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Molecular Systematics and Morphological Analyses of the Subgenus *Setihenricia* (Echinodermata: Asteroidea: *Henricia*) from Japan

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The subgenus *Setihenricia* Chichvarkhin and Chichvarkhina, 2017 currently consists of 32 out of 94 species of sea stars in the genus *Henricia* Gray, 1840. However, only 10 have been molecularly ascertained as to the phylogenetic position. Based on seven mitochondrial gene markers (16S rRNA, COI, tRNA-Ala, tRNA-Leu, tRNA-Asn, tRNA-Gln, and tRNA-Pro), we performed molecular analyses to assess the monophyly of *Setihenricia* using 16 species of *Henricia* from Japanese waters, as well as other congeners for which sequences were available in public databases. The monophyletic *Setihenricia* was only weakly recovered because the support values were low, but we assume this taxon may be valid in consideration of a morphological key. *Henricia kinkasana* Hayashi, 1940 is herein identified as a new member of *Setihenricia*, based on molecular and morphological evidence. Sequences in the public databases previously identified as *H. compacta* (Sladen, 1889) and *H. obesa* (Sladen, 1889) were nested in the *Setihenricia* clade; these two species are also likely members of *Setihenricia*. Our morphological assessment yielded three findings: (1) the number of the rows of spines on each inferomarginal plate, being three or more, appears to be a useful diagnostic character for *Setihenricia*, as has been suggested in previous studies, (2) the degree of spine tapering turned out to be less relevant in diagnosing the subgenus than previously supposed, (3) two newly introduced characters—(*i*) the width of adambulacral plates and (*ii*) the ratio of two measurements in ambulacral plates to the length of interradius—may be effective to distinguish members of this apparent *Henricia* subclade from other members of the genus.

Key Words: Echinasteridae, phylogeny, RAxML, MrBayes, taxonomic character, scanning electron microscopy (SEM), Pacific, Sea of Japan, East China Sea.

Introduction

At present, 94 species of sea stars in the genus *Henricia* Gray, 1840 are known worldwide, which account for 68% of the total species in the family Echinasteridae (Chichvarkhin 2017a, b; Chichvarkhin and Chichvarkhina 2017; Mah and Hansson 2017). *Henricia* has been recognized as a major taxon of sea stars along the coast of the North Pacific (Fisher 1911; Verrill 1914; Clark and Jewett 2010). From Japanese waters, Uchida (1928) described one species and Hayashi (1940) described or redescribed 15 species, one subspecies, and two forms of *Henricia*. The larval distribution is spatially limited due to breeding habits, causing many local variations (Hayashi 1973). Because the morphology in many species of *Henricia* intergrades almost continuously with one another, it is difficult to define species boundaries (Fisher 1911; Madsen 1987; Clark and Downey 1992; Mah and Blake 2012; Chichvarkhin 2017b). Numerous subspecies and varieties have been established, while a number of named taxa have turned out to be synonymous (Fisher 1910, 1911, 1928, 1930; Verrill 1914; Mortensen 1925; Uchida 1928; Hayashi 1940; D'jakonov 1958; Madsen 1987; Clark and Downey 1992; Clark and Jewett 2010; Eernisse *et al.* 2010).

Within *Henricia*, Chichvarkhin and Chichvarkhina (2017) proposed the new subgenus *Setihenricia*, including 31 species based on morphological characters. Using 16S rRNA (16S), cytochrome *c* oxidase subunit I (COI), and 28S rRNA sequences, Lopes *et al.* (2016) showed that *Henricia* formed a clade along with *Echinaster* (*Echinaster*) Müller and Troschel, 1840, which altogether was sister to *Echinaster* (*Othilia*) Gray, 1840. Of 31 *Setihenricia* species listed by Chichvarkhin and Chichvarkhina (2017), Lopes *et al.*'s (2016) analysis included only one, *H. sanguinolenta* (Müller, 1776). Chichvarkhin (2017b) showed that *Setihenricia* formed a clade with high nodal support in a molecular phylogeny of 16S in terms of six species of *Setihenricia*—*H. djakonovi* Chichvarkhin, 2017a, *H. hayashii* D'jakonov, 1961, *H. lineata* Clark and Jewett, 2010, *H. olga* Chichvarkhin, 2017b, *H. sanguinolenta*, and *H. uluudax* Clark and Jewett, 2010—and four of non-*Setihenricia*; the subgenus is currently composed of 32 species, with the inclusion of *H. olga*. Knott *et al*. (2018) performed phylogenetic analyses of the two groups formerly referred to as the '*pertusa* group' and '*perforata* group' based on 16S and COI. Chichvarkhin and Chichvarkhina (2017) implied that the '*pertusa* group' represents *Setihenricia*. The '*pertusa* group' also formed a highly supported clade in Knott *et al.*'s (2018) phylogeny, which included specimens morphologically identifiable as *H. hedingi* Madsen, 1987, *H. lisa* Clark, 1949, *H. pertusa* (Müller, 1776), *H. sanguinolenta*, and *H. spongiosa* (Fabricius, 1780), five of the 31 species originally listed as members of *Setihenricia* (Chichvarkhin and Chichvarkhina 2017). In summary, the monophyly of *Setihenricia* has been investigated in terms of only 10 out of 32 species. One pur-

Table 1. List of species and DDBJ/EMBL/GenBank accession numbers used in the analyses. Where applicable, museum catalogue number and locality of each voucher specimen used in this study are also provided.

Species	Catalogue number	Locality	16S	tRNA-cluster	COI	Source
Henricia alexeyi Chichvarkhin and Chichvarkhina, 2017	—	—	KY464042	—	—	Chichvarkhin (2017b)
Henricia compacta (Sladen, 1889)	—	—	KT268112	—	KT268147	Lopes *et al.* (2016)
Henricia djakonovi Chichvarkhin, 2017a	—	—	KY464038	—	—	Chichvarkhin (2017b)
Henricia granulifera D'jakonov, 1958	—	—	KY744469	—	—	Chichvarkhin (2017b)
Henricia hayashii D'jakonov, 1961	NSMT E-12501	off Iwate	LC333121	LC336753	LC336732	present study
Henricia hayashii D'jakonov, 1961	—	—	KY934074	—	—	Chichvarkhin (2017b)
Henricia hedingi Madsen, 1987[a]	—	—	KY853323	—	KY853274	Knott *et al.* (2018)
Henricia kinkasana Hayashi, 1940	NSMT E-12498	off Miyagi	LC333120	LC336752	LC336731	present study
Henricia lineata Clark and Jewett, 2010	—	—	MF133322	—	—	Chichvarkhin (2017b)
Henricia lisa Clark, 1949[a]	—	—	KY853377	—	KY853275	Knott *et al.* (2018)
Henricia nipponica Uchida, 1928	NSMT E-12511	Muroran, Hokkaido	LC333122	LC336754	LC336733	present study
Henricia nipponica Uchida, 1928	NSMT E-12508	Oshoro, Hokkaido	LC333123	LC336755	LC336734	present study
Henricia nipponica Uchida, 1928	—	—	D63737	—	—	Wada *et al.* (1996)
Henricia obesa (Sladen, 1889)	—	—	KT268113	—	KT268148	Lopes *et al.* (2016)
Henricia oculata (Pennant, 1777)	—	—	KT268116	—	KT268151	Lopes *et al.* (2016)
Henricia oculata (Pennant, 1777)	—	—	AY652500	—	—	Chichvarkhin (2017b)
Henricia oculata (Pennant, 1777)	—	—	KY853395	—	KY853317	Knott *et al.* (2018)
Henricia ohshimai Hayashi, 1935	NSMT E-12500	Misaki, Kanagawa	LC333125	LC336757	LC336736	present study
Henricia ohshimai Hayashi, 1935	NSMT E-12507	Oshoro, Hokakido	LC333124	LC336756	LC336735	present study
Henricia ohshimai Hayashi, 1935	—	—	AB084571	—	—	Matsubara *et al.* (2004)
Henricia olga Chichvarkhin, 2017b	—	—	KY934079	—	—	Chichvarkhin (2017b)
Henricia pachyderma Hayashi, 1940	—	—	D63739	—	—	Wada *et al.* (1996)
Henricia pachyderma Hayashi, 1940	—	—	KX610476	—	—	Chichvarkhin (2017b)
Henricia perforata (Müller, 1776)	—	—	KY853333	—	KY853302	Knott *et al.* (2018)
Henricia pertusa (Müller, 1776)	—	—	KY853337	—	KY853286	Knott *et al.* (2018)
Henricia regularis Hayashi, 1940	NSMT E-12506	Iki Island, Nagasaki	LC333128	LC336760	LC336739	present study
Henricia reniossa Hayashi, 1940	NSMT E-12505	off Iwanai, Hokkaido	LC333129	LC336761	LC336740	present study
Henricia reticulata Hayashi, 1940	NSMT E-12513	Akkeshi, Hokkaido	LC333126	LC336758	LC336737	present study
Henricia sanguinolenta (Müller, 1776)	—	—	AY652499	—	HM542200	Lopes *et al.* (2016)
Henricia sanguinolenta (Müller, 1776)	—	—	KT268115	—	—	Chichvarkhin (2017b)
Henricia sanguinolenta (Müller, 1776)[a]	—	—	KY853338	—	KY853253	Knott *et al.* (2018)
Henricia spongiosa (Fabricius, 1780)[a]	—	—	KY853393	—	KY853268	Knott *et al.* (2018)
Henricia tumida Verrill, 1909	NSMT E-12510	Akkeshi, Hokkaido	LC333136	LC336768	LC336747	present study
Henricia tumida Verrill, 1909	—	—	AF290033	—	AF290035	Foltz and Rocha-Olivares (unpublished)
Henricia uluudax Clark and Jewett, 2010	—	—	KY934075	—	—	Chichvarkhin (2017b)
Henricia sp. 1 (Akkeshi)	NSMT E-12509	Akkeshi, Hokkaido	LC333133	LC336765	LC336744	present study
Henricia sp. 2 (Abashiri 1)	NSMT E-12502	Abashiri, Hokkaido	LC333131	LC336763	LC336742	present study
Henricia sp. 3 (Abashiri 2)	NSMT E-12503	Abashiri, Hokkaido	LC333132	LC336764	LC336743	present study
Henricia sp. 4 (Fukushima)	NSMT E-12504	off Fukushima	LC333130	LC336762	LC336741	present study
Henricia sp. 5 (Okinawa)	NSMT E-12497	Okinawa Island, Okinawa	LC333127	LC336759	LC336738	present study
Henricia sp. 6 (Miyako)	NSMT E-12496	Miyako, Okinawa	LC333134	LC336766	LC336745	present study
Henricia sp. 7 (Nagannu)	NSMT E-12499	Nagannu Island, Okinawa	LC333135	LC336767	LC336746	present study
Henricia sp. 8 (Okinoerabu)	NSMT E-12495	Okinoerabu Island, Kagoshima	LC333119	LC336751	LC336730	present study
Henricia sp. 9[b]	—	—	KY853329	—	KY853310	Knott *et al.* (2018)
Outgroup						
Echinaster callosus Marenzeller, 1895	NSMT E-6709	Aka Island, Okinawa	LC333116	LC336748	—	present study
Echinaster callosus Marenzeller, 1895	—	—	KT268086	—	KT268121	Lopes *et al.* (2016)
Echinaster luzonicus (Gray, 1840)	NSMT E-12512	Iriomote Island, Okinawa	LC333117	LC336749	—	present study
Echinaster luzonicus (Gray, 1840)	—	—	KT268102	—	KT268137	Lopes *et al.* (2016)
Echinaster sepositus (Retzius, 1783)	NSMT E-12494	Iheya Island, Okinawa	LC333118	LC336750	LC336729	present study
Echinaster sepositus (Retzius, 1783)	—	—	KT268108	—	KT268146	Lopes *et al.* (2016)

[a]Following "initial identification" in Knott *et al.* (2018). [b]Referred to as "*Henricia perforata* group" or "*Henricia* sp., clade D" in Knott *et al.* (2018).

