Journal of Species Research 9(2):147-161, 2020

Seven new species of two genera *Scalarispongia* and *Smenospongia* (Demospongiae: Dictyoceratida: Thorectidae) from Korea

Young A Kim[1,*], Kyung Jin Lee[2] and Chung Ja Sim[3]

[1]*Natural History Museum, Hannam University, Daejeon 34430, Republic of Korea*
[2]*Animal Resources Division, National Institute of Biological Resources, Incheon 22689, Republic of Korea*
[3]*Department of Biological Sciences and Biotechnology, Hannam University, Daejeon 34430, Republic of Korea*

**Correspondent: yak199847@gmail.com*

Seven new species of two genera *Scalarispongia* and *Smenospongia* (Demospongiae: Dictyoceratida: Thorectidae) are described from Gageo Island and Jeju Island, Korea. Five new species of *Scalarispongia* are compared to nine reported species of the genus by the skeletal structure. *Scalarispongia viridis* n. sp. has regular ladder-like skeletal pattern arranged throughout the sponge body and has pseudo-tertiary fibres. *Scalarispongia favus* n. sp. is characterized by the honeycomb shape of the surface and is similar to *Sc. flava* in skeletal structure, but differs in sponge shape. *Scalarispongia lenis* n. sp. is similar to *Sc. regularis* in skeletal structure but has fibers that are smaller in size. *Scalarispongia canus* n. sp. has irregular skeletal structure in three dimensions and ladder-like which comes out of the surface and choanosome. *Scalarispongia subjiensis* n. sp. has pseudo-tertiary fibres and its regular ladder-like skeletal pattern occurs at the choanosome. Two new species of *Smenospongia* are distinguished from the other 19 reported species of the genus by the skeletal structure. *Smenospongia aspera* n. sp. is similar to *Sm. coreana* in sponge shape but new species has rarely secondary web and thin and thick bridged fibres at near surface. *Smenospongia mureungensis* n. sp. has very simple skeletal structure.

Keywords: Korea, new species, *Scalarispongia*, *Smenospongia*, Thorectidae

© 2020 National Institute of Biological Resources
DOI:10.12651/JSR.2020.9.2.147

Introduction

The genus *Scalarispongia* in subfamily Thorectinae, family Thorectidae was erected by Cook and Bergquist, 2000. This genus is characterized by the skeletal structure with a spongin fibre reticulum of concentrically laminated primary and secondary fibres, arranged in a regular, ladder-like pattern. The meshes in skeletal reticulum are often tough, precisely rectangular, with secondary fibres forming almost perfect right-angles to primary fibres. Primary fibres are cored with foreign material and secondary fibres are clear (Cook and Bergquist, 2000). Nine species of *Scalarispongia* were reported worldwide (Schmidt, 1862; Baar, 1904; Thiele, 1905; Pulitzer-Finali and Pronzato, 1981; Desqueyroux-Faúndez and Van Soest, 1997; Helmy *et al*., 2004; Lee and Sim, 2007), among them two species from Korea.

The genus *Smenospongia* is erected by Wiedenmayer, 1977. This genus is characterized by a well-developed secondary fibre reticulum, low collagen deposition, and surface which displays a characteristic honeycomb pattern (Cook and Bergquist, 2002). Nineteen species of *Smenospongia* were reported worldwide (Duchassaing and Michelotti, 1864; De Laubenfels, 1934; 1954; Lévi, 1969; Wiedenmayer, 1977; Pulitzer-Finali, 1986; Sim *et al*., 2016) among them 11 species from Korea. Additionally, there is a figure of a reported species, *Sm. coreana* Lee and Sim, 2005 (Fig. 11), in this paper for comparison with *Sm. aspera* n. sp.

Materials and Methods

Sponge collections were made from Gageo Island and Jeju Island, Korea. They were collected from the intertidal zone to the depth of 5−30 m using SCUBA during 2000−2019. Collected specimens preserved in 95% ethyl alcohol and were identified based on their morphological characteristics. The external feature of sponges was observed under stereo microscope (Stemi SV. 6, Carl

Zeiss, Germany). The skeletal fibres were studied under a light microscope (Axioscope II, Carl Zeiss, Germany). The type specimens were deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea.

Systematic Accounts

Phylum Porifera Grant, 1836
Class Demospongiae Sollas, 1885
Order Dictyoceratida Minchin, 1900
Family Thorectidae Bergquist, 1978
Genus *Scalarispongia* Cook and Bergquist, 2000

1. *Scalarispongia viridis* n. sp. (Fig. 1)
풀색스칼라각질해면 (신칭)

Type specimen. Holotype (NIBRIV0000862768), Korea: Sinchang-ri, Hankyung-myeon, Jeju-si, Jeju-do, 19 Aug 2001, collected by K.J. Lee, intertidal zone, rocky substrate, deposited at NIBR.
Description. Thick encrusting sponge, size up to 15 × 7 × 1.5 cm. Surface smooth with regular skeletal fibres come out from near surface and covered with very thin pseudo-tertiary fibres like lace (Fig. 1H). Some part of matrix missing, the only remaining near skeletal fibres part. Oscules, 3 mm in diameter. Color in life, green. Texture soft and compressible.

Skeleton: Primary fibres, 50−80−100 μm in diameter, cored spicules and partly fasciculate. Secondary fibres, ladder-like at surface (Fig. 1B, D, E), 30 μm in diameter. Ladder-like skeletal structure can be observed throughout sponge body. Length of bridged secondary fibres between primary fibres at near conules, 200−1,000 μm (commonly 600−700 μm) (Fig. 1G). Usually, pseudo-tertiary fibres, 10−20 μm in diameter, occurred at side of sponge surface (Fig. 1H).
Etymology. The species name, *viridis*, is named after the sponge green color in life.
Remarks. This new species is very unique in skeletal structure. Fibres of this species have regular ladder-like pattern throughout the sponge body. The sponge has irregular pseudo-tertiary fibres at the surface. The length of bridged secondary fibres between primary fibres is very long.

2. *Scalarispongia favus* n. sp. (Figs. 2, 3)
벌집스칼라각질해면 (신칭)

Type specimen. Holotype (NIBRIV0000862769), Korea: Mureungarch, Daejeong-eup, Seogwipo-si, Jeju-do, 20 Sep 2012, collected by Y.A. Kim, intertidal zone, rocky substrate, depth 5 m, deposited at NIBR.
Description. Thick encrusting small mass sponge, size up to 7 × 3 × 1 cm. Surface rough, honeycomb shape with short conules, covered with pigmented thin membrane. Several oscules occur on upper part of sponge, 0.5−2 mm in diameter. Color in life, black outside, beige inside. Texture firm and compressible.

Skeleton: Primary fibres, 70−100 μm in diameter, cored with sands. Secondary fibres, 30−50 μm in diameter, ladder-like and partly occur on side of sponge. Length of bridged secondary fibres between primary fibres, 300−700−900 μm. Most of the time, fibres arranged irregularly at near surface conules (Fig. 2G, H).
Etymology. This species name, *favus*, is named after the honeycomb pattern of sponge surface.
Remarks. This new species is characterized by the honeycomb shape of surface. Surface covered with thin pigmented membrane. Skeletal fibres do not come out to the surface and ladder-like skeletal form is very rare and mostly arranged irregularly. Primary fibres cored with large sands sparsely in contrast to other species which mostly cored with spicule pieces.

3. *Scalarispongia lenis* n. sp. (Fig. 4)
매끈이스칼라각질해면 (신칭)

Type specimen. Holotype (NIBRIV0000862770), Korea: Seopjikoji, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 17 Mar 2003, collected by K.J. Lee, intertidal zone, rocky substrate, deposited at NIBR.
Description. Thick encrusting sponge, size up to 5.5 × 4 × 3 cm. Surface smooth with low conules, covered with thin membrane which can be easily broken. Several oscules, 1.5−2 mm in diameter, open on surface. Color in life, brownish gray outside and ivory inside. Texture firm and compressible.

