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SULCICHITON ANSEEUWI GEN. N. AND SP. N. (MOLLUSCA, POLYPLACOPHORA, ACANTHOCHITONIDAE) FROM THE TROPICAL WEST PACIFIC

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A new genus and species of the family Acanthochitonidae is described from tropical waters of the West Pacific. The new genus, unlike the other genera of the family, has 5 tegmentum areas (jugal, 2 pleural and 2 lateral) on the intermediate valves, vs. 3 areas (jugal and 2 pleurolateral), a common state in the family. In addition, the new genus has grooves with narrow partitions in the pleural areas. It also lacks pustules typical of the other genera of the family. Besides this, the new genus is characterized by significantly thickened cusps of major lateral teeth of the radula, which are divided with grooves. Lastly, the genus has only 3 gills on each side. Comparisons are made between the structure of the tegmentum of the new genus and two other genera, *Bassethullia* and *Pseudotonicia*, that also have grooves.

Keywords: chiton, taxonomy, new genus, new species, Spratly Islands, Pacific Ocean

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The family Acanthochitonidae Pilsbry 1893 is one of the most diverse chitonid families in the tropical waters of the World Ocean including the West Pacific. Of all the genera of the family Acanthochitonidae the genus *Acanthochitona* Gray 1821 is the most widely distributed in tropical and subtropical waters. According to World Register of Marine Species (WoRMS) 81 species of the genus *Acanthochitona* are now known. The genera *Notoplax* H. Adams 1862 and *Leptoplax* Dall 1882 have 41 and 11 species respectively. The remaining seven genera have fewer than ten species each (WoRMS). The most complete species composition of this family has been studied in Australia, Vietnam and Japan, where 38, 20 and 11 species are now known respectively (Iredale, Hull, 1925; Saito, 2000, 2017; Sirenko, 2012; Sirenko, Saito, 2017). Indonesia has 11 species (Sowerby, 1841; Nierstrasz, 1905; Schwabe, 2005, 2007) and in Philippines waters are 7 species (Carpenter in Pilsbry, 1892; Nierstrasz, 1905; Ang, 1967; Saito, 2006). It should be noted here that the latter two areas represent a part of the Coral Triangle with the highest species diversity of marine animals. A small number of chiton species may indicate that not only acanthochitonids, but other species of polyplacophoran fauna in those areas, are poorly studied. There are species in the family with a wide distribution, such as *Acanthochitona biformis* (Nierstrasz 1905), *Craspedochiton laqueatus* (Sowerby 1841), and new species, but most species can be classified as endemic.

Recently, due to the use of new methods of collecting benthic invertebrates, French colleagues (Bouchet, 2009; Bouchet et al., 2002) and the author (Sirenko, 2012) have caught several small specimens of quite unusual chitons off the Philippines, the Spratly Islands (Truong Sa), Vietnam in the South China Sea and Vanuatu. A careful study of these specimens showed that they belong to a new, yet undescribed, species of chiton with unusual features of tegmentum structure and radular teeth. The presence of 20 tufts of needles on the perinotum, as well as the slit formula (5/1/4), indicated that they belonged to the family Acanthochitonidae. However, there is no genus in this family in which species possess the same mosaic of unique morphological traits as the collected specimens. All known genera of this family have more or less developed pustules on the valves. The collected chitons do not have pustules, but show longitudinal grooves on the pleural areas, which are absent in all genera of the family Acanthochitonidae except for two. Moreover, in contrast to three areas (jugal and two pleuro-lateral) found in all other Acanthochitonidae species, the new chitons have five areas on the intermediate valves. Instead of two combined pleurolateral areas, there are two pleural and two narrow lateral areas. All morphological traits of the shell mentioned above, as well as an unusual head of the major lateral teeth of radula, provide a basis for describing a new genus.

Fig. 1. *Sulcichiton anseeuwi* gen. n. et sp. n. South China Sea, Spratly Islands, holotype (ZISP 2382) BL – 3.4 mm: Whole animal, dorsal view.

Sixteen studied specimens collected by the French expeditions Campagne PANGLAO 2003 near Philippines and SANTO 2006 near Vanuatu were kindly placed at my disposal by Dr. Philippe Bouchet (Muséum National d'Histoire Naturelle, Paris, France, MNHN). Two additional specimens were collected during the first expedition of the Joint Russian-Vietnamese tropical research and technology center in Spratly Islands in 2018.