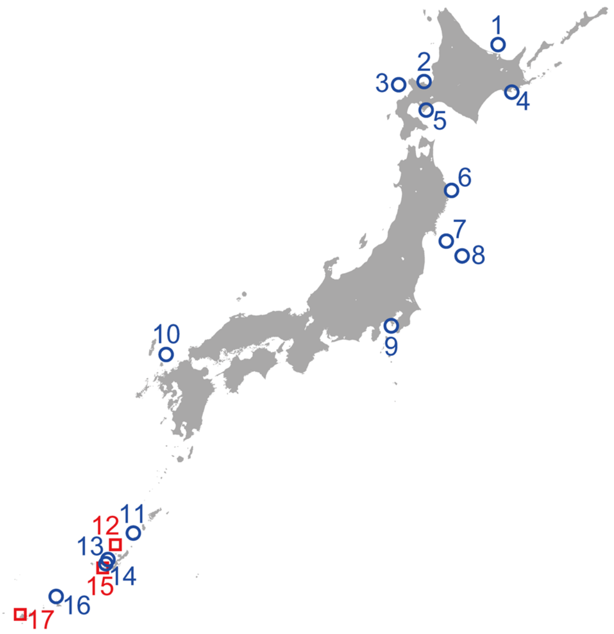

Fig. 1. Sampling locations of *Henricia* (circle) and *Echinaster* (square) specimens around Japan. (1) Off Abashiri, Hokkaido; *H.* sp. 2 (Abashiri 1), *H.* sp. 3 (Abashiri 2); (2) Oshoro, Hokkaido; *H. nipponica* (Oshoro), *H. ohshimai* (Oshoro); (3) Off Iwanai, Hokkaido; *H. reniossa*; (4) Akkeshi, Hokkaido; *H. reticulata*, *H. tumida*, *H.* sp. 1 (Akkeshi); (5) Muroran, Hokkaido; *H. nipponica* (Muroran); (6) Off Iwate; *H. hayashii*; (7) Off Miyagi; *H. kinkasana*; (8) Off Fukushima; *H.* sp. 4 (Fukushima); (9) Misaki, Kanagawa; *H. ohshimai* (Misaki); (10) Iki Island, Nagasaki; *H. regularis*; (11) Okinoerabu Island, Kagoshima; *H.* sp. 8 (Okinoerabu); (12) Iheya Island, Okinawa; *E. sepositus*; (13) Okinawa Island, Okinawa; *H.* sp. 5 (Okinawa); (14) Nagannu Island, Okinawa; *H.* sp. 7 (Nagannu); (15) Aka Island, Okinawa; *E. callosus*; (16) Miyako Island, Okinawa; *H.* sp. 6 (Miyako); (17) Iriomote Island, Okinawa; *E. luzonicus*.

Table 2. List of primers used in the present study.

Gene	Primer	Sequence (5′ to 3′)	Source
16S	16Sar	cgcctgtttatcaaaaacat	Palumbi (1996)
	16Sbr	ccggtctgaactcagatcacgt	Palumbi (1996)
tRNA-cluster	Pat2	ctttgaaggcttttagtttagattaac	Hart *et al.* (1997)
	ECOLc	ccaatatccttgtgtttagtaga	Smith *et al.* (1993)
COI	LCOech1aF1	ttttttctactaaacacaaggatattgg	Layton *et al.* (2016)
	HCO2198	taaacttcagggtgaccaaaaaatca	Folmer *et al.* (1994)

Table 3. Best partition scheme and nucleotide substitution models using AICc for maximum likelihood (ML) and BIC for Bayesian inference (BI) in PartitionFinder (Lanfear *et al.* 2012).

Subset partitions	Best model (ML)	Best model (BI)
16S	GTR+I+G	HKY+I+G
tRNA-Ala, tRNA-Leu, tRNA-Gln, tRNA-Pro	GTR+I+G	HKY+G
tRNA-Asn, COI 1st codon	GTR+I+G	K80+I
COI 2nd codon	GTR+G	F81
COI 3rd codon	GTR+I+G	HKY+I+G

pose of this study is to see if the monophyly of *Setihenricia* is still recovered even when additional OTUs from Japanese waters are included in an analysis. Our new OTUs include *H. nipponica* Uchida, 1928, *H. regularis* Hayashi, 1940, *H. reniossa* Hayashi, 1940, and *H. tumida* Verrill, 1909, which were listed as members of *Setihenricia* (Chichvarkhin and Chichvarkhina 2017) but have not been placed on a molecular phylogenetic context. We also test by morphological and molecular data if the three species *H. kinkasana* Hayashi, 1940, *H. ohshimai* Hayashi, 1935, and *H. reticulata* Hayashi, 1940 belong to *Setihenricia*, although they were not origi-

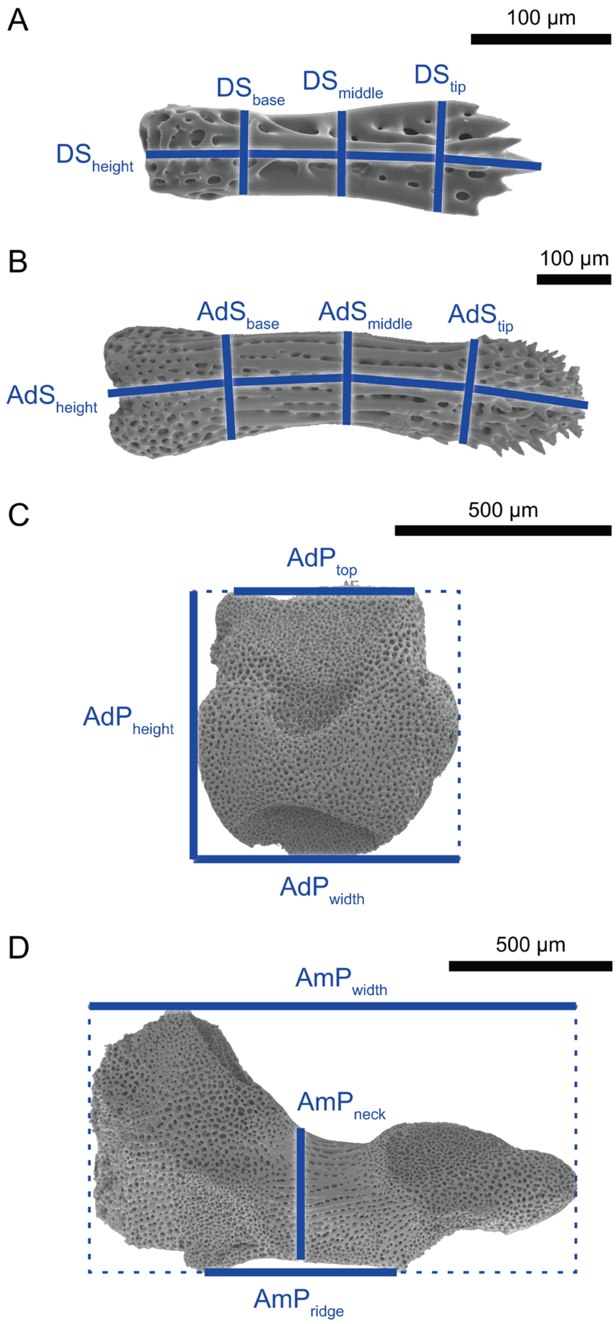

Fig. 2. Measurements (morphometrics) of four kinds of ossicles of *Henricia nipponica* (Oshoro): A, dorsal spine (DS); B, adambulacral spine (AdS); C, adambulacral plate (AdP), proximal view; D, ambulacral plate (AmP), proximal view.

Table 4. Abbreviations and definitions of the morphological characters used in this study.

Abbreviation	Measurement
Macroscopy	
R	length from the center of the mouth to the tip of the longest arm (in mm)
r	length from the center of the mouth to the midpoint of the margin of the longest interradus (in mm)
DS (dorsal spine)[a]	
DS_{height}	height (in μm)
DS_{base}	width at the quarter from the base (in μm)
DS_{middle}	width at the middle (in μm)
DS_{tip}	width at the quarter from the tip (in μm)
AdS (adambulacral spine)[b]	
AdS_{height}	height (in μm)
AdS_{base}	width at the quarter from the base (in μm)
AdS_{middle}	width at the middle (in μm)
AdS_{tip}	width at the quarter from the tip (in μm)
AdP (adambulacral plate)[c]	
AdP_{height}	height of the minimum circumscribed rectangle viewed proximally (in μm)[d]
AdP_{width}	width of the minimum circumscribed rectangle viewed proximally (in μm)[d]
AdP_{top}	length between the two aboral ridges viewed proximally (in μm)
AmP (ambulacral plate)[e]	
AmP_{width}	width of the circumscribed rectangle, the bottom edge of which is parallel to the line segment that connects the two oral ridges, viewed distro-proximally (in μm)
AmP_{ridge}	length between the two oral ridges (in μm)
AmP_{neck}	length of the line segment that runs on the plate and also crosses at the right angles the midpoint of the line segment connecting the two oral ridges (in μm)

[a]Measured for 2–10 spines at the aboral base of arms from each specimen. [b]Measured for 2–5 spines which are nearest to furrow spines within the range from about the fourth to tenth positions in the adambulacral plate series from each specimen. [c]Measured for 2–8 plates within the range from about the fourth to tenth positions in the adambulacral plate series from each specimen. [d]Measured for a rectangle formed by tangents to an adambulacral plate viewed distro-proximally, with the upper tangent passing between two aboral ridges. [e]Measured for 3–6 plates within the range from about the fourth to tenth positions in the ambulacral plate series from each specimen.

nally included in the subgenus. Assessment of whether *Setihenricia* is monophyletic would in turn resolve whether this subgenus should be accepted as a valid taxon.

Chichvarkhin and Chichvarkhina (2017) defined *Setihenricia* by (1) apical thorns of dorsal spines form crown, with the thorns pointed upwards or arranged on a club-shaped apex; (2) spines almost never tapering distally; (3) no thorns on spine shaft; (4) spines in inferomarginal brush-like pseudopaxillae in three or more rows; and (5) spines not covered by thick skin membrane. Among these characters, only (4) is quantitative, whereas objective assessment can be difficult as to the characters (1), (2), (3), and (5). The skeleton of a sea star comprises a variety of ossicles (Mortensen 1925; Blake 1987; Gale 1987); there might be some quantitative characters that were not mentioned in the diagnosis of *Setihenricia* but can effectively characterize the subgenus. On the assumption that this taxon is valid, the other purpose of our study is to explore whether some quantitative morphological characters can distinguish *Setihenricia* species from non-*Setihenricia* species. For this purpose, we measured several parts of four kinds of ossicles. We also attempted to quantify the degree of spine tapering to assess the diagnostic usefulness of the character (2).