Skeleton: Primary fibres cored spicules, 50−80 μm in diameter. Secondary fibres, 20−40 μm in diameter. Skeletal structure arranged regularly. Length of bridged secondary fibres between primary fibres, 300−600 μm.
Etymology. The species name, *lenis*, is named after the smooth surface of the sponge.
Remarks. This new species is similar to *Scalarispongia regularis* Lee and Sim, 2007 in skeletal structure but the size of fibres in new species is smaller. Numerous skeletal fibres do not come out to the surface. Surface covered with very low conules.

4. *Scalarispongia canus* n. sp. (Figs. 5, 6)
회색스칼라각질해면 (신칭)

Type specimen. Holotype (NIBRIV0000862771), Korea: Seopjikoji, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 17 Mar 2003, collected by K.J. Lee, intertidal zone,

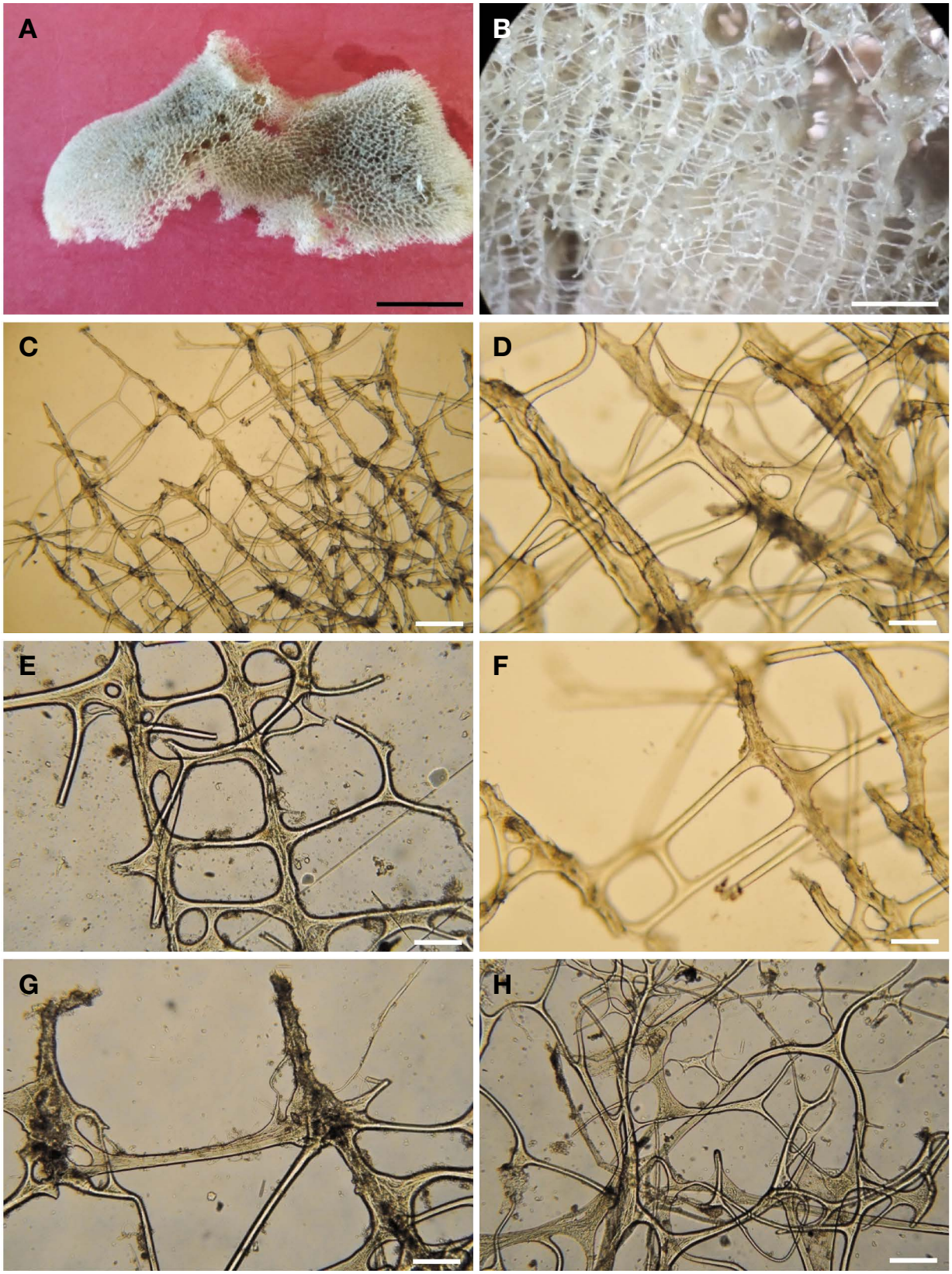

Fig. 1. *Scalarispongia viridis* n. sp. A, external morphology; B, surface under the dissecting microscope; C, D, ladder-like skeletal structure; E, F, primary and secondary fibres; G, cored primary fibres and bridged secondary fibres near conules; H, thin irregular pseudo-tertiary fibres covering the surface. Scale bars: A = 5 cm, B = 2 cm, C = 200 μm, D–H = 100 μm.

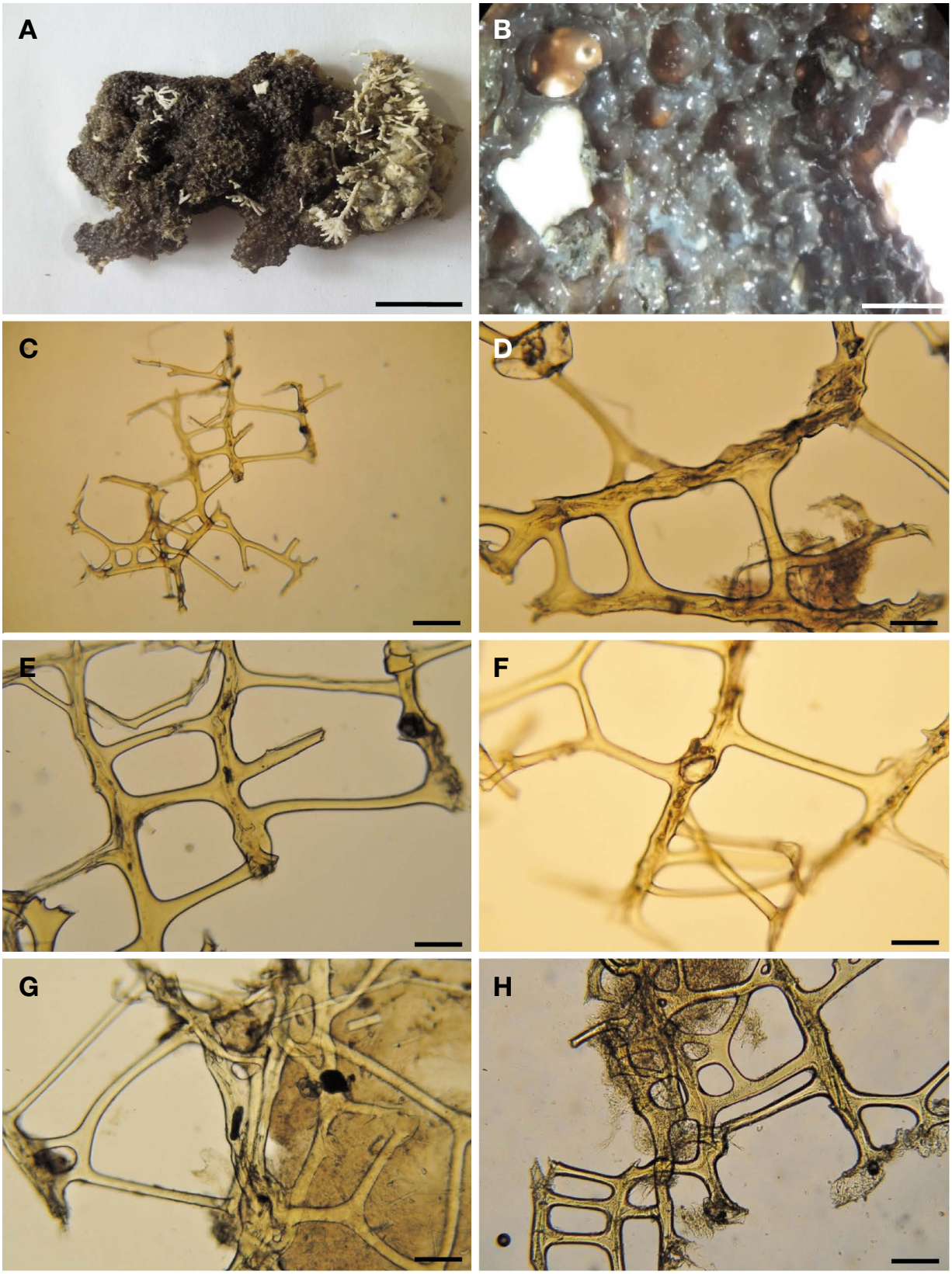

Fig. 2. *Scalarispongia favus* n. sp. A, external morphology; B, surface under the dissecting microscope; C, D, ladder-like skeletal structure; E, F, sands cored primary fibres and clear secondary fibres; G, H, skeletal structure with membrane. Scale bars: A = 2 cm, B = 0.5 cm, C = 200 μm, D–H = 100 μm.

