (2016b)	KU640271	
	Port de Cap D' Ail, Provence-Alpes-Code d' Azur, France; 2 Jun. 2007; S.M. Boo; CNU063927; Calderon & Boo (2016b)	KU640272	
Schottera cf. *nicaeensis* (J.V. Lamouroux ex Duby) Guiry & Hollenberg	Queenscliff Jetty, Victoria, Australia; G.W. Saunders; 17 Oct. 2004; GWS002452; Le Gall & Saunders (2010)	GQ338122	

REFERENCES

Cabrera, R., O'Shields, B. and López-Bautista, J. M. 2009. Confirmación molecular de *Chondracanthus saundersii* C.W. Schneider et C.E. Lane para Cuba. *Rev*. *Invest*. *Mar*. **30**: 85-9.

Calderon, M. S. and Boo, S. M. 2016a. A new genus *Phyllophorella* gen. nov. (Phyllophoraceae, Rhodophyta) from central Peru, including *Phyllophorella peruviana* comb. nov. *Phyllophorella humboldtiana* sp. nov., and *Phyllophorella limaensis* sp. nov. *Bot*. *Mar*. **59**: 339-52.

Calderon, M. S. and Boo, S. M. 2016b. Phylogeny of Phyllophoraceae (Rhodophyta, Gigartinales) reveals *Asterfilopsis* gen. nov. from the Southern Hemisphere. *Phycologia* **55**: 543-54.

Calderon, M. S., Miller, K. A., Seo, T. H. and Boo, S. M. 2016 Transfer of selected *Ahnfeltiopsis* (Phyllophoraceae, Rhodophyta) species to the genus *Besa* and description of *Schottera koreana* sp. nov.. *Eur*. *J*. *Phycol*. **51**: 431-43.

Gadberry, B. A., Colt, J., Maynard, D., Boratyn, D. C., Webb, K., Johnson, R. B., Saunders, G. W. and Boyer, R. H. 2018. Intensive land-based production of red and green macroalgae for human consumption in the Pacific Northwest: an evaluation of seasonal growth, yield, nutritional composition, and contaminant levels. *Algae* **33**: 109-25.

Guillemin, M.-L., Dubrasquet, H., Reyes, J. and Valero, M. 2018. Comparative phylogeography of six red algae along the Antarctic Peninsula: extreme genetic depletion linked to historical bottlenecks and recent expansion. *Polar Biol*. **41**: 827-37.

Hommersand, M. H., Fredericq, S. and Freshwater, D. W. 1994. Phylogenetic systematics and biogeography of the Gigartinaceae (Gigartinales, Rhodophyta) based on sequence analysis of *rbc*L. *Bot*. *Mar*. **37**: 193-203.

Hommersand, M. H., Fredericq, S., Freshwater, D. W. and Hughey, J. 1999. Recent developments in the systematics of the Gigartinaceae (Gigartinales, Rhodophyta) based on *rbc*L sequence analysis and morphological evidence. *Phycol*. *Res*. **47**: 139-51.

Hughey, J. R. and Hommersand, M. H. 2008. Morphological and molecular systematic study of *Chondracanthus* (Gigartinaceae, Rhodophyta) from Pacific North America. *Phycologia* **47**: 124-55.

Le Gall, L. and Saunders, G. W. 2010. DNA barcoding is a powerful tool to uncover algal diversity: a case study of the Phyllophoraceae (Gigartinales, Rhodophyta) in the Canadian flora. *J*. *Phycol*. **46**: 374-89.

Manghisi, A., Miladi, R., Armeli Minicante, S., Genovese, G., Le Gall, L., Abdelkafi, S., Saunders, G. W. and Morabito, M. 2019. DNA barcoding sheds light on novel records in the Tunisian red algal flora. *Crypogamie Algol*. **40**: 5-27.

Mineur, F., Le Roux, A., Stegenga, H., Verlaque, M. and Maggs, C. A. 2012. Four new exotic red seaweeds on European shores. *Biol*. *Invasions* **14**: 1635-41.

Robuchon, M., Valero, M., Gey, D. and Le Gall, L. 2015. How does molecular-assisted identification affect our estimation of α, β and γ biodiversity? An example from understory red seaweeds (Rhodophyta) of *Laminaria* kelp forests in Brittany, France. *Genetica* **143**: 207-23.

Rocha-Jorge, R., Nauer, F., Silva, I. B., Fujii, M. T., Necchi Jr., O., Le Gall, L. and Oliveira, M. C. 2018. Diversity of *Chondracanthus* (Gigartinaceae, Rhodophyta) on the Brazilian coast based on molecular and morphological evidences. *Braz*. *J*. *Bot*. **41**: 889-900.

Saunders, G. W. 2014. Long distance kelp rafting impacts seaweed biogeography in the northeast Pacific: the kelp conveyor hypothesis. *J*. *Phycol*. **50**: 968-74.

Saunders, G. W. and Millar, K. R. 2014. A DNA barcode survey of the red algal genus *Mazzaella* in British Columbia reveals overlooked diversity and new distributional records: descriptions of *M*. *dewreedei* sp. nov. and *M*. *macrocarpa* sp. nov. *Bot*. **92**: 223-31.