Materials and Methods

Specimens

In total, 18 specimens of *Henricia* (representing eight nominal species and eight unidentified ones) from Japanese waters were used in this study (Table 1, Fig. 1). Species identification followed Hayashi (1940) and D'jakonov (1961). Of the 18, six were freshly collected and preserved in 99% ethanol, while 12 ethanol-preserved specimens had been deposited in the National Museum of Nature and Science, Tsukuba, Japan (NSMT).

Molecular phylogeny

Total DNA was extracted from tube feet of ethanol-preserved specimens using silica (Boom *et al.* 1990) with some modifications. Three regions in the mitochondrial genome were amplified by polymerase chain reaction (PCR): a fragment of 16S, a segment comprising five tRNA genes (tRNA-cluster: tRNA-Ala, tRNA-Leu, tRNA-Asn, tRNA-Gln, and tRNA-Pro), and a fragment of COI, using primers listed in Table 2. PCR was performed by a thermal cycler, 2720 Thermal Cycler (Applied Biosystems), in a 10 μl reaction volume containing 2 μl of template DNA and 8 μl of premix made with 5.55 μl deionized water, 1 μl Ex *Taq* Buffer (TaKaRa Bio), 0.8 μl dNTP (each 2.5 mM), 0.3 μl each primer (each 10 μM), and 0.05 μl TaKaRa Ex *Taq* (5 U/μl, TaKaRa Bio).

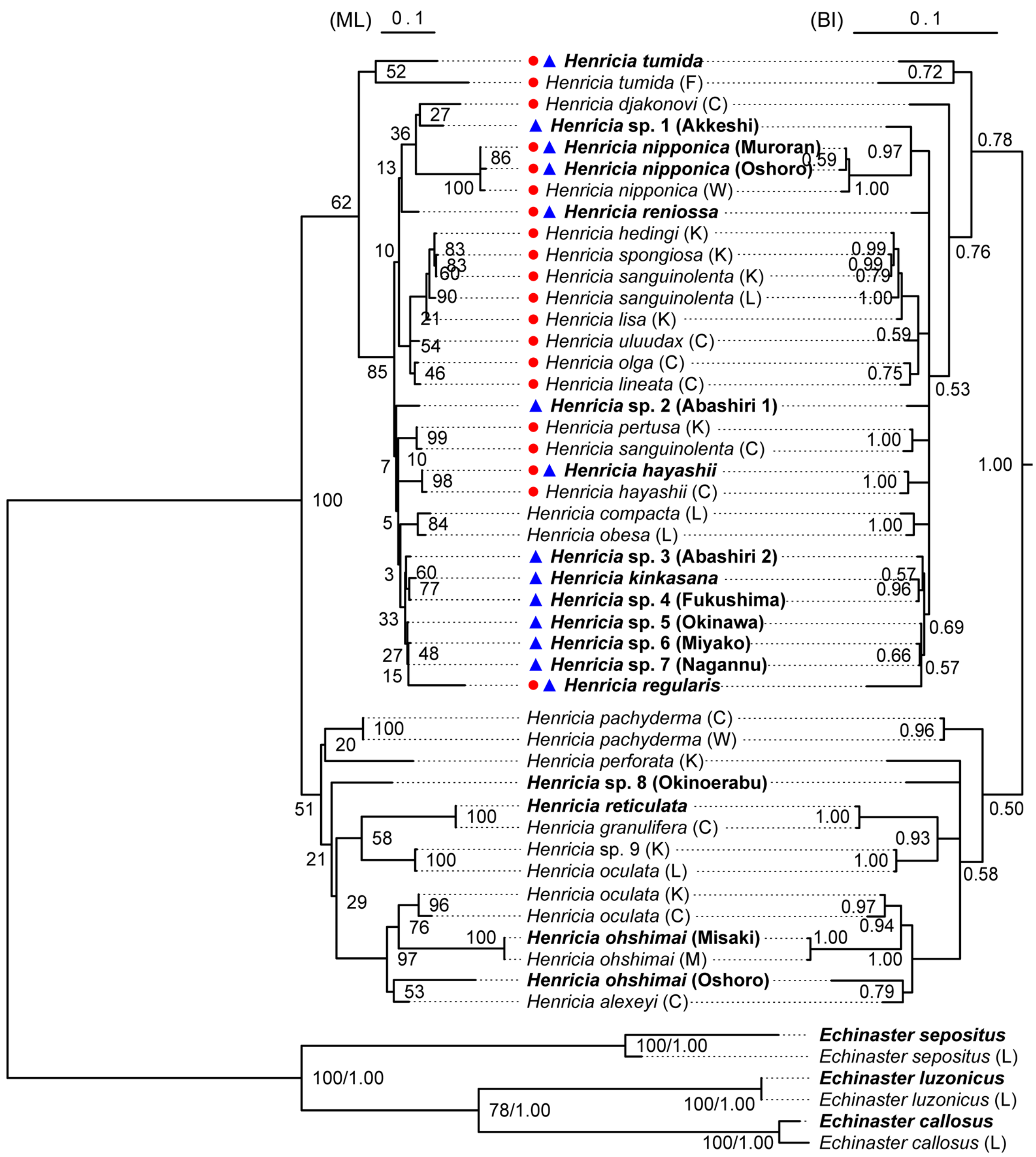

Fig. 3. Phylogenetic trees obtained from a concatenated dataset with a total length of 1,277 bp, consisting of seven mitochondrial genes (16S, tRNA-Ala, tRNA-Leu, tRNA-Asn, tRNA-Gln, tRNA-Pro, and COI). The trees were built based on maximum likelihood (ML, left) and Bayesian inference (BI, right). Values at nodes indicate bootstrap scores from ML and posterior probabilities from BI. Outgroups are only shown in the ML tree with both the support values. Scale bars indicate the number of nucleotide substitutions per site. OTUs sequenced in this study are in bold face. Each letter in parentheses after non-bold OTUs denotes the source: C, Chichvarkhin (2017b); F, Foltz and Rocha-Olivares (unpublished); K, Knott *et al.* (2018); L, Lopes *et al.* (2016); M, Matsubara *et al.* (2004); W, Wada *et al.* (1996). Circles indicate species listed as *Setihenricia* in Chichvarkhin and Chichvarkhina (2017). Triangles indicate species morphologically identified as *Setihenricia* in this study (see Fig. 4A).

Amplification consisted of an initial denaturation (1 min, 95°C); followed by 30 cycles of denaturation (30 sec, 95°C), annealing (30 sec, 50°C for 16S, 41°C for tRNA-cluster, 47°C for COI), and elongation (1 min, 72°C); ended by a final elongation (7 min, 72°C). The PCR product was purified using silica (Boom *et al.* 1990). Both strands were sequenced with a BigDye® Terminator ver. 3.1 Cycle Sequencing Kit (Applied Biosystems) following the manufacturer's protocol, using the same primer set as the initial PCR amplification (Table 2). Sequencing was performed with an ABI Prism 3730 DNA Analyzer (Applied Biosystems).

Chromatogram and sequence data were checked with MEGA ver. 6.06 (Tamura *et al.* 2013), eliminating primer sequences. COI sequences of *Echinaster callosus* Marenzeller, 1895 and *Echinaster luzonicus* (Gray, 1840) were not obtained in our study. Twenty-nine sequences of 16S and 14 sequences of COI were obtained from GenBank (Table 1). The 16S and tRNA-cluster sequences were aligned using MAFFT ver. 7 (Katoh and Standley 2013) with default parameters. The aligned tRNA-cluster sequences were divided into five gene sequences (tRNA-Ala, tRNA-Leu, tRNA-Asn, tRNA-Gln, and tRNA-Pro) based on the feature data in

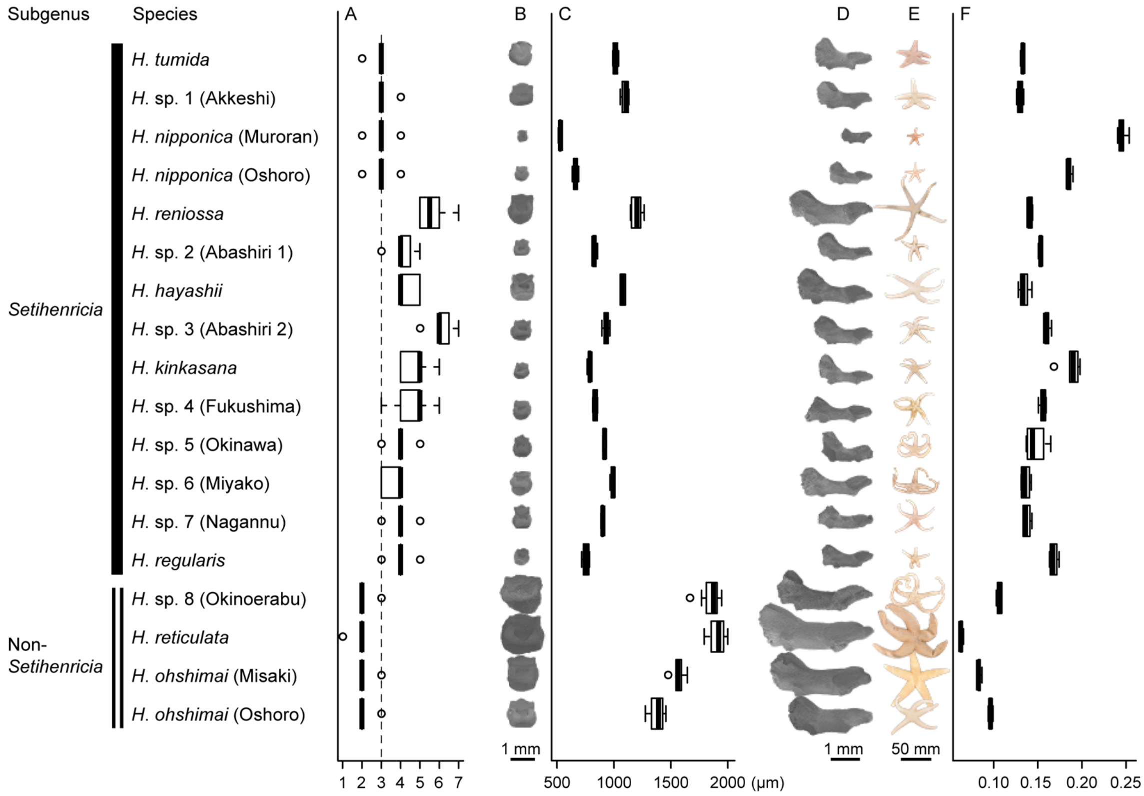

Fig. 4. Morphological characters which might be useful to distinguish *Setihenricia* species from non-*Setihenricia* species. A, number of rows of spines on each inferomarginal plate; B, SEM images of AdP; C, AdP_{width}; D, SEM images of AmP; E, photographs of entire body; F, ratios of $AmP_{width}/AmP_{neck}/r$. See Table 4 for abbreviations. Circles on boxplots (A, C, and F) indicate outliers. Specimens that show three (indicated by a vertical dashed line on A) or more rows of the spines can be identified as *Setihenricia* (Chichvarkhin and Chichvarkhina 2017). Enlarged images of B, D, and E are available in the figshare repository (Wakita *et al.* 2019).

GenBank (AY245501; Knott *et al.* 2003). The last nucleotide position in the tRNA-Ala was eliminated because it overlapped with the first position of the tRNA-Leu. The 16S, each of the tRNA, and COI sequences were trimmed using Gblocks ver. 0.91b (Talavera and Castresana 2007) with the most stringent option. The COI sequences contained no indels. The 16S, tRNA-cluster, and COI sequences were concatenated with Kakusan ver. 4 (Tanabe 2011). The final dataset had a total length of 1,277 bp, consisting of 16S (451 bp), tRNA-Ala (65 bp), tRNA-Leu (70 bp), tRNA-Asn (72 bp), tRNA-Gln (70 bp), tRNA-Pro (67 bp), and COI (482 bp).