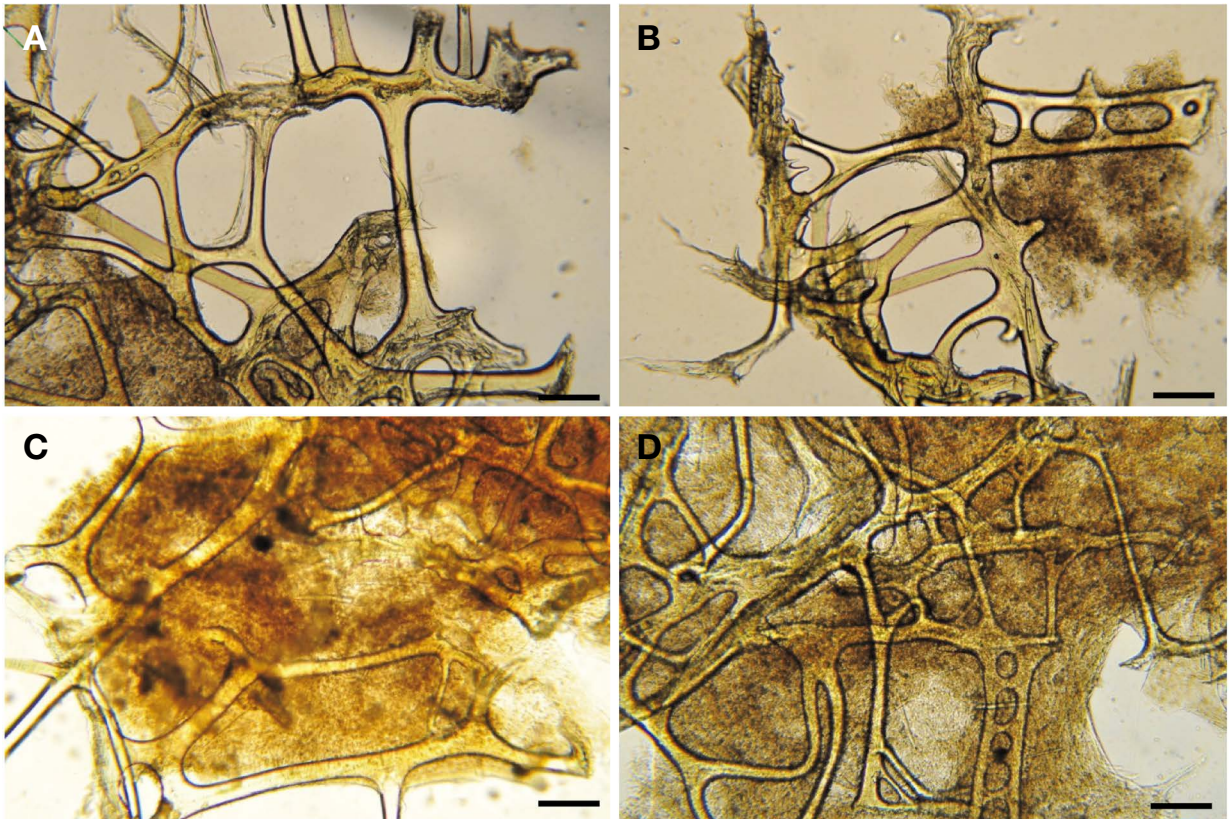

Fig. 3. *Scalarispongia favus* n. sp. A, B, ladder-like skeletal structure; C, D, skeletal structure with membrane. Scale bars: A–D = 100 μm.

rocky substrate, deposited at NIBR.

Description. Thick encrusting sponge, size up to 5.5 × 4.5 × 2.5 cm. Surface covered with grayish-black membrane and dense exposed skeletal fibres in light beige color which look like thin hair. Oscules not open on surface. Color in life, dark gray or black. Texture firm and compressible.

Skeleton: Skeletal structure with three dimensional arrangement. Primary fibres cored spicules, 80–140 μm in diameter. Secondary fibres, 40–100 μm in diameter, usually web type. Ladder-like skeletal structure mostly occurred at surface and choanosome. Skeletal fibres arranged regularly but could be in some part irregular. Length of bridged secondary fibres between primary fibres, 350–700 μm and 700–1,000 μm. Skeletal fibres are easily broken. Fibres are very thick outside of sponge.

Etymology. The species name, *canus*, is named after gray color of emerging skeletal fibres from the sponge surface.

Remarks. This new species is unique because the skeletal structure arranged in three dimensions. Surface covered with dense exposed ladder-like skeletal fibres like beige hair. Ladder-like skeletal fibres occur at the choanosome and sponge base. Diameter of fibres is thicker than other species of *Scalarispongia*.

5. *Scalarispongia subjiensis* n. sp. (Fig. 7)
섭지코지스칼라각질해면 (신칭)

Type specimen. Holotype (NIBRIV0000862772), Korea: Seopjikoji, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 17 Mar 2003, collected by K.J. Lee, intertidal zone, rocky substrate, deposited at NIBR.

Description. Thick encrusting sponge, size up to 9 × 5 × 2 cm. Surface smooth, honeycomb shape with exposed skeletal fibres. Several oscules 1–2 mm in diameter, open on surface. Color, gray in alcohol. Texture soft and compressible.

Skeleton: Skeletal structure with three dimensional arrangement. Primary fibres, 60–90 μm in diameter. Secondary fibres, 30–50 μm in diameter. Pseudo-tertiary fibres at surface, 10–20 μm in diameter. Length of bridged secondary fibres between primary fibres, 250–400–800 μm.

Etymology. The species name, *subjiensis*, is named after type locality, Seopjikoji, Sungsanpo, Jeju-do.

Remarks. This new species is very unique in skeletal structure. The regular ladder-like pattern occurs only at the choanosome.