Schneider, C. W. and Lane, C. E. 2005. Notes on the marine algae of the Bermudas. 7. Additions to the flora including *Chondracanthus saundersii* sp. nov. (Rhodophyta, Gigartinaceae) based on *rbc*L sequence analysis. *Phycologia* **44**: 72-83.

Schneider, C. W. Chengsupanimit, T. and Saunders, G. W. 2011. A new genus and species from the North Atlantic, *Archestenogramma profundum* (Phyllophoraceae, Rhodophyta), with taxonomic resolution of the orphaned *Leptofauchea brasiliensis*. *Eur*. *J*. *Phycol*. **46**: 442-52.

Yang, M. Y. and Kim, M. S. 2016. Molecular phylogeny of the genus *Chondracanthus* (Rhodophyta), focusing on the resurrection of *C*. *okamurae* and the description of *C*. *cincinnus* sp. nov. *Ocean Sci*. *J*. **51**: 517-29.

Yang, M. Y., Macaya, E. C. and Kim, M. S. 2015. Molecular evidence for verifying the distribution of *Chondracanthus chamissoi* and *C*. *teedei* (Gigartinaceae, Rhodophyta). *Bot*. *Mar*. **58**: 103-13.

Table S2. Summary for the Bayesian analyses on the basis of three datasets (*rbc*L for *Chondracanthus*, COI-5P for *Chondracanthus*, and *rbc*L for *Schottera*).

	*rbc*L for *Chondracanthus*	COI-5P for *Chondracanthus*	*rbc*L for *Schottera*
Number of taxa	48 (117)[*1]	31 (169)[*1]	6 (16) [*1]
Number of nucleotides (bp)	1227	564	1278
Substitution model[*2]	1st codons (GTR+G), 2nd codons (F81+I+G), 3rd codons (GTR+I+G)	1st codons (SYM+G), 2nd codons (F81), 3rd codons (GTR+I+G)	1st codons (GTR+G), 2nd codons (F81), 3rd codons (HKY+G)

[*1] The numbers within parentheses indicate original number of taxa including the samples with identical nucleotide sequences.

[*2] Each substitution model was selected by hierarchical likelihood ratio test using MrModeltest 2.3 software (Nylander, 2004).

REFERENCE

Nylander, J. A. A. 2004. *MrModeltest 2.3. Program distributed by the author*. Evolutionary Biology Centre, Uppsala University, Uppsala, Sweden.

Table S3. Matrix of *p* distances among the species of *Chondracanthus* used in the *rbc*L analysis.

	1	2	3	4	5	6	7	8	9	10
1. *C. acicularis* KJ202090[1)]	-									
2. *C. acicularis* MH648767	0.00081	-								
3. *C. acicularis* U02938	0.00571	0.00652	-							
4. *C. bajacalifornicus* DQ869091[2)]	0.06764	0.06846	0.06768	-						
5. *C. canaliculatus* DQ869084[3)]	0.06438	0.06520	0.06442	0.00326	-					
6. *C. canaliculatus* DQ869086	0.06520	0.06601	0.06523	0.00407	0.00081	-				
7. *C. chamissoi* AF146193	0.07172	0.07253	0.07176	0.03749	0.03586	0.03667	-			
8. *C. chamissoi* KP059077[4)]	0.07009	0.07090	0.07013	0.03586	0.03423	0.03504	0.00326	-		
9. *C. chamissoi* KP059086	0.06846	0.06927	0.06850	0.03260	0.03097	0.03178	0.00652	0.00326	-	
10. *C. chamissoi* KP059087	0.06927	0.07009	0.06932	0.03341	0.03178	0.03260	0.00733	0.00407	0.00081	-
11. *C. chamissoi* KP059088[5)]	0.06846	0.06927	0.06850	0.03341	0.03178	0.03260	0.00652	0.00326	0.00163	0.00244
12. *C. chamissoi* LC538288[6)]	0.06846	0.06927	0.06850	0.03423	0.03260	0.03341	0.00652	0.00326	0.00163	0.00244
13. *C. chapmanii* U02940	0.06764	0.06846	0.06769	0.06438	0.06112	0.06194	0.06846	0.06683	0.06520	0.06601
14. *C. cincinnus* KR909561[7)]	0.05623	0.05705	0.05627	0.05297	0.04971	0.05053	0.05542	0.05379	0.05053	0.05134
15. *C. cincinnus* KU640261	0.05705	0.05786	0.05708	0.05379	0.05053	0.05134	0.05623	0.05460	0.05134	0.05216
16. *C. corymbiferus* DQ869094	0.06601	0.06683	0.06605	0.02445	0.02445	0.02526	0.03015	0.02689	0.02526	0.02445
17. *C. corymbiferus* U02941	0.06846	0.06927	0.06849	0.02608	0.02608	0.02689	0.03260	0.02934	0.02689	0.02608
18. *C. exasperatus* DQ869105[8)]	0.06683	0.06764	0.06605	0.03749	0.03423	0.03504	0.03097	0.02771	0.02608	0.02689
19. *C. exasperatus* DQ869106[9)]	0.06764	0.06846	0.06686	0.03667	0.03341	0.03423	0.03015	0.02689	0.02526	0.02608
20. *C. harveyanus* DQ869115[10)]	0.05705	0.05786	0.05708	0.02526	0.02363	0.02445	0.02771	0.02445	0.02282	0.02363
21. *C. intermedius* KR909577[11)]	0.05705	0.05786	0.05708	0.05379	0.05053	0.05134	0.05623	0.05460	0.05134	0.05216
22. *C. intermedius* KR909579	0.05786	0.05868	0.05790	0.05460	0.05134	0.05216	0.05705	0.05542	0.05216	0.05297
23. *C. intermedius* LC538289[12)]	0.05786	0.05868	0.05789	0.05460	0.05134	0.05216	0.05705	0.05542	0.05216	0.05297
24. *C. okamurae* AF146196	0.05868	0.05949	0.05871	0.05542	0.05216	0.05297	0.05460	0.05297	0.05134	0.05216
25. *C. okamurae* DQ787588	0.05623	0.05705	0.05626	0.05460	0.05134	0.05216	0.05542	0.05379	0.05053	0.05134