Outgroups were chosen from *Echinaster* (*Echinaster*), which is sister to *Henricia* based on Lopes *et al.*'s (2016) analysis. Specifically, the selected outgroups were *Echinaster callosus*, *E. luzonicus*, and *E. sepositus* (Retzius, 1783) (Table 1). The best partition schemes and nucleotide substitution models were estimated using AICc for maximum likelihood (ML) and BIC for Bayesian inference (BI) in PartitionFinder ver. 1.1.1 (Lanfear *et al.* 2012) with the "greedy" scheme (Table 3). The concatenated sequences were analyzed with the ML and BI methods. ML phylogenetic tree was estimated by using RAxML ver. 8.2.10 (Stamatakis 2014) based on the GTR+I+G model. Bootstrap support was calculated from 1,000 replicates. BI phylogenetic tree was estimated with MrBayes ver. 3.2.6 (Ronquist *et al.* 2012) based on the Markov chain Monte Carlo algorithm (MCMC) for 1,000,000 generations in two runs, each with four chains, sampled with a frequency of every 100 generations. The convergence in MCMC was checked with Tracer ver. 1.6 (Rambaut *et al.* 2014); burn-in parameter was set to exclude the first 25% of the trees. The best ML tree and the 50% majority-rule consensus BI tree were visualized and manipulated in FigTree ver. 1.4.2 (Rambaut 2014).

Morphology

The number of the rows of spines on each inferomarginal plate was counted under a stereomicroscope; 20 plates were randomly selected within the range from about the fourth to tenth positions in the plate series of at least two arms. For observation of ossicles by scanning electron microscopy (SEM), body walls were cut and put in an undiluted solution of commercial bleach for an hour. Dorsal spines (DS; also referred to as aboral or abactinal spines) were extracted from the aboral walls at the base of an arm. Adambulacral spines (AdS), adambulacral plates (AdP), and ambulacral plates (AmP) were extracted from an ambulacral area at the base of an arm, ranging from about the fourth to tenth plate series. Ossicles of these four kinds were sub-sampled from each specimen, coated with gold using Ion Sputter E-1045 (Hitachi; 180 sec, 15 mA), and observed with S-3000N scanning electron microscope (Hitachi; 10.1 or 15.0 kV). Several parts in the ossicles were measured with ImageJ (Abràmoff *et al.* 2004) (Fig. 2A–D, Table 4).

Some measurements were combined into ratios. The de-

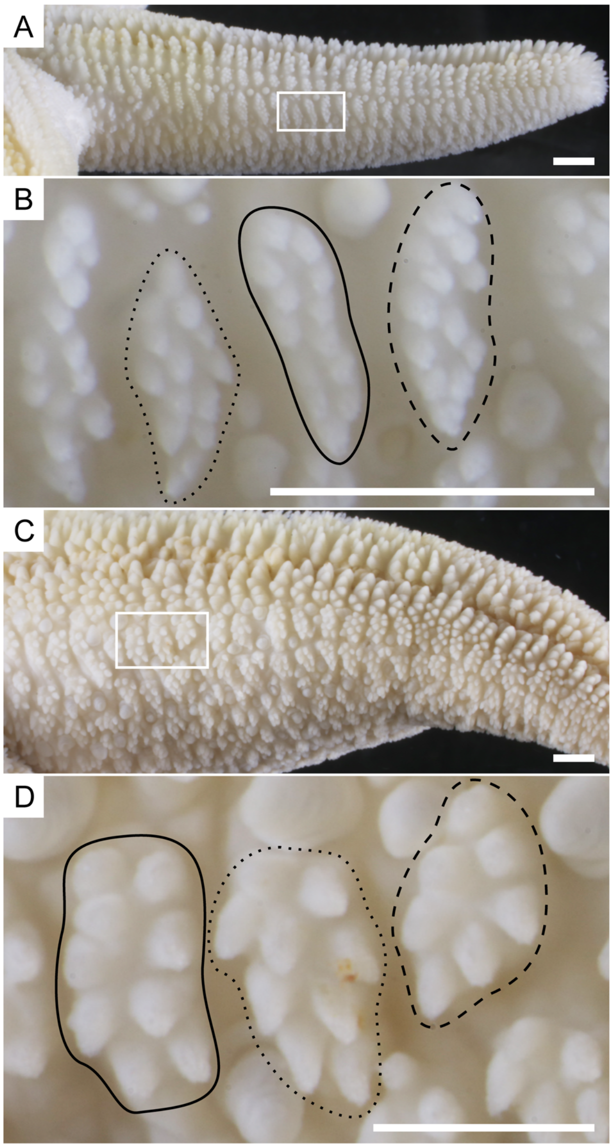

Fig. 5. Side views of the arms of *Henricia nipponica* (Oshoro) (A, B) and *Henricia tumida* (C, D). A, C, Lower magnification; B, D, higher magnification of the rectangle on A and C, respectively. The number of the rows of spines on the inferomarginal plate can be interpreted as either two (solid line), two or three (dashed line), or three (dotted line). Scale bars indicate 1 mm.

gree of tapering of DS and AdS was represented by DS_{base}/DS_{tip} (Fig. 2A) and AdS_{base}/AdS_{tip} (Fig. 2B), the ratios of the width at the quarter point from the base to the width at the quarter point from the tip in spines. The values of these ratios should be less than one if the spines are "almost never tapering distally" as stated in the diagnosis of *Setihenricia* (Chichvarkhin and Chichvarkhina 2017).

Results

The ML and BI trees moderately resembled each other in terms of topology, where *Henricia* was monophyletic with maximum support values (100/1.00; bootstrap score from ML and posterior probability from BI, respectively; Fig. 3). All the OTUs of *Henricia* were principally divided into two clades with low support; the first clade (62/0.78) included *H. compacta* (Sladen, 1889), *H. djakonovi*, *H. hayashii*, *H. hedingi*, *H. kinkasana*, *H. lineata*, *H. lisa*, *H. nipponica*, *H. obesa* (Sladen, 1889), *H. olga*, *H. pertusa*, *H. regularis*, *H. reniossa*, *H. sanguinolenta*, *H. spongiosa*, *H. tumida*, and *H. uluudax*, as well as the unidentified *H.* spp. 1–7; the second clade (51/0.50) had *H. alexeyi* Chichvarkhin and Chichvarkhina, 2017, *H. granulifera* D'jakonov, 1958, *H. oculata* (Pennant, 1777), *H. ohshimai*, *H. pachyderma* Hayashi, 1940, *H. perforata* (Müller, 1776), *H. reticulata*, and *H.* spp. 8 and 9.

Specimens with three or more rows of spines on each inferomarginal plate, and thus morphologically identifiable as *Setihenricia*, were *H. hayashii*, *H. kinkasana*, *H. regularis*, *H. reniossa*, *H.* spp. 1–7 (Fig. 4A). We also identified *H. nipponica* (Muroran), *H. nipponica* (Oshoro), and *H. tumida* as *Setihenricia*, because they showed mostly three or more, but rarely two, rows of the spines (Fig. 5A–D). The other four specimens—*H. ohshimai* (Misaki), *H. ohshimai* (Oshoro), *H. reticulata*, and *H.* sp. 8 (Okinoerabu)—were not identified as *Setihenricia* because they consistently had fewer than three rows of the spines. Among the morphological characters examined in this study (see Appendix), AdP_{width} (Fig. 4B, C) and $AmP_{width}/AmP_{neck}/r$ (Fig. 4D–F) appeared to be useful to distinguish *Setihenricia* from the others. Values of the ratio DS_{base}/DS_{tip} often exceeded more than one in the specimens identified as *Setihenricia*, except for *H. hayashii* (Fig. 6A, B). Values of the ratio AdS_{base}/AdS_{tip} were also more than one in the *Setihenricia* specimens, except for *H. hayashii*, *H. nipponica* (Oshoro), *H. tumida*, and *H.* sp. 3 (Abashiri 2) (Fig. 6C, D).

Discussion

In our dataset, 25 species names were applied to the OTUs included in the analyses. Of the 25, 14 had been originally listed as *Setihenricia* by Chichvarkhin and Chichvarkhina (2017). The 14 species are: *H. djakonovi*, *H. hayashii*, *H. hedingi*, *H. lineata*, *H. lisa*, *H. nipponica*, *H. olga*, *H. pertusa*, *H. regularis*, *H. reniossa*, *H. sanguinolenta*, *H. spongiosa*, *H. tumida*, and *H. uluudax*. Although our best tree from the analyses based on 16S, tRNA-cluster, and COI sequences included a monophyletic grouping of these species, its support values were low (62% bootstrap score in ML and 0.78 posterior probability in BI; Fig. 3). Thus the monophyly of *Setihenricia* was not strongly indicated, which suggests that we cannot positively accept the validity of this taxon. The lack of support was likely due to weak evidence for *H. tumida* grouping with other *Setihenricia*. Within the *Setihenricia* grouping, the ML and BI trees differed in terms of the position of *H. djakonovi*. To obtain a more robust phylogenetic estimate of the genus *Henricia*, other markers such as 18S and 28S rRNA genes and more complete taxon sampling should be sought in future analyses.

Assuming that *Setihenricia* may be a valid taxon, one of the characters that can define the subgenus appears to be

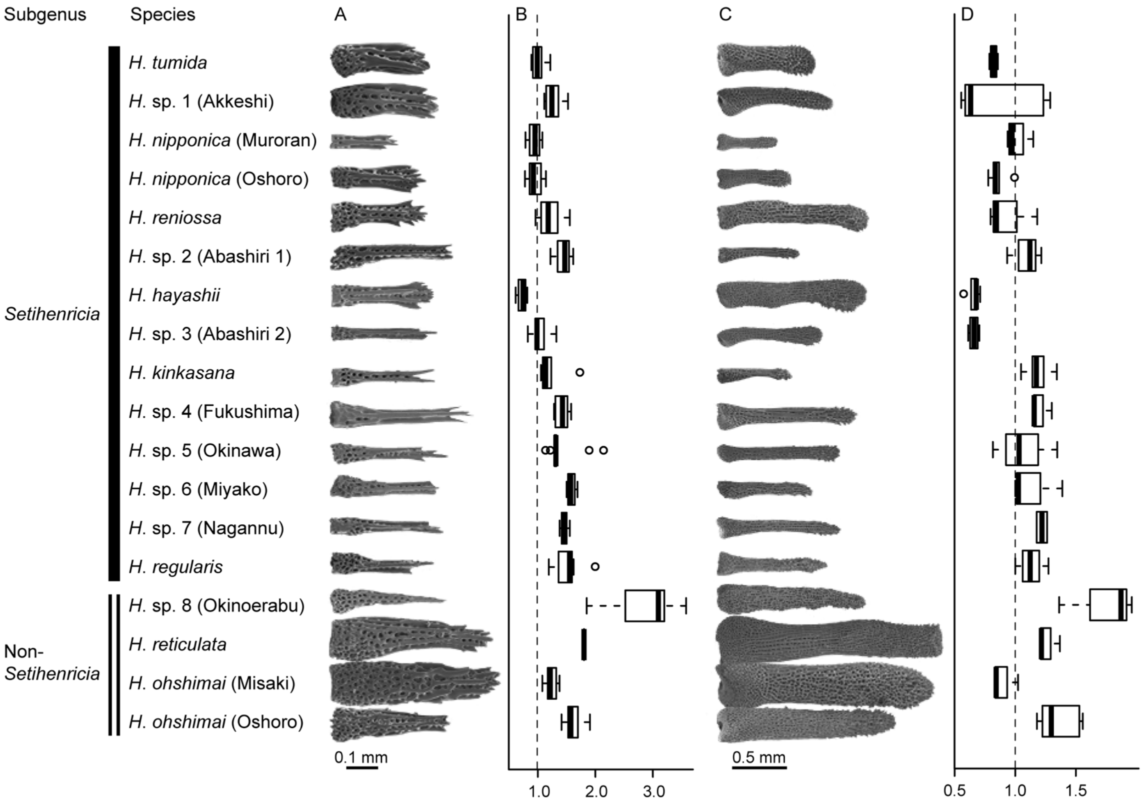

Fig. 6. Morphological characters representing the degree of tapering of spines. A, SEM images of DS; B, ratios of DS_{base}/DS_{tip}; C, SEM images of AdS; D, ratios of AdS_{base}/AdS_{tip}. See Table 4 for abbreviations. Circles on boxplots (B and D) indicate outliers. On B and D, a value above one (indicated by a vertical dashed line) can be interpreted that the spine is tapered. Enlarged images of A and C are available in the figshare repository (Wakita *et al.* 2019).