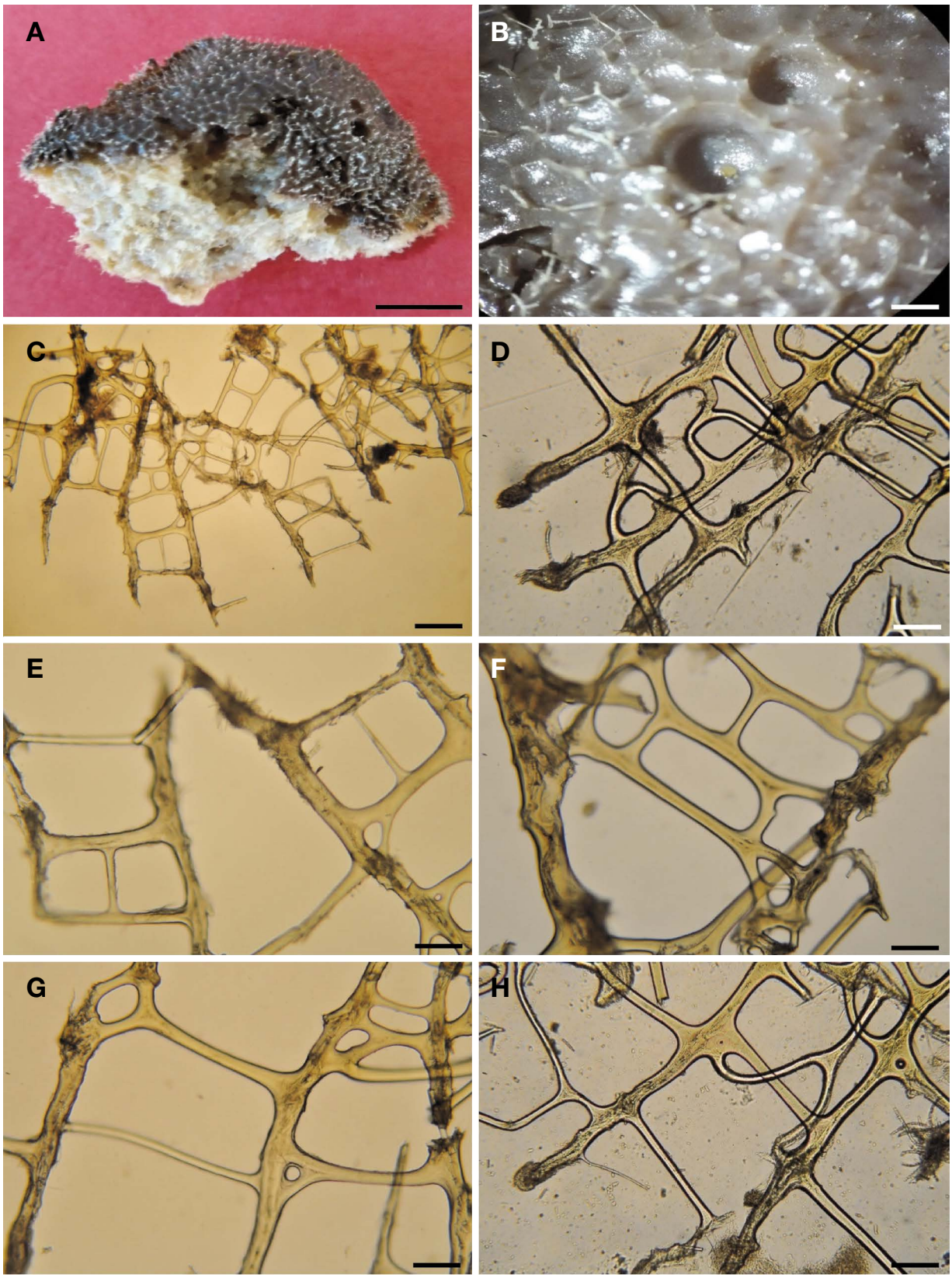

Fig. 4. *Scalarispongia lenis* n. sp. A, external morphology; B, surface under the dissecting microscope; C, skeletal structure near conules; D−F, ladder-like skeletal structure; G, light cored primary fibres; H, rare tertiary fibres. Scale bars: A = 2 cm, B = 0.1 cm, C = 200 μm, D−H = 100 μm.

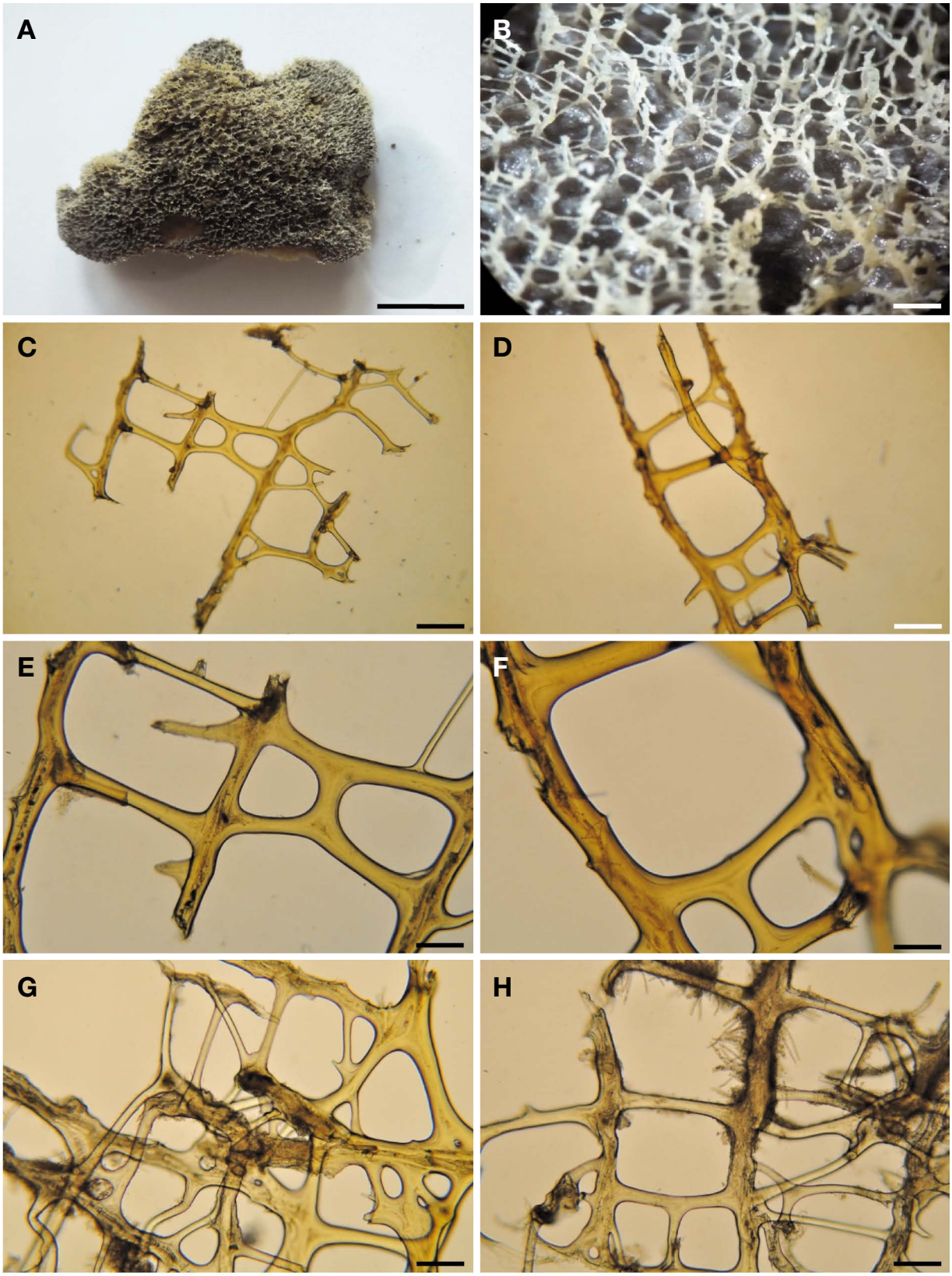

Fig. 5. *Scalarispongia canus* n. sp. A, external morphology; B, surface under the dissecting microscope; C, D, choanosome skeletal structure; E, F, ladder-like skeletal structure; G, irregular skeletal structure near surface; H, emerging skeletal structure. Scale bars: A = 2 cm, B = 0.1 cm, C, D = 200 μm, E–H = 100 μm.