Table S3. Continued.

	1	2	3	4	5	6	7	8	9	10
26. *C. okamurae* KR909568[13)]	0.05623	0.05705	0.05626	0.05460	0.05134	0.05216	0.05542	0.05379	0.05053	0.05134
27. *C. okamurae* KR909570[14)]	0.05542	0.05623	0.05545	0.05379	0.05053	0.05134	0.05460	0.05297	0.04971	0.05053
28. *C. okamurae* KR909573[15)]	0.05705	0.05786	0.05708	0.05542	0.05216	0.05297	0.05623	0.05460	0.05134	0.05216
29. *C. saundersii* AY698062[16)]	0.06275	0.06194	0.06279	0.05705	0.05379	0.05460	0.05705	0.05542	0.05216	0.05297
30. *C. saundersii* LC538291	0.06194	0.06275	0.06198	0.05460	0.05134	0.05216	0.05460	0.05297	0.04971	0.05053
31. *C. serratus* DQ869089[17)]	0.06520	0.06601	0.06523	0.00652	0.00489	0.00570	0.03586	0.03260	0.02934	0.03015
32. *C. spinosus* U02943	0.06846	0.06927	0.06605	0.03830	0.03504	0.03586	0.03178	0.02852	0.02689	0.02771
33. *C. squarrulosus* DQ869100	0.07090	0.07172	0.06931	0.04401	0.04075	0.04156	0.03504	0.03178	0.03015	0.03097
34. *C. squarrulosus* DQ869101[18)]	0.06927	0.07009	0.06931	0.04156	0.03830	0.03912	0.03260	0.02934	0.02771	0.02852
35. *C. teedei* KP059093[19)]	0.06683	0.06764	0.06687	0.04645	0.04319	0.04401	0.03667	0.03341	0.03178	0.03097
36. *C. teedei* MH648760[20)]	0.06927	0.07009	0.06932	0.04564	0.04238	0.04319	0.03423	0.03097	0.02934	0.02852
37. *C. teedei* U02945	0.07009	0.07090	0.06850	0.04645	0.04319	0.04401	0.03504	0.03178	0.03015	0.02934
38. *C. teedei* U03024	0.07090	0.07172	0.06931	0.05216	0.04971	0.05053	0.04238	0.03912	0.03749	0.03667
39. *C. tenellus* AF146197	0.05949	0.06031	0.05953	0.05868	0.05542	0.05623	0.06112	0.05949	0.05623	0.05705
40. *C. tenellus* KR909582[21)]	0.05786	0.05868	0.05789	0.05623	0.05297	0.05379	0.05949	0.05786	0.05460	0.05542
41. *C. tenellus* KR909583	0.06031	0.06112	0.06034	0.05868	0.05542	0.05623	0.06194	0.06031	0.05705	0.05786
42. *C. tenellus* KR909587[22)]	0.05868	0.05949	0.05871	0.05705	0.05379	0.05460	0.06031	0.05868	0.05542	0.05623
43. *C. tenellus* KR909589	0.05949	0.06031	0.05953	0.05786	0.05460	0.05542	0.06112	0.05949	0.05623	0.05705
44. *C. tenellus* LC538292	0.05786	0.05868	0.05789	0.05623	0.05297	0.05379	0.05949	0.05786	0.05460	0.05542
45. *Chondracanthus* sp. MK125367	0.05623	0.05705	0.05791	0.06031	0.05868	0.05949	0.06275	0.06112	0.05786	0.05868

Table S3. Continued.