three or more rows of spines on each inferomarginal plate (Fig. 4A). However, only two rows of spines were rarely observed in *H. nipponica* and *H. tumida* (Fig. 5). In such cases, some rows were arranged irregularly (Fig. 5B, D), making it difficult to assess the exact number of the rows. The "rows of spines" can be defined more strictly to exclude subjectivity, which, however, is beyond the scope of this study. Although the phylogenetic supports of *Setihenricia* were low, this taxon could be defined by this morphological character if we ignore the rare cases, so we here retain its validity for further discussions.

We found *H. kinkasana* represents a new member of *Setihenricia* based on its molecular phylogenetic position and morphological characters. In addition, *H. compacta* and *H. obesa* appear to belong to the subgenus as well, because the sequences in the public databases identified by Lopes *et al.* (2016) were nested among other *Setihenricia* species in our ML and BI trees (Fig. 3). These three (*H. compacta*, *H. kinkasana*, and *H. obesa*) were not originally included in *Setihenricia* by Chichvarkhin and Chichvarkhina (2017) probably because the number of the rows of spines on each inferomarginal plate—one of the diagnostic characters—had not been sufficiently described (Sladen 1889; Hayashi 1940; Rowe and Albertson 1986). Our specimen of *H. kinkasana* possessed four or more rows of the spines (Fig. 4A).

The degree of spine tapering appears to be less relevant in diagnosing *Setihenricia*. Chichvarkhin and Chichvarkhina (2017) stated that spines are "almost never tapering distally" in *Setihenricia*. If this character is represented by the ratio of the width at the quarter point from the base to the width at the quarter point from the tip in dorsal spines (DS_{base}/DS_{tip}, *cf.* Fig. 2A) and in adambulacral spines (AdS_{base}/AdS_{tip}, *cf.* Fig. 2B), these ratios should take values of less than one. Nevertheless, out of the 14 specimens identified as *Setihenricia* in our study, 13 in DS_{base}/DS_{tip} and 10 in AdS_{base}/AdS_{tip} showed the values of more than one (Fig. 6B, D), indicating that their dorsal and adambulacral spines are indeed tapering distally (Fig. 6A, C). This tendency was also recognized in more apical regions represented by DS_{middle}/DS_{tip} and AdS_{middle}/AdS_{tip} (*cf.* Fig. 2A, B, and Appendix).

We introduced quantitative morphological characters in terms of dorsal spine (DS), adambulacral spine (AdS), adambulacral plate (AdP), and ambulacral plate (AmP) in the hope of distinguishing *Setihenricia* species from non-*Setihenricia* species. Most of the characters seemed to be useless for this purpose, except two, which exhibited potential usefulness as new taxonomic characters. One was the width of adambulacral plates (AdP_{width}, *cf.* Fig. 2C), which was smaller in the species identified or identifiable as *Setihenricia* (Fig. 4C). The other was the ratio of two measurements in ambulacral plates to a macroscopic measurement ($AmP_{width}/AmP_{neck}/r$, *cf.* Fig. 2D); it was greater in the *Setihenricia* specimens (Fig. 4F). The intra- and interspecific variation of these characters should be investigated with a large sample size in future studies.

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References

Abràmoff, M. D., Magalhães, P. J., and Ram, S. J. 2004. Image processing with ImageJ. Biophotonics International 11: 36–42.

Blake, D. B. 1987. A classification and phylogeny of post-Paleozoic sea stars (Asteroidea: Echinodermata). Journal of Natural History 21: 481–528.

Boom, R., Sol, C. J. A., Salimans, M. M. M., Jansen, C. L., Wertheim-van Dillen, P. M. E., and van der Noordaa, J. 1990. Rapid and simple method for purification of nucleic acids. Journal of Clinical Microbiology 28: 495–503.

Chichvarkhin, A. Y. 2017a. *Henricia djakonovi* sp. nov. (Echinodermata, Echinasteridae): a new sea star species from the Sea of Japan. PeerJ 5: e2863.

Chichvarkhin, A. Y. 2017b. Sea star *Henricia spiculifera* (Clark, 1901) in the northwestern Pacific: one species or three? PeerJ 5: e3489.

Chichvarkhin, A. Y. and Chichvarkhina, O. V. 2017. A new sea star species of the genus *Henricia* Gray, 1840 (Echinodermata, Asteroidea) from the northwestern Sea of Japan and description of a new subgenus. Pp. 202–209. *In*: Dautova, T. N., Sun, X., Song, S., and Adrianov, A. (Eds) *Life-supporting Asia-Pacific Marine Ecosystems*. Science Press, Beijing.

Clark, A. M. and Downey, M. E. 1992. *Starfishes of the Altantic*. Chapman and Hall, London, xxvi+794 pp., 113 pls.

Clark, R. N. and Jewett, S. C. 2010. A new genus and thirteen new species of sea stars (Asteroidea: Echinasteridae) from the Aleutian Island Archipelago. Zootaxa 2571: 1–36.

D'jakonov, A. M. 1958. [Echinoderms (Echinodermata), except holothurians, collected by Kuril-Sakhalin expedition in 1947–1949]. Issledovaniya Dal'nevostochnykh Morei SSSR 5: 271–357. [In Russian]

D'jakonov, A. M. 1961. [Review of sea stars of the genus *Henricia* Gray from the north-western parts of Pacific Ocean]. Issledovaniya Dal'nevostochnykh Morei SSSR 7: 5–39. [In Russian]

Eernisse, D. J., Strathmann, M. F., and Strathmann R. R. 2010. *Henricia pumila* sp. nov.: a brooding seastar (Asteroidea) from the coastal northeastern Pacific. Zootaxa 2329: 22–36.

Fisher, W. K. 1910. New starfishes from the North Pacific, II: Spinulosa. Zoologischer Anzeiger 35: 568–574.

Fisher, W. K. 1911. *Asteroidea of the North Pacific and Adjacent Waters, Part 1: Phanerozonia and Spinulosa*. U. S. Government Printing Office, Washington, D. C., vi+419 pp., 122 pls.

Fisher, W. K. 1928. *Asteroidea of the North Pacific and Adjacent Waters, Part 2: Forcipulata (Part)*. U. S. Government Printing Office, Washington, D. C., iii+245 pp., 81 pls.

Fisher, W. K. 1930. *Asteroidea of the North Pacific and Adjacent Waters, Part 3: Forcipulata (Concluded)*. U. S. Government Printing Office, Washington, D. C., iii+356 pp., 93 pls.

Folmer, O., Black, M., Hoeh, W., Lutz, R., and Vrijenhoek, R. 1994. DNA primers for amplification of mitochondrial cytochrome *c* oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology 3: 294–299.

Gale, A. S. 1987. Phylogeny and classification of the Asteroidea (Echinodermata). Zoological Journal of the Linnean Society 89: 107–132.

Hart, M. W., Byrne, M., and Smith, M. J. 1997. Molecular phylogenetic analysis of life-history evolution in asterinid starfish. Evolution 51: 1848–1861.

Hayashi, R. 1940. Contributions to the classification of the sea-stars of Japan, I: Spinulosa. Journal of the Faculty of Science, Hokkaido Imperial University, Series 6, Zoology 7: 107–204.

Hayashi, R. 1973. *The Sea-stars of Sagami Bay*. Biological Laboratory, Imperial Household, Tokyo, xi+114 pp., 18 pls.

Katoh, K. and Standley, D. M. 2013. MAFFT multiple sequence alignment software version 7: improvements in performance and usability. Molecular Biology and Evolution 30: 772–780.

Knott, K. E., Balser, E. J., Jaeckle, W. B., and Wray, G. A. 2003. Identification of asteroid genera with species capable of larval cloning. Biological Bulletin 204: 246–255.

Knott, K. E., Ringvold, H., and Blicher, M. E. 2018. Morphological and molecular analysis of *Henricia* Gray, 1840 (Asteroidea: Echinodermata) from the Northern Atlantic Ocean. Zoological Journal of the Linnean Society 182: 791–807.

Lanfear, R., Calcott, B., Ho, S. Y., and Guindon, S. 2012. PartitionFinder: combined selection of partitioning schemes and substitution models for phylogenetic analyses. Molecular Biology and Evolution 29: 1695–1701.

Layton, K. K., Corstorphine, E. A., and Hebert, P. D. 2016. Exploring Canadian echinoderm diversity through DNA barcodes. PLOS ONE 11: e0166118.

Lopes, E. M., Pérez-Portela, R., Paiva, P. C., and Ventura, C. R. R. 2016. The molecular phylogeny of the sea star *Echinaster* (Asteroidea: Echinasteridae) provides insights for genus taxonomy. Invertebrate Biology 135: 235–244.

Madsen, F. J. 1987. The *Henricia sanguinolenta* complex (Echinodermata: Asteroidea) of the Norwegian Sea and adjacent waters: a re-evaluation, with notes on related species. Steenstrupia 13: 201–268.

Mah, C. L. and Blake, D. B. 2012. Global diversity and phylogeny of the Asteroidea (Echinodermata). PLoS ONE 7: e35644.

Mah, C. L. and Hansson, H. 2017. Echinasteridae. *In*: Mah, C. L. (Ed.) *World Asteroidea Database*. Accessed through: World Register of Marine Species. Available at http://www.marinespecies.org/aphia.php?p=taxdetails&id=123132 (17 November 2017).

Matsubara, M., Komatsu, M., and Wada, H. 2004. Close relationship between *Asterina* and Solasteridae (Asteroidea) supported by both nuclear and mitochondrial gene molecular phylogenies. Zoological Science 21: 785–793.

Mortensen, T. 1925. Papers from Dr. Th. Mortensen's Pacific expedition 1914–16, 29: echinoderms of New Zealand and the Auckland-Cambell Islands, 3–5: Asteroidea, Holothurioidea and Crinoidea.

Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening 79: 261–420.

Palumbi, S. R. 1996. Nucleic acids II: the polymerase chain reaction. Molecular Systematics 2: 205–247.

Rambaut, A. 2014. FigTree 1.4.2 software. Institute of Evolutionary Biology, University of Edinburgh. Available at http://tree.bio.ed.ac.uk/software/figtree/ (22 July 2016).