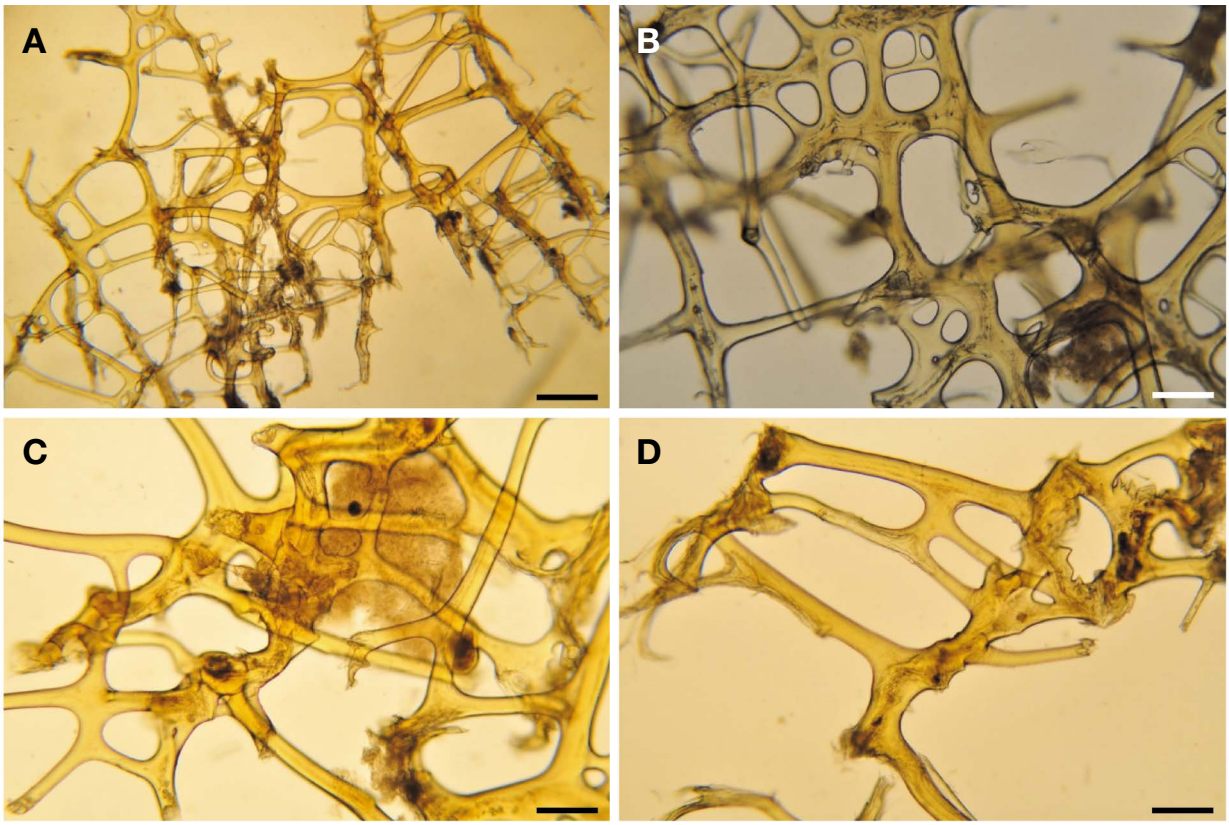

Fig. 6. *Scalarispongia canus* n. sp. A, skeletal structure; B, irregular skeletal structure; C, D, choanosome irregular skeletal structure. Scale bars: A = 200 μm, B–D = 100 μm.

Genus *Smenospongia* Wiedenmayer, 1977

6. *Smenospongia aspera* n. sp. (Figs. 8, 9)
거친스미노해면 (신칭)

Type specimen. Holotype (NIBRIV0000862773), Korea: Jakeunganyeo, Gageodo-ri, Heuksan-myeon, Sinan-gun, Jeollanam-do, 26 Jun 2000, collected by H. J. Kim and K. J. Lee, by SCUBA, depth 15 m, rocky substrate, deposited at NIBR.
Description. Round mass sponge, size up to 7 × 7 × 5.5 cm. Surface rough with thick conules which made groove and covered with thick membrane. Skeletal fibres easily separated from ectodermal matrix because of very simple secondary fibres structure. Several oscules, 1–4 mm in diameter, open on top of sponge. Color in life gray turns to dark brown. Texture firm and compressible.

Skeleton: Primary fibres with three-dimensional arrangement, 100–250 μm in diameter. Secondary fibres, 40–100 μm in diameter, long bridge type (Fig. 8D, F) and partly web type between primary fibres (Fig. 8C, G, H).
Etymology. This species name, *aspera*, is named after its rough surface.

Remarks. This new species is similar to *Smenospongia* coreana Lee and Sim, 2005 (Fig. 11) in sponge shape but differs in surface and skeletal structure. Secondary fibres of *Sm. coreana* has rather complex mesh throughout the sponge but this new species has secondary mesh at near surface conules.

7. *Smenospongia mureungensis* n. sp. (Fig. 10)
무릉스미노해면 (신칭)

Type specimen. Holotype (NIBRIV0000862774), Korea: Mureungarch, Mureung-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 8 Jul 2019, collected by S. E. Moon, by SCUBA, depth 15–20 m, rocky substrate, deposited at NIBR.
Description. Thick massive cushion shape sponge, size up to 16 × 10 × 5 cm. Surface smooth with low sharp conules and shiny membrane. Small oscules, 1–2 mm in diameter, open throughout sponge. Color in life brown turns to grayish black. Texture soft and compressible.

Skeleton: Fibres of near surface, light yellow color, with easily detected cored spicules. Primary fibres, 100–200 μm in diameter. Secondary fibres, 30–170 μm in diameter with almost no network. Secondary fibres usually

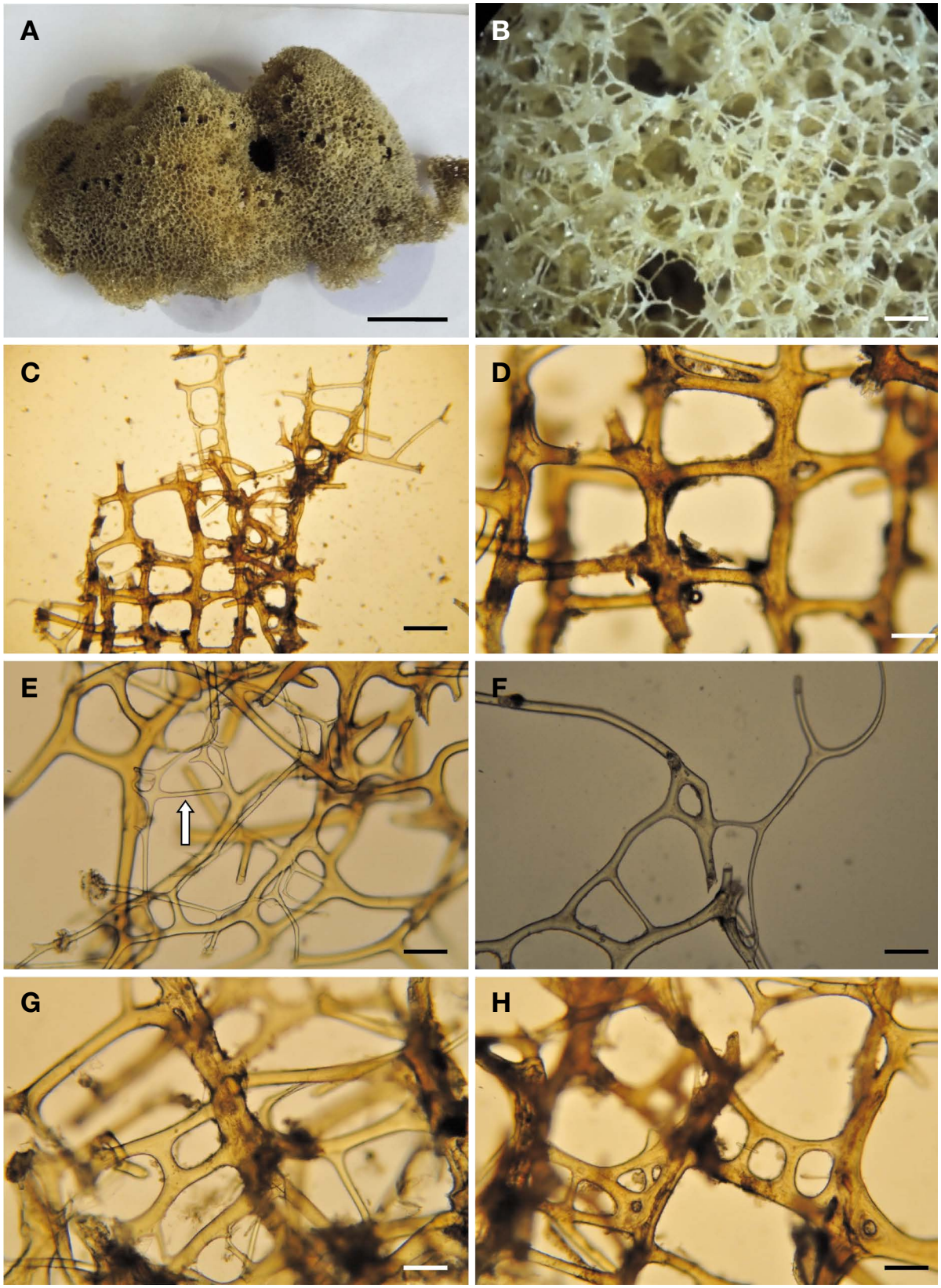

Fig. 7. *Scalarispongia subjiensis* n. sp. A, external morphology; B, surface under the dissecting microscope; C, D, ladder-like skeletal structure; E, F, pseudo-tertiary fibres at the surface (arrow in E); G, H, skeletal structure near surface. Scale bars: A = 2 cm, B = 0.2 cm, C = 200 μm, D–H = 100 μm.