	11	12	13	14	15	16	17	18	19	20
1. *C. acicularis* KJ202090[1)]										
2. *C. acicularis* MH648767										
3. *C. acicularis* U02938										
4. *C. bajacalifornicus* DQ869091[2)]										
5. *C. canaliculatus* DQ869084[3)]										
6. *C. canaliculatus* DQ869086										
7. *C. chamissoi* AF146193										
8. *C. chamissoi* KP059077[4)]										
9. *C. chamissoi* KP059086										
10. *C. chamissoi* KP059087										
11. *C. chamissoi* KP059088[5)]	-									
12. *C. chamissoi* LC538288[6)]	0.00163	-								
13. *C. chapmanii* U02940	0.06601	0.06520	-							
14. *C. cincinnus* KR909561[7)]	0.05134	0.05216	0.04890	-						
15. *C. cincinnus* KU640261	0.05216	0.05297	0.04971	0.00081	-					
16. *C. corymbiferus* DQ869094	0.02445	0.02526	0.06275	0.05053	0.05134	-				
17. *C. corymbiferus* U02941	0.02689	0.02771	0.06438	0.05216	0.05297	0.00244	-			
18. *C. exasperatus* DQ869105[8)]	0.02445	0.02608	0.06275	0.05297	0.05379	0.03015	0.03260	-		
19. *C. exasperatus* DQ869106[9)]	0.02363	0.02526	0.06194	0.05216	0.05297	0.02934	0.03178	0.00081	-	
20. *C. harveyanus* DQ869115[10)]	0.02200	0.02282	0.05868	0.04971	0.05053	0.01793	0.01874	0.02526	0.02445	-
21. *C. intermedius* KR909577[11)]	0.05216	0.05297	0.05134	0.00407	0.00489	0.05134	0.05297	0.05542	0.05460	0.05053
22. *C. intermedius* KR909579	0.05297	0.05379	0.05216	0.00489	0.00570	0.05216	0.05379	0.05623	0.05542	0.05134
23. *C. intermedius* LC538289[12)]	0.05297	0.05379	0.05216	0.00489	0.00407	0.05216	0.05379	0.05623	0.05542	0.05134
24. *C. okamurae* AF146196	0.05216	0.05297	0.05460	0.00978	0.00896	0.05379	0.05542	0.05542	0.05460	0.05053
25. *C. okamurae* DQ787588	0.05134	0.05216	0.05216	0.00733	0.00652	0.05542	0.05379	0.05460	0.05379	0.04971

Table S3. Continued.

	11	12	13	14	15	16	17	18	19	20
26. *C. okamurae* KR909568[13)]	0.05134	0.05216	0.05216	0.00570	0.00652	0.05216	0.05379	0.05460	0.05379	0.04971
27. *C. okamurae* KR909570[14)]	0.05053	0.05134	0.05134	0.00652	0.00733	0.05134	0.05297	0.05379	0.05297	0.04890
28. *C. okamurae* KR909573[15)]	0.05216	0.05297	0.05297	0.00652	0.00570	0.05297	0.05460	0.05542	0.05460	0.05053
29. *C. saundersii* AY698062[16)]	0.05297	0.05379	0.05297	0.03178	0.03097	0.05542	0.05705	0.05297	0.05216	0.05216
30. *C. saundersii* LC538291	0.05053	0.05134	0.05216	0.02852	0.02771	0.05297	0.05460	0.05053	0.04971	0.05134
31. *C. serratus* DQ869089[17)]	0.03015	0.03097	0.06194	0.05053	0.05134	0.02282	0.02445	0.03586	0.03504	0.02200
32. *C. spinosus* U02943	0.02526	0.02689	0.06357	0.05379	0.05460	0.03097	0.03341	0.00244	0.00163	0.02608
33. *C. squarrulosus* DQ869100	0.02852	0.03015	0.06438	0.05705	0.05786	0.03667	0.03912	0.01548	0.01467	0.02852
34. *C. squarrulosus* DQ869101[18)]	0.02608	0.02771	0.06275	0.05460	0.05542	0.03423	0.03667	0.01304	0.01222	0.02771
35. *C. teedei* KP059093[19)]	0.03178	0.03178	0.06438	0.05297	0.05379	0.03993	0.04238	0.02608	0.02526	0.03423
36. *C. teedei* MH648760[20)]	0.02934	0.02771	0.06357	0.05379	0.05460	0.03749	0.03993	0.02363	0.02282	0.03178
37. *C. teedei* U02945	0.03015	0.02852	0.06438	0.05460	0.05542	0.03830	0.04075	0.02445	0.02363	0.03260
38. *C. teedei* U03024	0.03749	0.03749	0.06927	0.05786	0.05868	0.04564	0.04645	0.03178	0.03097	0.03830
39. *C. tenellus* AF146197	0.05705	0.05786	0.05542	0.01956	0.01874	0.05868	0.05868	0.06031	0.05949	0.05379
40. *C. tenellus* KR909582[21)]	0.05542	0.05623	0.05216	0.00896	0.00978	0.05379	0.05542	0.05705	0.05623	0.05297
41. *C. tenellus* KR909583	0.05786	0.05868	0.05460	0.01141	0.01222	0.05623	0.05786	0.05949	0.05868	0.05542
42. *C. tenellus* KR909587[22)]	0.05623	0.05705	0.05297	0.00978	0.00896	0.05460	0.05623	0.05786	0.05705	0.05379
43. *C. tenellus* KR909589	0.05705	0.05786	0.05379	0.01059	0.00978	0.05542	0.05705	0.05868	0.05786	0.05460
44. *C. tenellus* LC538292	0.05542	0.05623	0.05216	0.01059	0.00978	0.05379	0.05542	0.05705	0.05623	0.05297
45. *Chondracanthus* sp. MK125367	0.05868	0.05949	0.03586	0.04482	0.04564	0.06112	0.06275	0.06275	0.06194	0.05542

Table S3. Continued.