Specimens selected for a scanning electron microscopy (SEM) study were boiled in 7% KOH for 5–7 minutes, and then boiled twice in fresh water or were treated with Sodium hypochlorite (NaOCl) with a control under microscope and then rinsed in fresh water. Also several valves (usually valves I, II, IV, V and VIII), half of the radula and a portion of the girdle were chosen for a Scanning Electron Microscope FEI SEM Quanta 250 scan. The remains of radulae and girdles were dried and put in Canada balsam for examination under a light microscope.

Class Polyplacophora Gray 1821

Subclass Neoloricata Bergenhayn 1955

Order Chitonida Thiele 1909

Superfamily Cryptoplacoidea H. & A. Adams 1858

Family Acanthochitonidae Pilsbry 1893

Genus ***Sulcichiton*** Sirenko gen. n.

Type species. *Sulcichiton anseeuwi* Sirenko sp. n.

Diagnosis. Tegmentum of intermediate valves with five areas: jugal, two pleural and two lateral. Pleural areas with 8–9 narrow, longitudinal, slightly curve, forwardly converging grooves. Head valve, lateral areas of intermediate valves and postmucronal area of tail valve covered with small granules. Girdle dorsally covered with small, flattened, distally rounded, oval spicules, among them larger spicules found. Twenty tufts of slightly bent needles around shell. Girdle with marginal fringe of long, straight, longitudinally ribbed, sharply pointed spines and large, flat, sharply pointed scales. Three gills in one side. Three thickened denticles of head of major lateral radula teeth with deep grooves between them.

Distinctive diagnosis. Five areas in tegmentum of intermediate valves (vs three areas in other genera), small granules in head valve, lateral areas of intermediate valves and in postmucronal area of tail valves (vs only pustules in other genera), grooves in pleural areas (vs no grooves in other genera except two ones), 3 gills on each side (vs 10 gills and more on each side in other genera), grooves between cusp in major lateral teeth of radula (no grooves between cusps in other genera).

Two genera, *Pseudotonicia* Ashby 1928 and *Bassethullia* Pilsbry 1928, are the only ones recorded for the Acanthochitonidae in which lateral and pleural areas possess grooves. However the grooves in these genera have a different structure than those in *Sulcichiton*. In the new genus grooves occupy the entire surface of the pleural area. In the *Pseudotonicia* the surface is formed by small grooves and triangular pits occupying only a part of the pleural and lateral areas. In the *Bassethullia* pleural and lateral areas are formed by ridges and grooves, often with pustules. Gowlett-Holmes (1991) considers that "the similarities between the two groups (*Bassethullia* and *Pseudotonicia*) may be attributable to convergent evolution towards a similar habitat rather than common ancestry". Apart from grooves, the three genera discussed have few common features. It may indicate that the similarities in tegmentum grooves development in these genera are convergent and do not reflect true homology. The habitat conditions of the new genus living on coral reefs are significantly different from those of the two abovementioned genera living in temperate waters, which may indicate the independent development of grooves in the new genus.