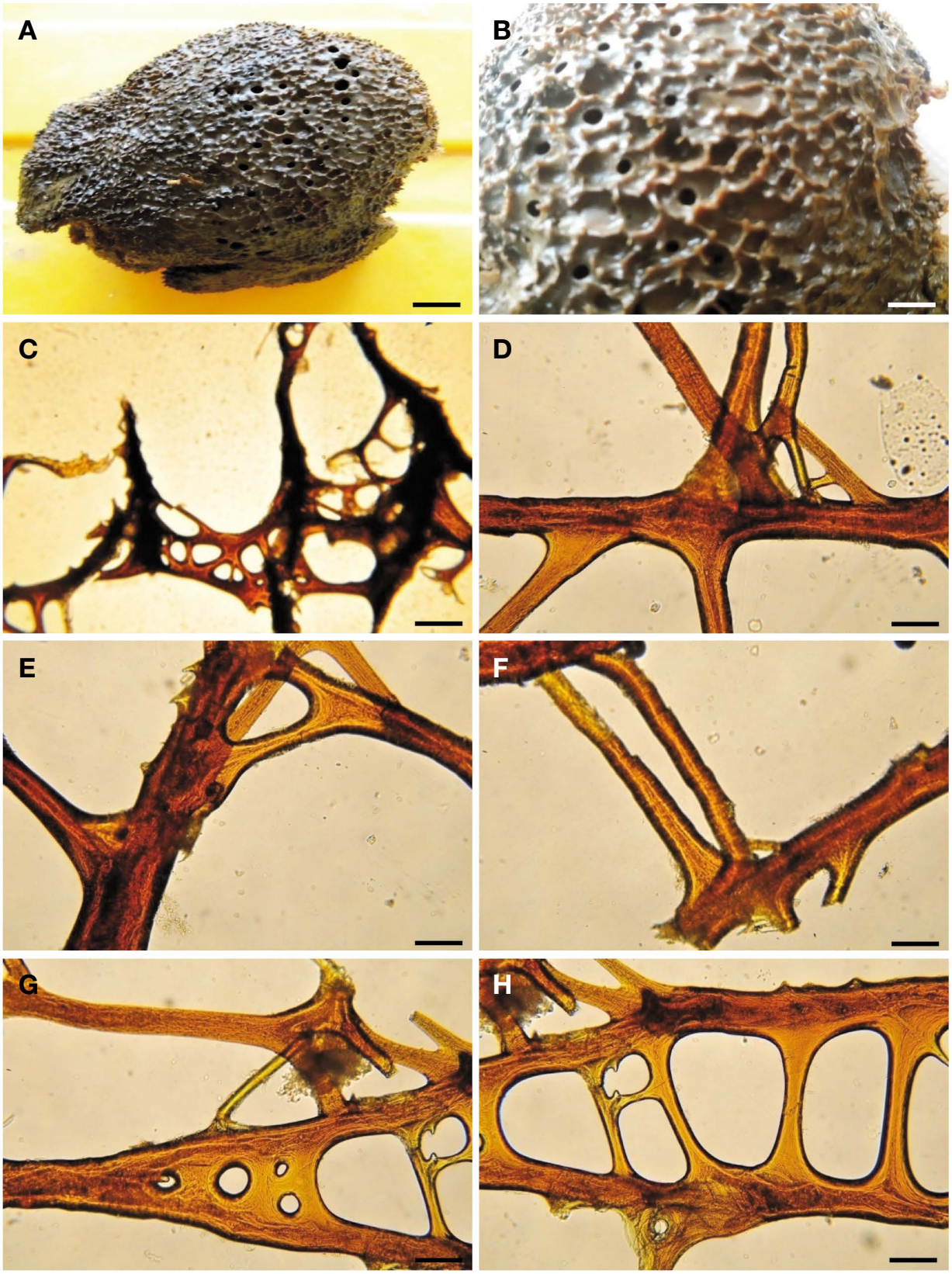

Fig. 8. *Smenospongia aspera* n. sp. A, external morphology; B, surface close up; C, skeletal structure near conules and web type secondary fibres; D, skeletal structure; E, cored primary fibres; F, bridged secondary fibres; G, H, secondary web. Scale bars: A = 1 cm, B = 0.1 cm, C = 200 μm, D–H = 100 μm.

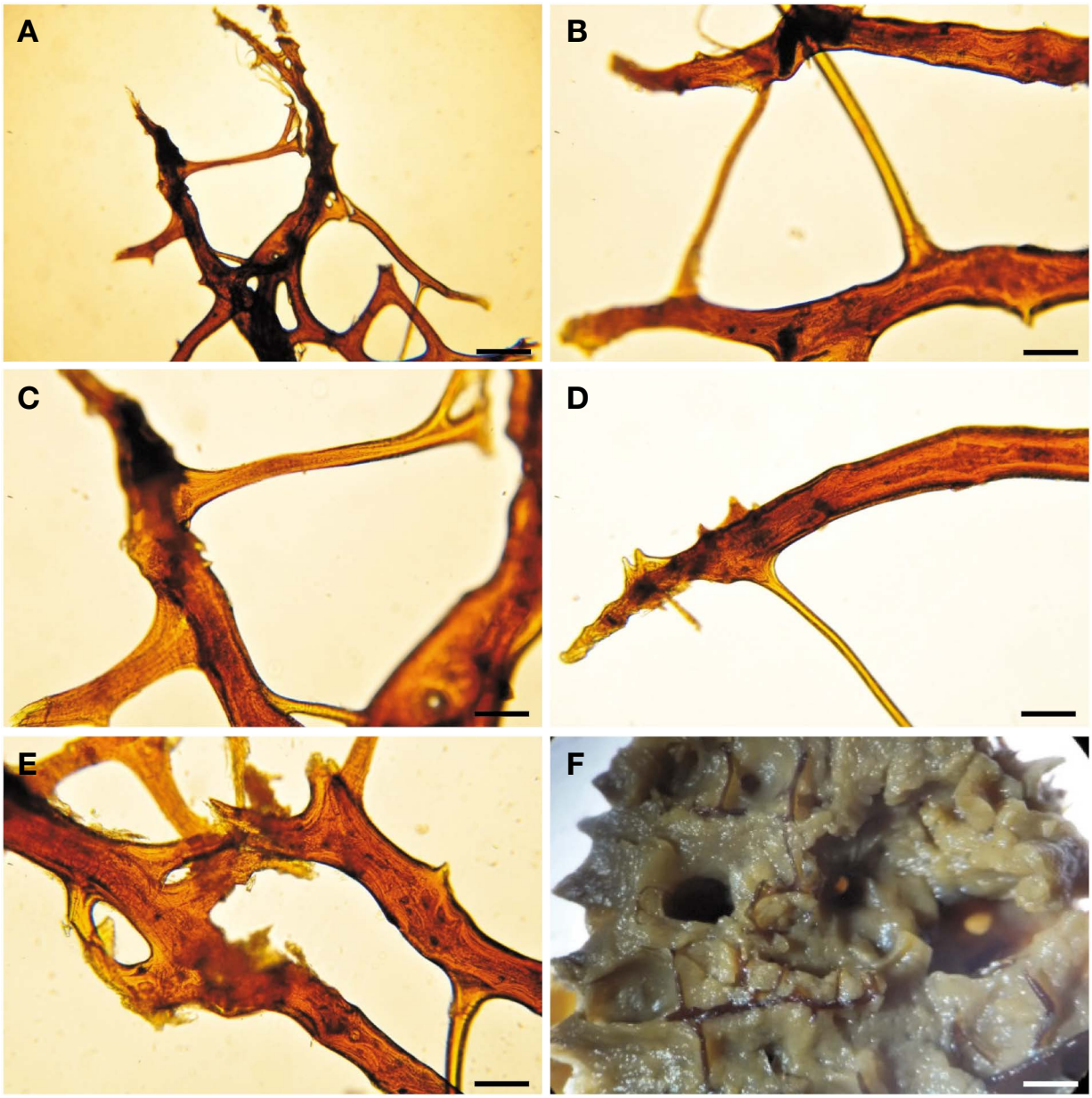

Fig. 9. *Smenospongia aspera* n. sp. A, skeletal structure near conules; B, bridged thin secondary fibres; C, bridged thick secondary fibres; D, spined primary fibres and bridged thin secondary fibres; E, primary fibres; F, skeletal structure under the dissecting microscope. Scale bars: A = 200 μm, B–E = 100 μm, F = 500 μm.

bridge type between primary fibres, 1,000–1,500 μm in length (Fig. 10G, H).