	21	22	23	24	25	26	27	28	29	30
1. *C. acicularis* KJ202090[1)]										
2. *C. acicularis* MH648767										
3. *C. acicularis* U02938										
4. *C. bajacalifornicus* DQ869091[2)]										
5. *C. canaliculatus* DQ869084[3)]										
6. *C. canaliculatus* DQ869086										
7. *C. chamissoi* AF146193										
8. *C. chamissoi* KP059077[4)]										
9. *C. chamissoi* KP059086										
10. *C. chamissoi* KP059087										
11. *C. chamissoi* KP059088[5)]										
12. *C. chamissoi* LC538288[6)]										
13. *C. chapmanii* U02940										
14. *C. cincinnus* KR909561[7)]										
15. *C. cincinnus* KU640261										
16. *C. corymbiferus* DQ869094										
17. *C. corymbiferus* U02941										
18. *C. exasperatus* DQ869105[8)]										
19. *C. exasperatus* DQ869106[9)]										
20. *C. harveyanus* DQ869115[10)]										
21. *C. intermedius* KR909577[11)]	-									
22. *C. intermedius* KR909579	0.00081	-								
23. *C. intermedius* LC538289[12)]	0.00081	0.00163	-							
24. *C. okamurae* AF146196	0.01059	0.01141	0.00978	-						
25. *C. okamurae* DQ787588	0.00815	0.00896	0.00733	0.00407	-					

Table S3. Continued.

	21	22	23	24	25	26	27	28	29	30
26. *C. okamurae* KR909568[13)]	0.00652	0.00733	0.00733	0.00407	0.00163	-				
27. *C. okamurae* KR909570[14)]	0.00733	0.00815	0.00815	0.00489	0.00081	0.00081	-			
28. *C. okamurae* KR909573[15)]	0.00733	0.00815	0.00652	0.00326	0.00081	0.00081	0.00163	-		
29. *C. saundersii* AY698062[16)]	0.03260	0.03341	0.03178	0.03341	0.03260	0.03423	0.03341	0.03341	-	
30. *C. saundersii* LC538291	0.02934	0.03015	0.02852	0.03015	0.02934	0.03097	0.03015	0.03015	0.00326	-
31. *C. serratus* DQ869089[17)]	0.05134	0.05216	0.05216	0.05297	0.05216	0.05216	0.05134	0.05297	0.05460	0.05216
32. *C. spinosus* U02943	0.05623	0.05705	0.05705	0.05623	0.05542	0.05542	0.05460	0.05623	0.05379	0.05134
33. *C. squarrulosus* DQ869100	0.05949	0.06031	0.06031	0.05949	0.05868	0.05868	0.05786	0.05949	0.05705	0.05623
34. *C. squarrulosus* DQ869101[18)]	0.05705	0.05786	0.05786	0.05705	0.05623	0.05623	0.05542	0.05705	0.05460	0.05379
35. *C. teedei* KP059093[19)]	0.05542	0.05623	0.05623	0.05542	0.05460	0.05460	0.05379	0.05542	0.05460	0.05379
36. *C. teedei* MH648760[20)]	0.05623	0.05705	0.05705	0.05623	0.05542	0.05542	0.05460	0.05623	0.05542	0.05460
37. *C. teedei* U02945	0.05705	0.05786	0.05786	0.05705	0.05623	0.05623	0.05542	0.05705	0.05623	0.05542
38. *C. teedei* U03024	0.06031	0.06112	0.06112	0.06031	0.05949	0.05949	0.05868	0.06031	0.05868	0.05786
39. *C. tenellus* AF146197	0.02037	0.02119	0.01956	0.02200	0.02037	0.02037	0.02119	0.01956	0.03912	0.03749
40. *C. tenellus* KR909582[21)]	0.00978	0.01059	0.01059	0.01141	0.00978	0.00815	0.00896	0.00896	0.03504	0.03178
41. *C. tenellus* KR909583	0.01222	0.01304	0.01304	0.01385	0.01222	0.01059	0.01141	0.01141	0.03749	0.03423
42. *C. tenellus* KR909587[22)]	0.01059	0.01141	0.00978	0.01059	0.00896	0.00896	0.00978	0.00815	0.03423	0.03097
43. *C. tenellus* KR909589	0.01141	0.01222	0.01059	0.01141	0.00978	0.00978	0.01059	0.00896	0.03504	0.03178
44. *C. tenellus* LC538292	0.01141	0.01222	0.01059	0.01141	0.00978	0.00978	0.01059	0.00896	0.03341	0.03015
45. *Chondracanthus* sp. MK125367	0.04401	0.04482	0.04482	0.04890	0.04645	0.04645	0.04564	0.04727	0.04564	0.04564

Table S3. Continued.