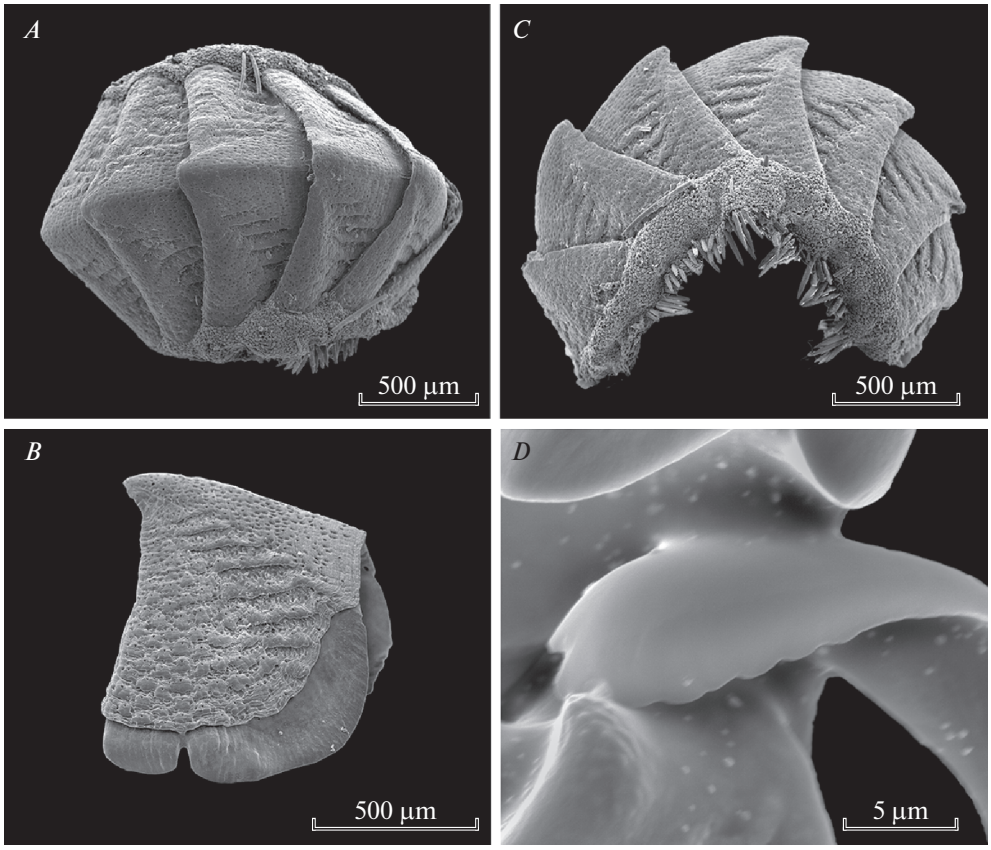

Fig. 2. *Sulcichiton anseeuwi* gen. n. et sp. n. Philippines, paratype (MNHN-IM-2013-49561) BL – 3.5 mm *A*, *B*), paratype (MNHN-IM-2013-49561) BL – 3.4 mm (*C*, *D*): *A* – whole animal, dorsal view; *B* – whole animal, lateral view; *C* – valve V, lateral view; *D* – heads of major lateral teeth and undulating edge of top of major uncinal radula tooth.

Distribution. The Pacific Ocean: Spratly Islands (Truong Sa), Vietnam, the South China Sea, off Philippines and Vanuatu, 9–90 m in depth.

Etymology. From the Latin sulcus, groove, referring to grooves in pleural areas.

Sulcichiton anseeuwi Sirenko sp. n.
(Figs 1–9)

Type material. Holotype and one paratype are kept in Zoological Institute Russian Academy of Sciences, St. Petersburg, Russia, (ZISP), other paratypes are in MNHN. Holotype (ZISP 2382) now disarticulated, consisting of SEM stub of valves I, II, V, VIII, part of perinotum and radula, mount of part of perinotum and radula and vial with other valves, and paratype (ZISP 2383).

Type locality. The South China Sea, Spratly Islands, 10°10′17″ N, 114°21′59.2″ E, 48–50 m depth.

Material examined. **Philippines**, PANGLAO 2004, stn L51–60, 9°37.7′ N, 123°47.9/48.1′ E, 62 m, 2 spms (MNHN-IM-2013-49561) BL 3.5 mm, 19–22.10.2003; PANGLAO 2004, stn L65–68, 9°29.9′ N, 123°55.1′ E, 55 m, 3 spms (MNHN-IM-2013-49557) BL 2.0–2.5 mm, 27.10.2003;. PANGLAO 2004, stn B7, 9°35.9′ N, 123°51.8′ E, 4–30 m, 6 paratypes (MNHN-IM-2013-49558) BL 1.5–2.5 mm, 05.06.2004; PANGLAO 2004, stn B19, 9°29.4′ N, 123°56.0′ E, 75–80 m, 2 paratypes (MNHN-IM-2013-67051) BL 2.5–3.4 mm, 21.06.2004; PANGLAO 2004, stn L41, 9°31.3′ N, 123°41.2′ E, 90–100 m, 1 spm (MNHN-IM-2013-49559) BL 1.5 mm, 01.07.2004; SANTO 2006, **Vanuatu**, stn EP39, 15°33.6′/33.7′ S, 167°16.3′/16.5′ E, 75–80 m, 1 paratype (MNHN-IM-2007-32003) BL 3.0 mm, 17.10.2006; **South China Sea, Spratly Islands**, sample 22, SCUBA, 10°10′17″ N, 114°21′59.2″ E, 6–9 m, holotype (ZISP 2382) BL 3.4 mm, 04.12.2018, leg. B. Sirenko; sample 23, SCUBA, 10°10′17″ N, 114°21′59.2″ E, 48–50 m, paratype (ZISP 2383) BL 3.0 mm, 05.12.2018, leg. B. Sirenko.