Rambaut, A., Suchard, M. A., Xie, W., and Drummond, A. J. 2014. Tracer v. 1.6. Institute of Evolutionary Biology, University of Edinburgh. Available at http://tree.bio.ed.ac.uk/software/tracer/ (22 July 2016).

Ronquist, F., Teslenko, M., van der Mark, P., Ayres, D. L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M. A., and Huelsenbeck, J. P. 2012. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. Systematic Biology 61: 539–542.

Rowe, F. E. W. and Albertson, E. L. 1986. The echinoderm genus *Henricia* Gray, 1840 (Asteroidea: Echinasteridae) in southern and southeastern Australian waters, with the description of a new species. Proceedings of the Linnean Society of New South Wales 109: 183–194.

Sladen, W. P. 1889. Report on the Asteroidea collected during the voyage of HMS Challenger during the years 1873–76. Pp. 1–893. *In*: Thomson, C. W. and Murray, J. (Eds) *Report on the Scientific Results of the Voyage of HMS Challenger During the Years 1873–76, Zoology, Volume 30*. Her Majesty's Government, London.

Smith, M. J., Arndt, A., Gorski, S., and Fajber, E. 1993. The phylogeny of echinoderm classes based on mitochondrial gene arrangements. Journal of Molecular Evolution 36: 545–554.

Stamatakis, A. 2014. RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. Bioinformatics 30: 1312–1313.

Talavera, G. and Castresana, J. 2007. Improvement of phylogenies after removing divergent and ambiguously aligned blocks from protein sequence alignments. Systematic Biology 56: 564–577.

Tamura, K., Stecher, G., Peterson, D., Filipski, A., and Kumar, S. 2013. MEGA6: molecular evolutionary genetics analysis version 6.0. Molecular Biology and Evolution 30: 2725–2729.

Tanabe, A. S. 2011. Kakusan4 and Aminosan: two programs for comparing nonpartitioned, proportional and separate models for combined molecular phylogenetic analyses of multilocus sequence data. Molecular Ecology Resources 11: 914–921.

Uchida, T. 1928. Report of the biological survey of Mutsu Bay, 11: starfishes of Mutsu Bay. Scientific Reports of Tohoku Imperial University 4: 785–803.

Verrill, A. E. 1914. *Monograph of the Shallow-water Starfishes of the North Pacific Coast from the Arctic Ocean to California*. Smithsonian Institution, Washington, D. C., xii+408 pp., 110 pls.

Wada, H., Komatsu, M., and Satoh, N. 1996. Mitochondrial rDNA phylogeny of the Asteroidea suggests the primitiveness of the Paxillosida. Molecular Phylogenetics and Evolution 6: 97–106.

Wakita, D., Fujita, T., and Kajihara, H. 2019. Supplementary figures of "Molecular Systematics and Morphological Analyses of the Subgenus *Setihenricia* (Echinodermata: Asteroidea: *Henricia*) from Japan". figshare. Available at https://doi.org/10.6084/m9.figshare.7570676.v1 (10 January 2019).

Appendix

Measured values of morphological characters used in this study. Combined ratios are not shown except for DS_{base}/DS_{tip}, AdS_{base}/AdS_{tip}, and $AmP_{width}/AmP_{neck}/r$ (see Figs 6B, 6D, and 4F, respectively) as well as DS_{middle}/DS_{tip} and AdS_{middle}/AdS_{tip}. For each kind of ossicles, values in the same column of each specimen were obtained from the same ossicle. See Table 4 for abbreviations.

Species	Number of rows of spines on each inferomarginal plate																				R	r
Henricia tumida	3	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	29	9.0
Henricia sp. 1 (Akkeshi)	3	4	4	3	3	3	3	3	3	4	3	3	3	3	3	3	3	4	3	3	40	9.0
Henricia nipponica (Muroran)	4	3	3	3	3	3	4	3	4	3	2	3	3	3	3	3	2	3	3	3	14	4.5
Henricia nipponica (Oshoro)	3	3	3	3	3	3	2	3	3	2	3	3	4	3	3	3	2	3	3	3	20	6.0
Henricia reniossa	5	5	6	5	5	6	5	6	5	5	5	6	7	6	5	6	6	6	6	5	64	8.0
Henricia sp. 2 (Abashiri 1)	3	4	5	4	4	5	4	4	4	4	3	4	4	5	4	4	5	5	4	4	26	7.0
Henricia hayashii	4	4	5	4	4	4	4	4	4	4	4	4	5	5	4	4	5	4	5	5	57	9.0
Henricia sp. 3 (Abashiri 2)	6	6	6	6	7	7	6	5	6	6	6	7	7	6	6	6	7	6	6	5	35	7.0
Henricia kinkasana	5	5	6	5	5	4	4	5	5	5	5	5	5	4	4	4	5	4	4	5	31	6.5
Henricia sp. 4 (Fukushima)	4	4	5	5	6	5	5	6	5	5	5	4	5	5	4	3	4	5	4	4	45	8.5
Henricia sp. 5 (Okinawa)	4	3	3	4	4	3	4	4	4	4	5	4	4	3	4	4	4	4	5	4	45	7.5
Henricia sp. 6 (Miyako)	3	3	4	4	4	4	3	4	4	4	4	4	3	3	4	4	4	3	4	4	60	8.5
Henricia sp. 7 (Nagannu)	4	4	4	4	4	5	4	4	5	4	4	3	4	4	5	4	4	4	3	4	40	7.5
Henricia regularis	3	4	4	4	3	4	4	4	4	5	4	4	4	5	3	4	4	3	4	4	27	6.5
Henricia sp. 8 (Okinoerabu)	2	3	3	2	2	2	3	2	2	2	2	3	2	2	2	2	2	2	2	2	77	10.0
Henricia reticulata	2	2	2	2	2	2	2	2	2	2	1	2	2	2	1	2	2	2	2	2	83	17.0
Henricia ohshimai (Misaki)	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	3	2	2	2	2	56	13.0
Henricia ohshimai (Oshoro)	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50	11.0

Species	DS_{height}									
Henricia tumida	287	278	260	301	287	249	300	302	283	—
Henricia sp. 1 (Akkeshi)	315	324	246	326	251	287	284	279	381	268
Henricia nipponica (Muroran)	199	216	235	243	211	222	—	—	—	—
Henricia nipponica (Oshoro)	282	276	321	290	270	278	274	280	281	263
Henricia reniossa	291	272	324	298	293	300	277	280	315	282
Henricia sp. 2 (Abashiri 1)	372	386	301	—	—	—	—	—	—	—
Henricia hayashii	300	241	244	234	265	305	—	—	—	—
Henricia sp. 3 (Abashiri 2)	268	319	301	334	301	259	407	295	268	318
Henricia kinkasana	291	315	300	324	321	307	—	—	—	—
Henricia sp. 4 (Fukushima)	446	419	438	424	447	—	—	—	—	—
Henricia sp. 5 (Okinawa)	318	326	324	349	323	309	342	304	318	—
Henricia sp. 6 (Miyako)	335	326	319	330	—	—	—	—	—	—
Henricia sp. 7 (Nagannu)	345	353	340	—	—	—	—	—	—	—
Henricia regularis	310	276	302	315	299	318	311	311	—	—
Henricia sp. 8 (Okinoerabu)	463	292	298	349	315	255	449	—	—	—
Henricia reticulata	618	510	—	—	—	—	—	—	—	—
Henricia ohshimai (Misaki)	433	468	542	521	484	501	526	494	494	498
Henricia ohshimai (Oshoro)	346	342	356	367	375	373	366	356	348	381

Species	DS_{base}									
Henricia tumida	86	90	94	93	90	101	101	93	85	—
Henricia sp. 1 (Akkeshi)	95	93	90	95	76	101	95	96	89	84
Henricia nipponica (Muroran)	39	35	42	39	41	40	—	—	—	—
Henricia nipponica (Oshoro)	60	57	55	54	51	59	57	57	59	52
Henricia reniossa	55	56	63	53	61	78	62	69	66	69
Henricia sp. 2 (Abashiri 1)	63	61	47	—	—	—	—	—	—	—
Henricia hayashii	54	55	53	52	51	55	—	—	—	—
Henricia sp. 3 (Abashiri 2)	31	33	32	35	41	33	43	37	31	31
Henricia kinkasana	39	39	39	37	37	38	—	—	—	—
Henricia sp. 4 (Fukushima)	50	49	47	50	53	—	—	—	—	—
Henricia sp. 5 (Okinawa)	59	45	52	54	59	52	45	49	42	
Henricia sp. 6 (Miyako)	62	54	51	49	—	—	—	—	—	—
Henricia sp. 7 (Nagannu)	42	56	40	—	—	—	—	—	—	—
Henricia regularis	58	58	60	60	60	51	56	61	—	—
Henricia sp. 8 (Okinoerabu)	68	49	46	50	58	37	64	—	—	—
Henricia reticulata	137	128	—	—	—	—	—	—	—	—
Henricia ohshimai (Misaki)	101	111	138	124	123	115	124	102	116	128
Henricia ohshimai (Oshoro)	96	109	86	104	101	93	117	87	102	102

(Continued)

Species	DS$_{middle}$									
Henricia tumida	84	81	90	73	82	93	94	88	79	—
Henricia sp. 1 (Akkeshi)	77	68	80	85	67	79	80	81	75	75
Henricia nipponica (Muroran)	37	34	39	35	39	44	—	—	—	—
Henricia nipponica (Oshoro)	59	47	46	48	56	53	42	50	57	49
Henricia reniossa	43	34	50	44	39	50	36	48	48	53
Henricia sp. 2 (Abashiri 1)	43	54	33	—	—	—	—	—	—	—
Henricia hayashii	53	56	46	43	55	52	—	—	—	—
Henricia sp. 3 (Abashiri 2)	26	29	30	30	26	30	39	33	27	29
Henricia kinkasana	30	32	29	31	26	30	—	—	—	—
Henricia sp. 4 (Fukushima)	36	36	38	34	39	—	—	—	—	—
Henricia sp. 5 (Okinawa)	36	29	36	38	36	27	33	34	29	—
Henricia sp. 6 (Miyako)	45	34	43	37	—	—	—	—	—	—
Henricia sp. 7 (Nagannu)	30	38	28	—	—	—	—	—	—	—
Henricia regularis	42	38	42	37	37	36	46	41	—	—
Henricia sp. 8 (Okinoerabu)	43	27	23	32	38	29	31	—	—	—
Henricia reticulata	100	93	—	—	—	—	—	—	—	—
Henricia ohshimai (Misaki)	87	94	135	114	115	115	115	102	111	122
Henricia ohshimai (Oshoro)	87	89	74	78	73	75	87	76	80	77