Etymology. The specific name, *mureungensis*, is named after locality, Mureungarch, Korea.

Remarks. This new species is similar to *Smenospongia* nigra Sim *et al*., 2016 partly in sponge shape but differs in fibres color and shape. The primary fibres of this new species have only cored spicules and unlike *Sm. nigra* surface is not honeycomb shape. Secondary fibres are very simple and regular.

Discussion

The genus *Scalarispongia* is characterized by ladder-like pattern of skeletal fibres. In most species of this genus, ladder-like skeletal fibres are not always developed throughout the sponge, and it sometimes occurs partially. *Scalarispongia viridis* n. sp. and *Sc. lenis* n. sp. have regular ladder-like skeletal fibres throughout the sponge. *Scalarispongia favus* n. sp. rarely has regular ladder-like pattern only at the side of sponge. Regular ladder form of

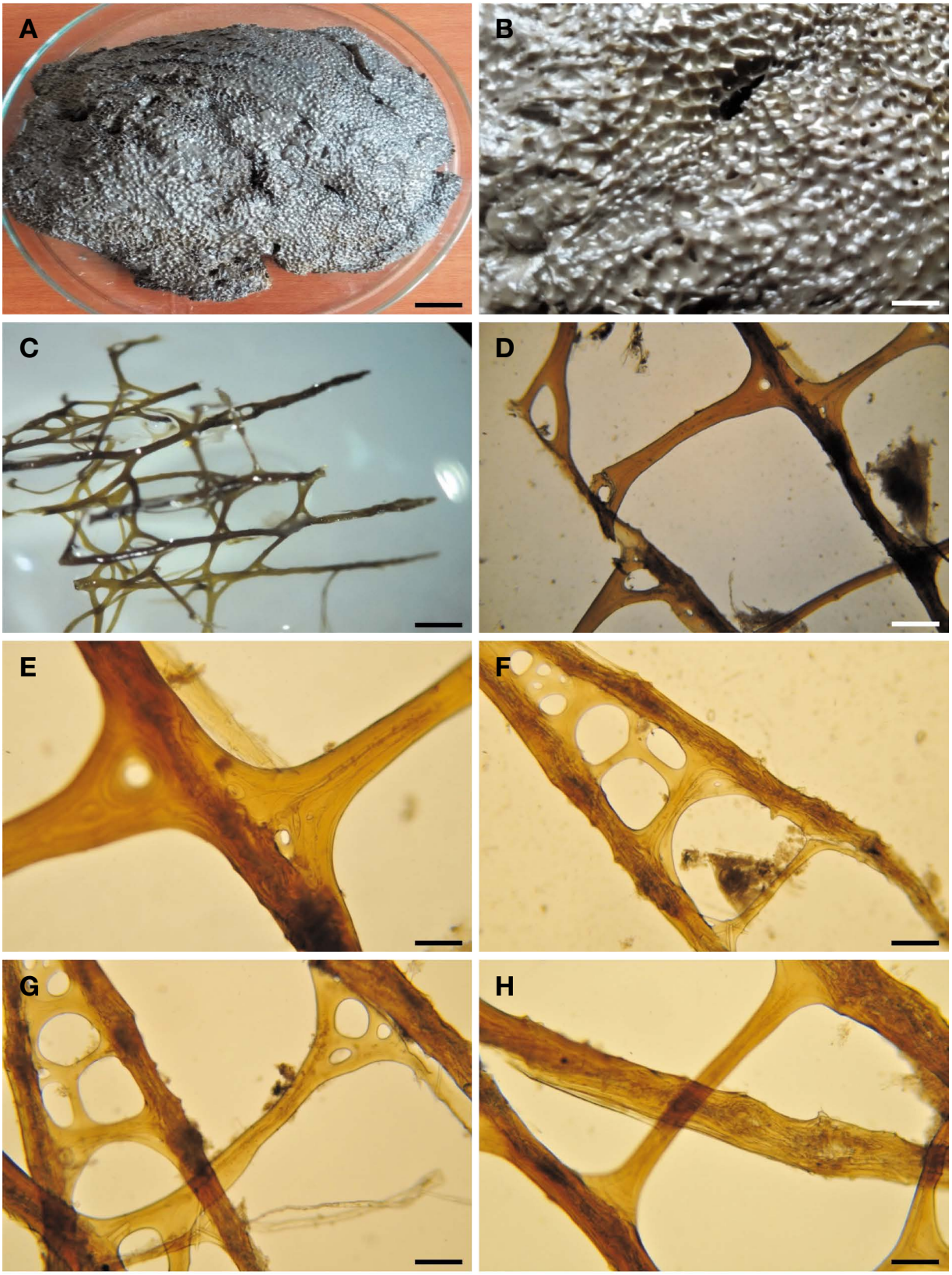

Fig. 10. *Smenospongia mureungensis* n. sp. A, external morphology; B, surface close up; C, skeletal structure under the dissecting microscope; D, simple skeletal structure; E, closed primary and secondary fibres; F, G, secondary fibres web near conules; H, bridged secondary fibres. Scale bars: A = 2 cm, B = 0.2 cm, C = 500 μm, D = 200 μm, E–H = 100 μm.