Description. Holotype body length (BL) 3.4 mm. Shell elongate-oval (Fig. 7), highly elevated (elevation ratio in valve V 0.46). Valves carinated, beaked, side slopes straight. Color of tegmentum creamy white with light brown streak in pleural areas, valve III is monochrome reddish.

Head valve semicircular, posterior margin V-shaped; anterior slope straight; structured with small, weakly

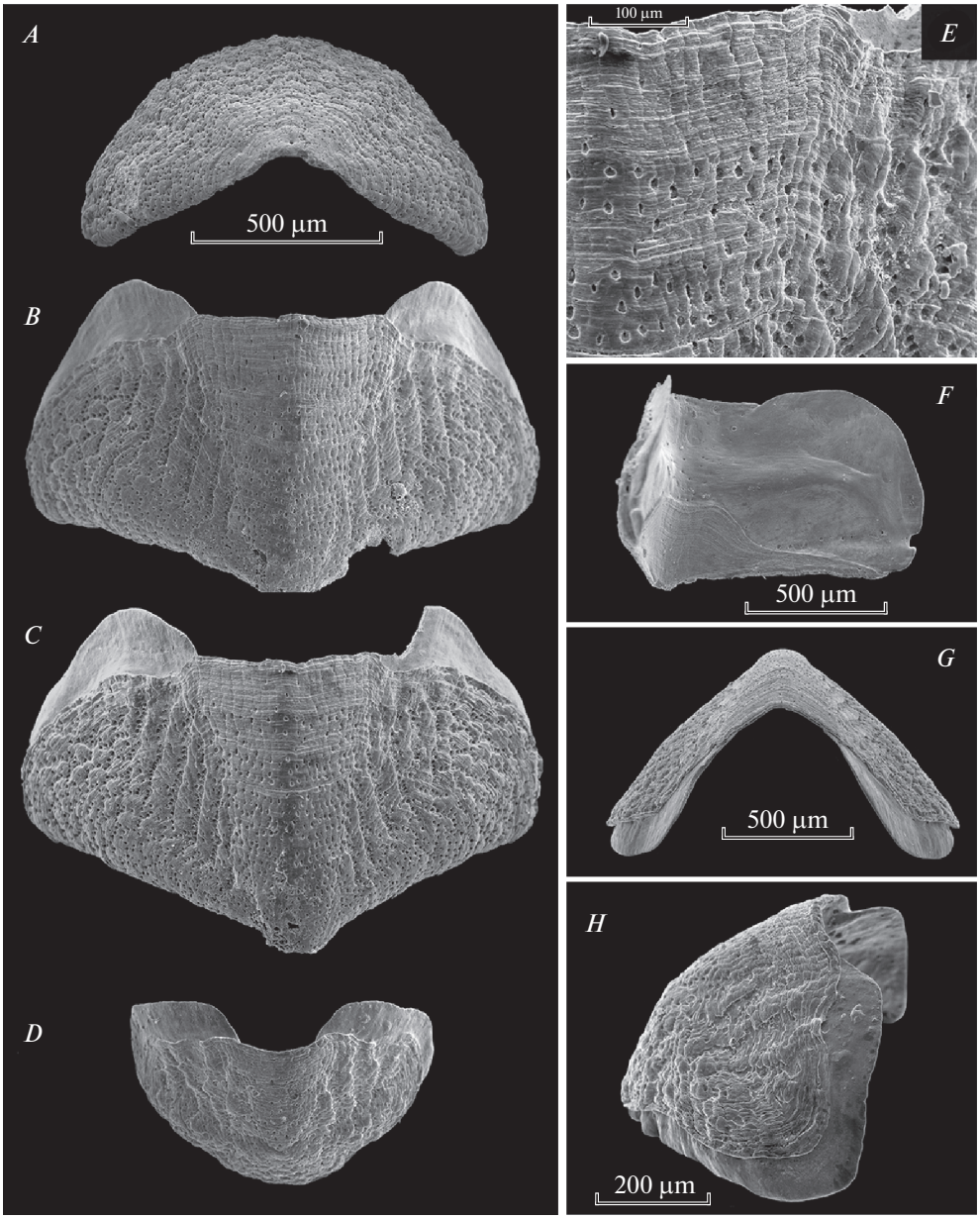

Fig. 3. *Sulcichiton anseeuwi* gen. n. et sp. n. South China Sea, Spratly Islands, holotype (ZISP 2382) BL – 3.4 mm: *A* – valve I, dorsal view; *B* – valve II, dorsal view; *C* – valve V, dorsal view; *D* – valve VIII, dorsal view; *E* – valve V, tegmentum sculpture in jugal and pleural areas; *F*– valve IV, ventral view; *G* – valve V, rostral view; *H* – valve VIII, lateral view.