	31	32	33	34	35	36	37	38	39	40
26. *C. okamurae* KR909568[13]										
27. *C. okamurae* KR909570[14]										
28. *C. okamurae* KR909573[15]										
29. *C. saundersii* AY698062[16]										
30. *C. saundersii* LC538291										
31. *C. serratus* DQ869089[17]	-									
32. *C. spinosus* U02943	0.03667	-								
33. *C. squarrulosus* DQ869100	0.04238	0.01467	-							
34. *C. squarrulosus* DQ869101[18]	0.03993	0.01385	0.00244	-						
35. *C. teedei* KP059093[19]	0.04482	0.02689	0.03015	0.02771	-					
36. *C. teedei* MH648760[20]	0.04401	0.02445	0.02771	0.02526	0.00407	-				
37. *C. teedei* U02945	0.04482	0.02363	0.02689	0.02608	0.00489	0.00081	-			
38. *C. teedei* U03024	0.05053	0.02934	0.03504	0.03423	0.00652	0.01059	0.00978	-		
39. *C. tenellus* AF146197	0.05623	0.06112	0.06520	0.06357	0.06194	0.06275	0.06357	0.06520	-	
40. *C. tenellus* KR909582[21]	0.05379	0.05786	0.06275	0.06031	0.05868	0.05949	0.06031	0.06357	0.01222	-
41. *C. tenellus* KR909583	0.05623	0.06031	0.06520	0.06275	0.06112	0.06194	0.06275	0.06601	0.01467	0.00244
42. *C. tenellus* KR909587[22]	0.05460	0.05868	0.06357	0.06112	0.05949	0.06031	0.06112	0.06438	0.01141	0.00081
43. *C. tenellus* KR909589	0.05542	0.05949	0.06438	0.06194	0.06031	0.06112	0.06194	0.06520	0.01222	0.00163
44. *C. tenellus* LC538292	0.05379	0.05786	0.06275	0.06031	0.05868	0.05949	0.06031	0.06357	0.01059	0.00163
45. *Chondracanthus* sp. MK125367	0.05949	0.06357	0.06438	0.06275	0.06683	0.06764	0.06846	0.07090	0.04645	0.04564

Table S3. Continued.

	41	42	43	44	45
26. *C. okamurae* KR909568[13)]					
27. *C. okamurae* KR909570[14)]					
28. *C. okamurae* KR909573[15)]					
29. *C. saundersii* AY698062[16)]					
30. *C. saundersii* LC538291					
31. *C. serratus* DQ869089[17)]					
32. *C. spinosus* U02943					
33. *C. squarrulosus* DQ869100					
34. *C. squarrulosus* DQ869101[18)]					
35. *C. teedei* KP059093[19)]					
36. *C. teedei* MH648760[20)]					
37. *C. teedei* U02945					
38. *C. teedei* U03024					
39. *C. tenellus* AF146197					
40. *C. tenellus* KR909582[21)]					
41. *C. tenellus* KR909583	-				
42. *C. tenellus* KR909587[22)]	0.00326	-			
43. *C. tenellus* KR909589	0.00407	0.00081	-		
44. *C. tenellus* LC538292	0.00407	0.00081	0.00163	-	
45. *Chondracanthus* sp. MK125367	0.04808	0.04645	0.04727	0.04564	-

[1)]The *rbc*L sequences of KP059097, KR909558, KR909559 and KR909560 are identical to KJ202090.

[2)]The *rbc*L sequences of DQ869092 and DQ869093 are identical to DQ869091.

[3)]The *rbc*L sequences of DQ869085, DQ869087 and DQ869088 are identical to DQ869084.

[4]The *rbc*L sequences of KP059078 - KP059082 are identical to KP059077.

[5]The *rbc*L sequences of KP059089 - KP059092 are identical to KP059088.

[6]The *rbc*L sequences of JQ405738, KP059083 - KP059085 are identical to LC538288.

[7]The *rbc*L sequences of KR909562 - KR909567 are identical to KR909561.

[8]The *rbc*L sequences of DQ869109, DQ869110 and DQ869113 are identical to DQ869105.

[9]The *rbc*L sequences of AF146194, DQ869107, DQ869108, DQ869111, DQ869112, DQ869114 and JN403073 are identical to DQ869106.

[10]The *rbc*L sequence of DQ869116 is identical to DQ869115.

[11] The *rbc*L sequence of KR909578 is identical to KR909577.

[12]The *rbc*L sequences of KR909580, KR909581 and U02942 are identical to LC538289.

[13]The *rbc*L sequences of KR909569, KR909571, KR909572 and KR909575 are identical to KR909568.

[14] The *rbc*L sequence of KR909574 is identical to KR909570.

[15] The *rbc*L sequence of KR909576 is identical to KR909573.

[16]The *rbc*L sequences of FJ513458, MH648764 - MH648766 and U02942 are identical to AY698062.

[17] The *rbc*L sequence of DQ869090 is identical to DQ869089.

[18]The *rbc*L sequences of DQ869102 - DQ869104 are identical to DQ869101.

[19]The *rbc*L sequences of KP059094 - KP059096 are identical to KP059093.

[20]The *rbc*L sequences of MH648761 - MH648763 are identical to MH648760.

[21]The *rbc*L sequences of KR909584-KR909586 are identical to KR909582.

[22]The *rbc*L sequences of KR909588 and KR909590 are identical to KR909587.

Table S4. Matrix of *p* distances among the species of *Chondracanthus* used in the COI-5P analysis.