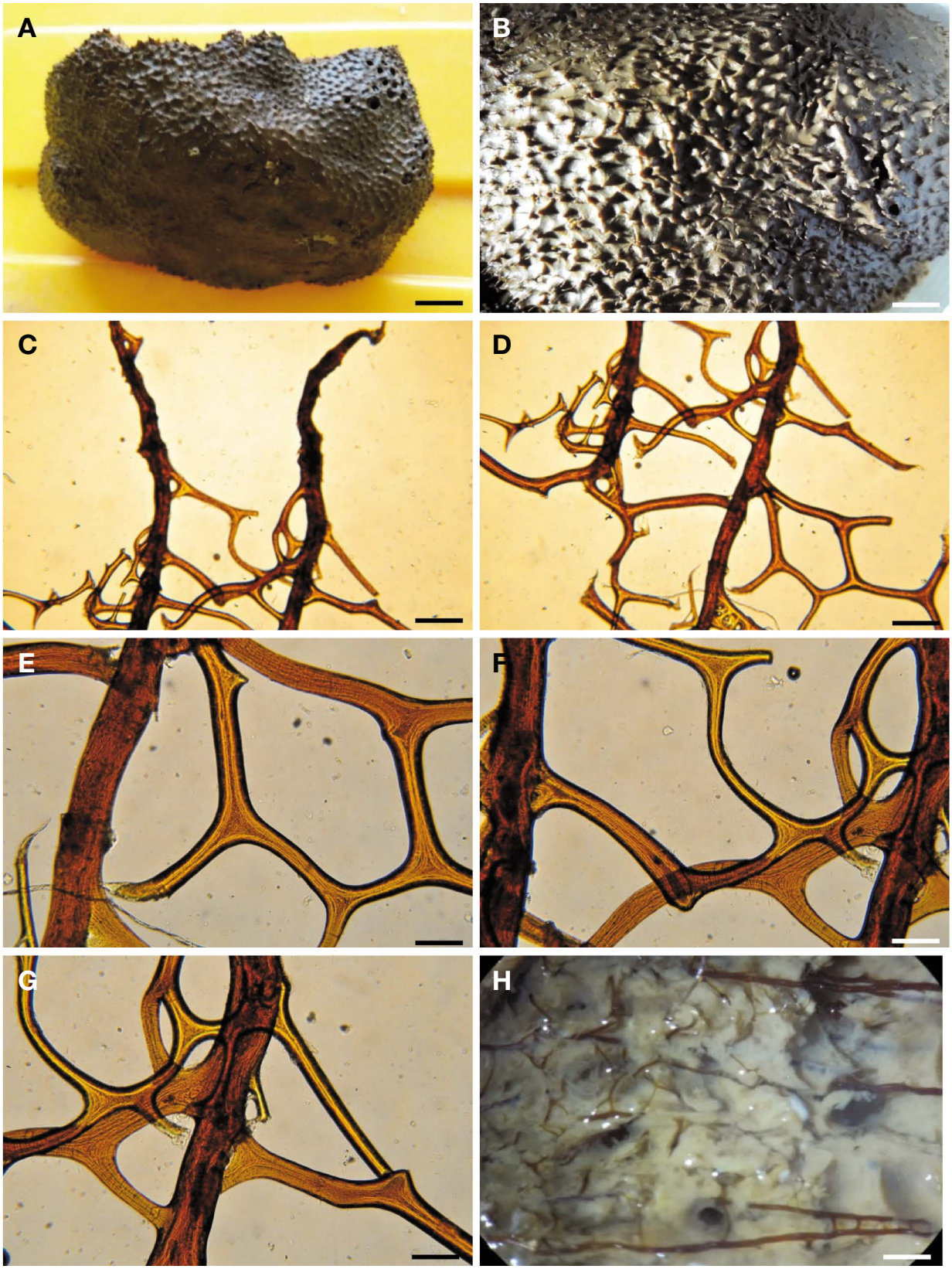

Fig. 11. *Smenospongia* coreana Lee and Sim, 2005. A, external morphology; B, surface close up; C, D, skeletal structure near conules; E–G, net form mesh secondary fibres between primary fibres; H, skeletal structure under the dissecting microscope. Scale bars: A = 2 cm, B = 0.2 cm, C, D = 200 μm, E–G = 100 μm, H = 500 μm.

skeletal fibres in *Sc. canus* n. sp. occurs out of surface, at the choanosome and sponge base. Near surface presents irregular skeletal fibres with three dimensions. *Scalarispongia subjiensis* n. sp. shows a regular pattern at the choanosome with three dimensions. Simple primary fibres of this species mostly show traces of coring with broken spicules but on rare occasions species cored with sands sparsely. In this study, we found that the pattern of primary fibres of genus *Scalarispongia* is very simple without fascicles and their diameter is mostly below 100 μm, except rare species have over 100 μm. Secondary fibres of this genus in our specimens are all clear without detritus, but *Sc. similis* (Thiele, 1905) shows cored with sands in secondary fibres. Secondary fibres of some new species have secondary web or divided mesh with two sections (Fig. 4E, F). *Scalarispongia viridis* and *Sc. subjiensis* have pseudo-tertiary fibres. Pseudo-tertiary fibres also occurs in *Spongia* (*Heterofibria*) *corallina* Kim and Sim, 2009 and *Sp.* (*H.*) *purpurea* Kim and Sim, 2009 which are not restricted to forming networks within a single mesh of the secondary fibres reticulum (Kim and Sim, 2009). Important characteristics of genus *Scalarispongia* are simple primary fibres without fascicles cored with detritus and ladder-like pattern of skeletal structure. Secondary fibres are clear and not cored with detritus. Sandes *et al.* (2016) had reported two *Scalarispongia* from Brazil, but we do not accepted them because secondary fibres of these brazilian species were cored with detritus and network not ladder form. For these reasons, we suggest reclassifying them to another genus.

The genus *Smenospongia* is characterized by a change of color to black upon collection and simple and thick fibres. The color of fibres is always dark brown like amber. Primary fibres of *Smenospongia coreana* are very simple and thick and makes it difficult to see cored detritus in fibres (Fig. 11E–G). Arrangement of secondary fibres in this species is very different from other new species of this genus.

Acknowledgements

This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of Republic of Korea (NIBR No. 201902204). Special thanks to Dr. Fazi Mofidi, former Environmental Supervisor, Department of Water and Power, Los Angeles, California, for her review of the manuscript.

References

Baar, R. 1904. Hornschwämme aus dem Pacific. Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896/97. Zoologische Jahrbücher Abteilung Systematik, Geographie und Biologie der Thiere 19:27-36.

Cook, S.deC. and P.R. Bergquist. 2000. Two new genera and five new species of the '*Cacospongia*' group (Porifera, Demospongiae, Dictyoceratida). Zoosystema 22(2):383-400.

Cook, S.deC. and P.R. Bergquist. 2002. Family Threctidae Bergquist, 1978. In: J.N.A. Hooper and R.W.M. Van Soest (eds.), Systema Porifera. A guide to the classification of sponges. Kluwer Academic/Plenum Publishers: New York, Boston, Dordrecht, London, Moscow. pp. 1028-1050.

De Laubenfels, M.W. 1934. New sponges from the Puerto Rican deep. Smithsonian Miscellaneous Collections 91(17):1-28.

De Laubenfels, M.W. 1954. The sponges of the West-Central Pacific. Oregon State Monographs. Studies in Zoology 7: i-x, 1-306, pls I-XII.

Desqueyroux-Faúndez, R. and R.W.M. Van Soest. 1997. Shallow water Demosponges of the Galápagos Islands. Revue suisse de Zoologie 104(2):379-467.

Duchassaing de Fonbressin, P. and G. Michelotti. 1864. Spongiaires de la mer Caraibe. Natuurkundige verhandelingen van de Hollandsche maatschappij der wetenschappen te Haarlem 21(2):1-124, pls I-XXV.

Helmy, T., E.H. Serehy, S.Z. Mohamed and R.W.M. Van Soest. 2004. Description and classification of dictyoceratid sponges from the northern Red Sea. Beaufortia 54(6):81-91.

Kim, H.R. and C.J. Sim. 2009. Two new *Spongia* species (Dictyoceratida: Spongiidae) from Korea. Animal Cells and Systems 13:141-145.

Lee, K.J. and C.J. Sim. 2005. A new sponge of the genus *Smenospongia* (Dictyoceratida: Thorectidae) from Gageodo Island, Korea. Integrative Biosciences 9(1):9-11.

Lee, K.J. and C.J. Sim. 2007. Four new species of dictyoceratid sponges (Demospongiae) from Korea. Integrative Biosciences 11(1):55-60.

Lévi, C. 1969. Spongiaires du Vema Seamount (Atlantique-Sud). Bulletin du Muséum National d'Histoire Naturelle 41(4):952-973.

Pulitzer-Finali, G. 1986. A collection of West Indian Demospongiae (Porifera). In appendix, a list of the Demospongiae hitherto recorded from the West Indies. Annali del Museo civico di storia naturale Giacomo Doria 86:65-216.

Pulitzer-Finali, G. and R. Pronzato. 1981. The Keratosa in a collection of Mediterranean sponges mainly from the Italian coasts. Annali del Museo civico di storia naturale Giacomo Doria 83:127-158.

Sandes, J., G. Muricy and U. Pinheiro. 2016. Thorectinae (Porifera: Demospongiae: Dictyoceratida) from Northeastern Brazil: two new species and transfer of *Scalarispongia cincta* (Boury-Esnault, 1973) to the genus *Thorecta* Lendenfeld, 1888. Zootaxa 4184(1):158-170.

Schmidt, O. 1862. Die Spongien des adriatischen Meeres. (Wilhelm Engelmann: Leipzig): i-viii, 1-88, pls 1-7.

Sim, C.J., K.J. Lee and Y.A. Kim. 2016. Twelve new species of two genera *Smenospongia* and *Cacospongia* (Demospongia: Dictyoceratida: Thorectidae) from Korea. Journal of Species Research 5(1):31-48.

Thiele, J. 1905. Die Kiesel-und Hornschwämme der Sammlung Plate. Zoologische Jahrbücher Supplement 6 (Fauna Chilensis III) 407-496, pls 27-33.

Wiedenmayer, F. 1977. Shallow-water sponges of the western Bahamas. Experientia Supplementum 28:1-287.

Submitted: April 6, 2020
Revised: April 30, 2020
Accepted: May 1, 2020