Species	DS$_{tip}$									
Henricia tumida	94	90	106	83	91	83	95	102	91	—
Henricia sp. 1 (Akkeshi)	76	75	78	83	56	78	68	63	80	74
Henricia nipponica (Muroran)	42	34	49	40	38	51	—	—	—	—
Henricia nipponica (Oshoro)	68	54	49	63	63	58	50	60	76	58
Henricia reniossa	52	36	59	54	49	58	40	62	51	72
Henricia sp. 2 (Abashiri 1)	39	50	32	—	—	—	—	—	—	—
Henricia hayashii	88	70	65	70	77	74	—	—	—	—
Henricia sp. 3 (Abashiri 2)	28	34	35	30	31	40	45	35	31	32
Henricia kinkasana	33	37	23	34	30	35	—	—	—	—
Henricia sp. 4 (Fukushima)	35	31	36	39	35	—	—	—	—	—
Henricia sp. 5 (Okinawa)	28	34	44	41	45	28	41	38	32	—
Henricia sp. 6 (Miyako)	40	36	32	29	—	—	—	—	—	—
Henricia sp. 7 (Nagannu)	29	36	29	—	—	—	—	—	—	—
Henricia regularis	37	37	37	40	39	26	47	50	—	—
Henricia sp. 8 (Okinoerabu)	19	9	15	16	23	20	20	—	—	—
Henricia reticulata	76	71	—	—	—	—	—	—	—	—
Henricia ohshimai (Misaki)	78	103	117	90	105	92	94	87	106	95
Henricia ohshimai (Oshoro)	68	64	57	68	53	58	69	57	66	62

Species	DS$_{base}$/DS$_{tip}$									
Henricia tumida	0.915	1.000	0.887	1.120	0.989	1.217	1.063	0.912	0.934	—
Henricia sp. 1 (Akkeshi)	1.250	1.240	1.154	1.145	1.357	1.295	1.397	1.524	1.113	1.135
Henricia nipponica (Muroran)	0.929	1.029	0.857	0.975	1.079	0.784	—	—	—	—
Henricia nipponica (Oshoro)	0.882	1.056	1.122	0.857	0.810	1.017	1.140	0.950	0.776	0.897
Henricia reniossa	1.058	1.556	1.068	0.981	1.245	1.345	1.550	1.113	1.294	0.958
Henricia sp. 2 (Abashiri 1)	1.615	1.220	1.469	—	—	—	—	—	—	—
Henricia hayashii	0.614	0.786	0.815	0.743	0.662	0.743	—	—	—	—
Henricia sp. 3 (Abashiri 2)	1.107	0.971	0.914	1.167	1.323	0.825	0.956	1.057	1.000	0.969
Henricia kinkasana	1.182	1.054	1.696	1.088	1.233	1.086	—	—	—	—
Henricia sp. 4 (Fukushima)	1.429	1.581	1.306	1.282	1.514	—	—	—	—	—
Henricia sp. 5 (Okinawa)	2.107	1.324	1.182	1.317	1.311	1.857	1.098	1.289	1.313	—
Henricia sp. 6 (Miyako)	1.550	1.500	1.594	1.690	—	—	—	—	—	—
Henricia sp. 7 (Nagannu)	1.448	1.556	1.379	—	—	—	—	—	—	—
Henricia regularis	1.568	1.568	1.622	1.500	1.538	1.962	1.191	1.220	—	—
Henricia sp. 8 (Okinoerabu)	3.579	5.444	3.067	3.125	2.522	1.850	3.200	—	—	—
Henricia reticulata	1.803	1.803	—	—	—	—	—	—	—	—
Henricia ohshimai (Misaki)	1.295	1.078	1.179	1.378	1.171	1.250	1.319	1.172	1.094	1.347
Henricia ohshimai (Oshoro)	1.412	1.703	1.509	1.529	1.906	1.603	1.696	1.526	1.545	1.645

(Continued)

Species	DS_{middle}/DS_{tip}									
Henricia tumida	0.894	0.900	0.849	0.880	0.901	1.120	0.989	0.863	0.868	—
Henricia sp. 1 (Akkeshi)	1.013	0.907	1.026	1.024	1.196	1.013	1.176	1.286	0.938	1.014
Henricia nipponica (Muroran)	0.881	1.000	0.796	0.875	1.026	0.863	—	—	—	—
Henricia nipponica (Oshoro)	0.868	0.870	0.939	0.762	0.889	0.914	0.840	0.833	0.750	0.845
Henricia reniossa	0.827	0.944	0.847	0.815	0.796	0.862	0.900	0.774	0.941	0.736
Henricia sp. 2 (Abashiri 1)	1.103	1.080	1.031	—	—	—	—	—	—	—
Henricia hayashii	0.602	0.800	0.708	0.614	0.714	0.703	—	—	—	—
Henricia sp. 3 (Abashiri 2)	0.929	0.853	0.857	1.000	0.839	0.750	0.867	0.943	0.871	0.906
Henricia kinkasana	0.909	0.865	1.261	0.912	0.867	0.857	—	—	—	—
Henricia sp. 4 (Fukushima)	1.029	1.161	1.056	0.872	1.114	—	—	—	—	—
Henricia sp. 5 (Okinawa)	1.286	0.853	0.818	0.927	0.800	0.964	0.805	0.895	0.906	—
Henricia sp. 6 (Miyako)	1.125	0.944	1.344	1.276	—	—	—	—	—	—
Henricia sp. 7 (Nagannu)	1.034	1.056	0.966	—	—	—	—	—	—	—
Henricia regularis	1.135	1.027	1.135	0.925	0.949	1.385	0.979	0.820	—	—
Henricia sp. 8 (Okinoerabu)	2.263	3.000	1.533	2.000	1.652	1.450	1.550	—	—	—
Henricia reticulata	1.316	1.310	—	—	—	—	—	—	—	—
Henricia ohshimai (Misaki)	1.115	0.913	1.154	1.267	1.095	1.250	1.223	1.172	1.047	1.284
Henricia ohshimai (Oshoro)	1.279	1.391	1.298	1.147	1.377	1.293	1.261	1.333	1.212	1.242

Species	AdS_{height}				
Henricia tumida	807	714	759	848	—
Henricia sp. 1 (Akkeshi)	977	989	932	1028	1105
Henricia nipponica (Muroran)	473	471	533	538	—
Henricia nipponica (Oshoro)	679	638	665	652	649
Henricia reniossa	1272	1308	1251	—	—
Henricia sp. 2 (Abashiri 1)	807	758	758	—	—
Henricia hayashii	1298	1304	1308	1260	1161
Henricia sp. 3 (Abashiri 2)	921	936	941	833	—
Henricia kinkasana	664	754	740	683	704
Henricia sp. 4 (Fukushima)	1033	1113	1120	—	—
Henricia sp. 5 (Okinawa)	1018	1033	965	—	—
Henricia sp. 6 (Miyako)	859	980	866	—	—
Henricia sp. 7 (Nagannu)	1054	1065	—	—	—
Henricia regularis	978	943	951	—	—
Henricia sp. 8 (Okinoerabu)	1283	1245	1282	1258	—
Henricia reticulata	2091	2007	2043	—	—
Henricia ohshimai (Misaki)	1911	1959	1956	—	—
Henricia ohshimai (Oshoro)	1548	1536	1547	1482	1562

Species	AdS_{base}				
Henricia tumida	223	178	214	210	—
Henricia sp. 1 (Akkeshi)	181	178	178	203	215
Henricia nipponica (Muroran)	89	101	121	101	—
Henricia nipponica (Oshoro)	139	141	136	125	141
Henricia reniossa	181	149	144	—	—
Henricia sp. 2 (Abashiri 1)	102	95	95	—	—
Henricia hayashii	210	176	216	171	197
Henricia sp. 3 (Abashiri 2)	123	123	116	110	—
Henricia kinkasana	101	115	105	120	110
Henricia sp. 4 (Fukushima)	142	127	130	—	—
Henricia sp. 5 (Okinawa)	115	106	95	—	—
Henricia sp. 6 (Miyako)	136	150	129	—	—
Henricia sp. 7 (Nagannu)	113	116	—	—	—
Henricia regularis	147	115	126	—	—
Henricia sp. 8 (Okinoerabu)	206	219	216	208	—
Henricia reticulata	355	327	370	—	—
Henricia ohshimai (Misaki)	354	341	355	—	—
Henricia ohshimai (Oshoro)	300	296	316	281	316

(Continued)

Species	AdS_{middle}				
Henricia tumida	202	166	191	178	—
Henricia sp. 1 (Akkeshi)	135	139	188	203	196
Henricia nipponica (Muroran)	83	86	112	92	—
Henricia nipponica (Oshoro)	129	128	118	125	124
Henricia reniossa	153	149	135	—	—
Henricia sp. 2 (Abashiri 1)	89	82	75	—	—
Henricia hayashii	203	180	183	206	169
Henricia sp. 3 (Abashiri 2)	106	106	103	90	—
Henricia kinkasana	78	89	71	73	78
Henricia sp. 4 (Fukushima)	110	117	120	—	—
Henricia sp. 5 (Okinawa)	102	111	98	—	—
Henricia sp. 6 (Miyako)	100	121	116	—	—
Henricia sp. 7 (Nagannu)	88	100	—	—	—
Henricia regularis	119	111	114	—	—
Henricia sp. 8 (Okinoerabu)	163	178	203	165	—
Henricia reticulata	276	295	318	—	—
Henricia ohshimai (Misaki)	363	377	350	—	—
Henricia ohshimai (Oshoro)	271	234	230	251	302

Species	AdS_{tip}				
Henricia tumida	252	198	246	230	—
Henricia sp. 1 (Akkeshi)	154	156	244	271	277
Henricia nipponica (Muroran)	91	102	111	105	—
Henricia nipponica (Oshoro)	156	163	148	139	143
Henricia reniossa	163	170	159	—	—
Henricia sp. 2 (Abashiri 1)	95	99	84	—	—
Henricia hayashii	261	226	262	234	244
Henricia sp. 3 (Abashiri 2)	161	150	148	137	—
Henricia kinkasana	93	104	102	105	91
Henricia sp. 4 (Fukushima)	120	116	119	—	—
Henricia sp. 5 (Okinawa)	95	104	107	—	—
Henricia sp. 6 (Miyako)	110	150	127	—	—
Henricia sp. 7 (Nagannu)	102	100	—	—	—
Henricia regularis	126	107	126	—	—
Henricia sp. 8 (Okinoerabu)	130	143	177	136	—
Henricia reticulata	290	291	327	—	—
Henricia ohshimai (Misaki)	395	377	350	—	—
Henricia ohshimai (Oshoro)	264	224	236	238	285

Species	AdS_{base}/AdS_{tip}				
Henricia tumida	0.885	0.899	0.870	0.913	—
Henricia sp. 1 (Akkeshi)	1.175	1.141	0.730	0.749	0.776
Henricia nipponica (Muroran)	0.978	0.990	1.090	0.962	—
Henricia nipponica (Oshoro)	0.891	0.865	0.919	0.899	0.986
Henricia reniossa	1.110	0.876	0.906	—	—
Henricia sp. 2 (Abashiri 1)	1.074	0.960	1.131	—	—
Henricia hayashii	0.805	0.779	0.824	0.731	0.807
Henricia sp. 3 (Abashiri 2)	0.764	0.820	0.784	0.803	—
Henricia kinkasana	1.086	1.106	1.029	1.143	1.209
Henricia sp. 4 (Fukushima)	1.183	1.095	1.092	—	—
Henricia sp. 5 (Okinawa)	1.211	1.019	0.888	—	—
Henricia sp. 6 (Miyako)	1.236	1.000	1.016	—	—
Henricia sp. 7 (Nagannu)	1.108	1.160	—	—	—
Henricia regularis	1.167	1.075	1.000	—	—
Henricia sp. 8 (Okinoerabu)	1.585	1.531	1.220	1.529	—
Henricia reticulata	1.224	1.124	1.131	—	—
Henricia ohshimai (Misaki)	0.896	0.905	1.014	—	—
Henricia ohshimai (Oshoro)	1.136	1.321	1.339	1.181	1.109

(Continued)