	1	2	3	4	5	6	7	8	9	10	11	12
1. *C. acicularis* KJ202081[1]	-											
2. *C. acicularis* KJ960534	0.00887	-										
3. *C. acicularis* KJ960535	0.00709	0.00177	-									
4. *C. acicularis* MG030757	0.00177	0.00709	0.00532	-								
5. *C. acicularis* MH648759	0.00355	0.00887	0.00709	0.00177	-							
6. *C. canaliculatus* KM254238[2]	0.10638	0.11170	0.10993	0.10461	0.10638	-						
7. *C. chamissoi* KP059063[3]	0.08688	0.08865	0.08688	0.08511	0.08688	0.05674	-					
8. *C. chamissoi* KP059065[4]	0.08333	0.08511	0.08333	0.08156	0.08333	0.06028	0.00532	-				
9. *C. chamissoi* KP059069[5]	0.08333	0.08511	0.08333	0.08156	0.08333	0.05674	0.00532	0.00355	-			
10. *C. chamissoi* LC538295[6]	0.08511	0.08688	0.08511	0.08333	0.08511	0.05851	0.00355	0.00177	0.00177	-		
11. *C. cincinnus* KR909524[7]	0.08688	0.09220	0.09043	0.08511	0.08333	0.10638	0.07801	0.07624	0.07979	0.07801	-	
12. *C. corymbiferus* KM254267[8]	0.09397	0.09574	0.09397	0.09220	0.09397	0.04965	0.04433	0.04610	0.04610	0.04433	0.08688	-
13. *C. exasperatus* KM254513[9]	0.08688	0.08865	0.08688	0.08511	0.08688	0.05319	0.04610	0.04433	0.04078	0.04255	0.08688	0.05496
14. *C. harveyanus* HQ544210[10]	0.07979	0.08156	0.07979	0.07801	0.07979	0.04787	0.04787	0.04255	0.04255	0.04433	0.08688	0.04787
15. *C. harveyanus* KM254520[11]	0.07979	0.08156	0.07979	0.07801	0.07979	0.04965	0.04965	0.04433	0.04433	0.04610	0.08865	0.04610
16. *C. intermedius* KR909537	0.08688	0.09220	0.09043	0.08511	0.08333	0.10284	0.08156	0.07979	0.07979	0.08156	0.01064	0.08688
17. *C. intermedius* LC538296[12]	0.08511	0.09043	0.08865	0.08333	0.08156	0.10638	0.07801	0.07624	0.07979	0.07801	0.01064	0.08688
18. *C. okamurae* KR909525[13]	0.08688	0.09220	0.09043	0.08511	0.08333	0.10106	0.06915	0.06738	0.07092	0.06915	0.02482	0.08333
19. *C. okamurae* KR909526[14]	0.08511	0.09043	0.08865	0.08333	0.08156	0.09929	0.06738	0.06560	0.06915	0.06738	0.02660	0.08156
20. *C. okamurae* KR909529	0.09043	0.09574	0.09397	0.08865	0.08688	0.10461	0.07270	0.07092	0.07447	0.07270	0.02128	0.08688
21. *C. okamurae* KR909530	0.08865	0.09397	0.09220	0.08688	0.08511	0.10284	0.07092	0.06915	0.07270	0.07092	0.02305	0.08511
22. *C. saundersii* LC538298[15]	0.08156	0.08333	0.08156	0.07979	0.08156	0.09220	0.06383	0.06560	0.06206	0.06383	0.07270	0.07447
23. *C. teedei* KP059073[16]	0.08511	0.08688	0.08511	0.08333	0.08511	0.05851	0.04078	0.04255	0.03901	0.04078	0.07979	0.04787
24. *C. teedei* MH648728[17]	0.08511	0.08688	0.08511	0.08333	0.08511	0.06028	0.04255	0.04433	0.04078	0.04255	0.07979	0.04965
25. *C. teedei* MH648737	0.08333	0.08511	0.08333	0.08156	0.08333	0.06206	0.04433	0.04610	0.04255	0.04433	0.07801	0.04787
26. *C. tenellus* KR909541	0.08333	0.08865	0.08688	0.08156	0.07979	0.09929	0.06915	0.07092	0.07092	0.06915	0.02837	0.08688
27. *C. tenellus* LC538299[18]	0.08511	0.09043	0.08865	0.08333	0.08156	0.10106	0.07092	0.07270	0.07270	0.07092	0.02660	0.08865

Table S4. Continued.

	13	14	15	16	17	18	19	20	21	22	23	24
1. *C. acicularis* KJ202081[1)]												
2. *C. acicularis* KJ960534												
3. *C. acicularis* KJ960535												
4. *C. acicularis* MG030757												
5. *C. acicularis* MH648759												
6. *C. canaliculatus* KM254238[2)]												
7. *C. chamissoi* KP059063[3)]												
8. *C. chamissoi* KP059065[4)]												
9. *C. chamissoi* KP059069[5)]												
10. *C. chamissoi* LC538295[6)]												
11. *C. cincinnus* KR909524[7)]												
12. *C. corymbiferus* KM254267[8)]												
13. *C. exasperatus* KM254513[9)]	-											
14. *C. harveyanus* HQ544210[10)]	0.03723	-										
15. *C. harveyanus* KM254520[11)]	0.03901	0.00177	-									
16. *C. intermedius* KR909537	0.08688	0.08333	0.08511	-								
17. *C. intermedius* LC538296[12)]	0.08688	0.08333	0.08511	0.00709	-							
18. *C. okamurae* KR909525[13)]	0.07979	0.07979	0.08156	0.02482	0.02128	-						
19. *C. okamurae* KR909526[14)]	0.07801	0.07801	0.07979	0.02660	0.02305	0.00177	-					
20. *C. okamurae* KR909529	0.08333	0.08333	0.08511	0.02128	0.01773	0.00355	0.00532	-				
21. *C. okamurae* KR909530	0.08156	0.08156	0.08333	0.02305	0.01950	0.00177	0.00355	0.00177	-			
22. *C. saundersii* LC538298[15)]	0.06738	0.06915	0.07092	0.06915	0.06915	0.06206	0.06028	0.06206	0.06028	-		
23. *C. teedei* KP059073[16)]	0.02837	0.03546	0.03723	0.07979	0.07979	0.07624	0.07447	0.07979	0.07801	0.06738	-	
24. *C. teedei* MH648728[17)]	0.03014	0.03723	0.03901	0.07979	0.07979	0.07624	0.07447	0.07979	0.07801	0.06738	0.00177	-
25. *C. teedei* MH648737	0.02837	0.03901	0.04078	0.07801	0.07801	0.07447	0.07270	0.07801	0.07624	0.06560	0.00355	0.00177
26. *C. tenellus* KR909541	0.07624	0.08333	0.08511	0.02837	0.02837	0.02482	0.02660	0.02482	0.02305	0.06206	0.07624	0.07624
27. *C. tenellus* LC538299[18)]	0.07801	0.08511	0.08688	0.02660	0.02660	0.02305	0.02482	0.02305	0.02128	0.06383	0.07801	0.07801

Table S4. Continued.

	25	26	27
1. *C. acicularis* KJ202081[1)]			
2. *C. acicularis* KJ960534			
3. *C. acicularis* KJ960535			
4. *C. acicularis* MG030757			
5. *C. acicularis* MH648759			
6. *C. canaliculatus* KM254238[2)]			
7. *C. chamissoi* KP059063[3)]			
8. *C. chamissoi* KP059065[4)]			
9. *C. chamissoi* KP059069[5)]			
10. *C. chamissoi* LC538295[6)]			
11. *C. cincinnus* KR909524[7)]			
12. *C. corymbiferus* KM254267[8)]			
13. *C. exasperatus* KM254513[9)]			
14. *C. harveyanus* HQ544210[10)]			
15. *C. harveyanus* KM254520[11)]			
16. *C. intermedius* KR909537			
17. *C. intermedius* LC538296[12)]			
18. *C. okamurae* KR909525[13)]			
19. *C. okamurae* KR909526[14)]			
20. *C. okamurae* KR909529			
21. *C. okamurae* KR909530			
22. *C. saundersii* LC538298[15)]			
23. *C. teedei* KP059073[16)]			
24. *C. teedei* MH648728[17)]			
25. *C. teedei* MH648737	-		
26. *C. tenellus* KR909541	0.07447	-	
27. *C. tenellus* LC538299[18)]	0.07624	0.00177	-

[1)]The COI-5P sequences of KR909519-KP909521 are identical to KJ202081.

[2)]The COI-5P sequences of HQ544186, KM254287, KM254319, KM254787, KM254793, KM254878 and KM254892 are identical to KM254238.

[3)]The COI-5P sequence of KP059064 is identical to KP059063.

[4)]The COI-5P sequences of KP059066- KP059068 are identical to KP059065.

[5]The COI-5P sequences of KP059070- KP059072 are identical to KP059069.

[6)]The COI-5P sequences of KP059060-KP059062 are identical to LC538295.

[7)]The COI-5P sequences of KU640325, KR909522, KR909523 and KR909525 are identical to KR909524.

[8)]The COI-5P sequences of GQ398090, HQ544218, HQ544221, KM254376, KM254441, KM254448, KM254457, KM254575 and KM254942 are identical to KM254267.

[9)]The COI-5P sequences of GQ398091, KM254593, KM254607, KM254733, KM254927, KM254953 and KX281899 are identical to KM254513.

[10)]The COI-5P sequences of HM915561, HM915570, HQ919433, HQ544688, HQ544692, HQ544697, HQ544707, HQ544896, HQ544906, HQ544930, HQ544979, HQ544982, HQ544996, HQ545003, HQ919434, HQ919442, KM254231, KM254277, KM254341, KM254374, KM254421, KM254447, KM254461, KM254530, KM254564, KM254626, KM254650, KM254690, KM254711, KM254744, KM254811, KM254817, KM254862, KM254899, KM254919, KM254931 and KM254979 are identical to HQ544210.

[11)]The COI-5P sequences of KM254718 and KM254915 are identical to KM254520.

[12)]The COI-5P sequences of KR909534-KR909536, KR909538, KR909539 and LC538297 are identical to LC538296.

[13]The COI-5P sequences of KR909527, KR909528 and KR909531 are identical to KR909525.

[14]The COI-5P sequences of KR909532 and KR909533 are identical to KR909526.

[15]The COI-5P sequences of MH648738-MH648757 are identical to LC538298.

[16]The COI-5P sequences of KP059074- KP059076 are identical to KP059073.

[17]The COI-5P sequences of MH648729- MH648736 are identical to MH648728.

[18]The COI-5P sequences of KR909540, KR909542-KR909557 are identical to LC538299.