Species	AdS_{middle}/AdS_{tip}				
Henricia tumida	0.802	0.838	0.776	0.774	—
Henricia sp. 1 (Akkeshi)	0.877	0.891	0.770	0.749	0.708
Henricia nipponica (Muroran)	0.912	0.843	1.009	0.876	—
Henricia nipponica (Oshoro)	0.827	0.785	0.797	0.899	0.867
Henricia reniossa	0.939	0.876	0.849	—	—
Henricia sp. 2 (Abashiri 1)	0.937	0.828	0.893	—	—
Henricia hayashii	0.778	0.796	0.698	0.880	0.693
Henricia sp. 3 (Abashiri 2)	0.658	0.707	0.696	0.657	—
Henricia kinkasana	0.839	0.856	0.696	0.695	0.857
Henricia sp. 4 (Fukushima)	0.917	1.009	1.008	—	—
Henricia sp. 5 (Okinawa)	1.074	1.067	0.916	—	—
Henricia sp. 6 (Miyako)	0.909	0.807	0.913	—	—
Henricia sp. 7 (Nagannu)	0.863	1.000	—	—	—
Henricia regularis	0.944	1.037	0.905	—	—
Henricia sp. 8 (Okinoerabu)	1.254	1.245	1.147	1.213	—
Henricia reticulata	0.952	1.014	0.972	—	—
Henricia ohshimai (Misaki)	0.919	1.000	1.000	—	—
Henricia ohshimai (Oshoro)	1.027	1.045	0.975	1.055	1.060

Species	AdP_{height}							
Henricia tumida	989	976	995	954	1050	982	—	—
Henricia sp. 1 (Akkeshi)	977	959	967	965	—	—	—	—
Henricia nipponica (Muroran)	558	547	543	—	—	—	—	—
Henricia nipponica (Oshoro)	708	678	740	690	—	—	—	—
Henricia reniossa	1289	1326	1211	1277	1215	—	—	—
Henricia sp. 2 (Abashiri 1)	825	778	813	773	—	—	—	—
Henricia hayashii	1206	1128	—	—	—	—	—	—
Henricia sp. 3 (Abashiri 2)	918	826	934	—	—	—	—	—
Henricia kinkasana	792	791	803	791	—	—	—	—
Henricia sp. 4 (Fukushima)	888	914	973	1021	—	—	—	—
Henricia sp. 5 (Okinawa)	925	893	924	1012	—	—	—	—
Henricia sp. 6 (Miyako)	1108	1055	1124	1150	1134	—	—	—
Henricia sp. 7 (Nagannu)	994	934	946	—	—	—	—	—
Henricia regularis	777	787	804	726	777	—	—	—
Henricia sp. 8 (Okinoerabu)	1627	1666	1562	1601	1564	1495	1552	1601
Henricia reticulata	1988	1617	1800	1728	—	—	—	—
Henricia ohshimai (Misaki)	1622	1610	1316	1597	1546	—	—	—
Henricia ohshimai (Oshoro)	1395	1267	1315	1290	—	—	—	—

Species	AdP_{width}							
Henricia tumida	994	1007	990	1040	1031	1010	—	—
Henricia sp. 1 (Akkeshi)	1121	1055	1090	1131	—	—	—	—
Henricia nipponica (Muroran)	534	532	512	—	—	—	—	—
Henricia nipponica (Oshoro)	690	634	666	658	—	—	—	—
Henricia reniossa	1266	1154	1201	1234	1145	—	—	—
Henricia sp. 2 (Abashiri 1)	818	855	815	827	—	—	—	—
Henricia hayashii	1100	1055	—	—	—	—	—	—
Henricia sp. 3 (Abashiri 2)	964	894	932	—	—	—	—	—
Henricia kinkasana	798	791	765	789	—	—	—	—
Henricia sp. 4 (Fukushima)	815	820	849	856	—	—	—	—
Henricia sp. 5 (Okinawa)	909	930	926	901	—	—	—	—
Henricia sp. 6 (Miyako)	1007	976	993	1006	965	—	—	—
Henricia sp. 7 (Nagannu)	906	885	902	—	—	—	—	—
Henricia regularis	757	732	785	717	779	—	—	—
Henricia sp. 8 (Okinoerabu)	1870	1896	1666	1879	1945	1914	1769	1853
Henricia reticulata	1792	1916	2000	1923	—	—	—	—
Henricia ohshimai (Misaki)	1561	1545	1474	1592	1645	—	—	—
Henricia ohshimai (Oshoro)	1275	1399	1456	1384	—	—	—	—

(Continued)

Species	AdP$_{top}$							
Henricia tumida	772	823	801	802	849	802	—	—
Henricia sp. 1 (Akkeshi)	905	820	857	911	—	—	—	—
Henricia nipponica (Muroran)	428	401	441	—	—	—	—	—
Henricia nipponica (Oshoro)	490	493	527	534	—	—	—	—
Henricia reniossa	922	941	988	1032	981	—	—	—
Henricia sp. 2 (Abashiri 1)	632	629	452	611	—	—	—	—
Henricia hayashii	954	869	—	—	—	—	—	—
Henricia sp. 3 (Abashiri 2)	720	677	733	—	—	—	—	—
Henricia kinkasana	601	781	520	622	—	—	—	—
Henricia sp. 4 (Fukushima)	604	628	747	741	—	—	—	—
Henricia sp. 5 (Okinawa)	679	677	620	666	—	—	—	—
Henricia sp. 6 (Miyako)	657	756	838	827	736	—	—	—
Henricia sp. 7 (Nagannu)	732	592	589	—	—	—	—	—
Henricia regularis	608	583	572	616	581	—	—	—
Henricia sp. 8 (Okinoerabu)	1545	1549	1458	1545	1612	1613	1493	1618
Henricia reticulata	1543	1545	1420	1682	—	—	—	—
Henricia ohshimai (Misaki)	1303	1249	1271	1124	1165	—	—	—
Henricia ohshimai (Oshoro)	1087	1068	909	1064	—	—	—	—

Species	AmP$_{width}$					
Henricia tumida	549	582	620	—	—	—
Henricia sp. 1 (Akkeshi)	661	635	631	737	—	—
Henricia nipponica (Muroran)	354	412	378	364	350	317
Henricia nipponica (Oshoro)	401	459	456	—	—	—
Henricia reniossa	755	762	774	815	775	—
Henricia sp. 2 (Abashiri 1)	487	440	434	—	—	—
Henricia hayashii	632	737	677	—	—	—
Henricia sp. 3 (Abashiri 2)	581	560	597	—	—	—
Henricia kinkasana	476	440	471	409	342	—
Henricia sp. 4 (Fukushima)	522	533	546	538	529	—
Henricia sp. 5 (Okinawa)	492	502	487	494	—	—
Henricia sp. 6 (Miyako)	519	573	525	582	564	—
Henricia sp. 7 (Nagannu)	458	441	472	518	—	—
Henricia regularis	465	459	495	454	—	—
Henricia sp. 8 (Okinoerabu)	878	727	761	664	—	—
Henricia reticulata	1015	1109	1154	—	—	—
Henricia ohshimai (Misaki)	971	958	891	—	—	—
Henricia ohshimai (Oshoro)	918	1000	862	—	—	—

Species	AmP$_{ridge}$					
Henricia tumida	838	861	883	—	—	—
Henricia sp. 1 (Akkeshi)	887	876	992	870	—	—
Henricia nipponica (Muroran)	467	527	531	441	528	458
Henricia nipponica (Oshoro)	623	600	709	—	—	—
Henricia reniossa	1342	1397	1323	1333	1349	—
Henricia sp. 2 (Abashiri 1)	869	777	919	—	—	—
Henricia hayashii	1358	1396	1275	—	—	—
Henricia sp. 3 (Abashiri 2)	1096	1090	1020	—	—	—
Henricia kinkasana	1030	953	1071	997	1001	—
Henricia sp. 4 (Fukushima)	1111	1180	1084	1149	1106	—
Henricia sp. 5 (Okinawa)	988	953	982	1033	—	—
Henricia sp. 6 (Miyako)	1169	1169	1078	1178	1110	—
Henricia sp. 7 (Nagannu)	880	876	870	936	—	—
Henricia regularis	844	837	797	761	—	—
Henricia sp. 8 (Okinoerabu)	1525	1661	1545	1410	—	—
Henricia reticulata	1649	1681	1683	—	—	—
Henricia ohshimai (Misaki)	1703	1656	1773	—	—	—
Henricia ohshimai (Oshoro)	1251	1420	1439	—	—	—

(Continued)

Species	AmP_{neck}					
Henricia tumida	458	496	511	—	—	—
Henricia sp. 1 (Akkeshi)	560	549	556	611	—	—
Henricia nipponica (Muroran)	327	361	340	329	321	290
Henricia nipponica (Oshoro)	366	415	400	—	—	—
Henricia reniossa	684	664	692	707	696	—
Henricia sp. 2 (Abashiri 1)	448	417	404	—	—	—
Henricia hayashii	549	571	565	—	—	—
Henricia sp. 3 (Abashiri 2)	525	504	515	—	—	—
Henricia kinkasana	370	356	371	338	313	—
Henricia sp. 4 (Fukushima)	387	416	403	412	400	—
Henricia sp. 5 (Okinawa)	470	451	474	400	—	—
Henricia sp. 6 (Miyako)	464	473	471	487	491	—
Henricia sp. 7 (Nagannu)	440	441	472	482	—	—
Henricia regularis	438	428	451	401	—	—
Henricia sp. 8 (Okinoerabu)	805	689	739	608	—	—
Henricia reticulata	908	1042	1102	—	—	—
Henricia ohshimai (Misaki)	903	850	831	—	—	—
Henricia ohshimai (Oshoro)	841	943	835	—	—	—

Species	$AmP_{width}/AmP_{neck}/r$					
Henricia tumida	0.1332	0.1304	0.1348	—	—	—
Henricia sp. 1 (Akkeshi)	0.1312	0.1285	0.1261	0.1340	—	—
Henricia nipponica (Muroran)	0.2406	0.2536	0.2471	0.2459	0.2423	0.2429
Henricia nipponica (Oshoro)	0.1826	0.1843	0.1900	—	—	—
Henricia reniossa	0.1380	0.1434	0.1398	0.1441	0.1392	—
Henricia sp. 2 (Abashiri 1)	0.1553	0.1507	0.1535	—	—	—
Henricia hayashii	0.1279	0.1434	0.1331	—	—	—
Henricia sp. 3 (Abashiri 2)	0.1581	0.1587	0.1656	—	—	—
Henricia kinkasana	0.1979	0.1901	0.1953	0.1862	0.1681	—
Henricia sp. 4 (Fukushima)	0.1587	0.1507	0.1594	0.1536	0.1556	—
Henricia sp. 5 (Okinawa)	0.1396	0.1484	0.1370	0.1647	—	—
Henricia sp. 6 (Miyako)	0.1316	0.1425	0.1311	0.1406	0.1351	—
Henricia sp. 7 (Nagannu)	0.1388	0.1333	0.1333	0.1433	—	—
Henricia regularis	0.1633	0.1650	0.1689	0.1742	—	—
Henricia sp. 8 (Okinoerabu)	0.1091	0.1055	0.1030	0.1092	—	—
Henricia reticulata	0.0658	0.0626	0.0616	—	—	—
Henricia ohshimai (Misaki)	0.0827	0.0867	0.0825	—	—	—
Henricia ohshimai (Oshoro)	0.0992	0.0964	0.0938	—	—	—