expressed, flattened granules. Intermediate valves roughly trapezoidal in outline, anterior margin straight between apophyses, then there is a small notch and a convex front edge of pleural area, hind margin slightly concave at both sides of beak; jugum wide wedge-shaped, with wavy side. Areas of intermediate valve differ from each other only in sculpture. Pleural areas structured with 8–9 grooves, lateral areas formed like head valve and jugal area smooth. Longitudinal grooves of pleural areas shallow, slightly curve, forwardly converging. Tail valve much smaller than head valve, trapezoidal, anterior margin concave in jugal area, mucro posterior, antemucronal and postmucronal slopes slightly convex, pleural areas sculptured like pleural areas of intermediate valves, and postmucronal area like head valve and lateral areas.

Aesthete pores arranged sinuously-circularly in head valve, lateral areas of intermediate valve and in postmucronal area of tail valve, in longitudinal rows in jugal area, and mainly in grooves in pleural areas of intermediate valves. Pores tear- or oval-shaped. Their size varies from 6–13 μm.

Articulamentum rather thin, translucent throughout, with transverse callus in middle of valves, a few

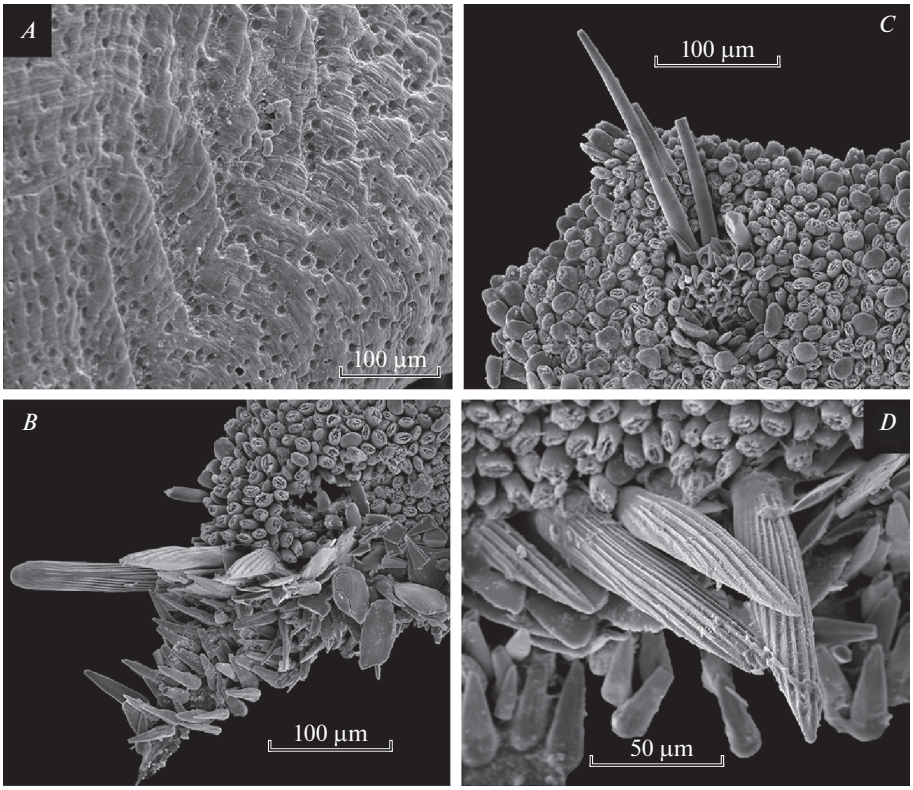

Fig. 4. *Sulcichiton anseeuwi* gen. n. et sp. n. South China Sea, Spratly Islands, holotype (ZISP 2382) BL – 3.4 mm: *A* – valve V, tegmentum sculpture in jugal, pleural and lateral areas; *B*, *D* – dorsal spicules, marginal spines and scales and ventral spicules; *C* – dorsal spicules and tuft of needles and scales.

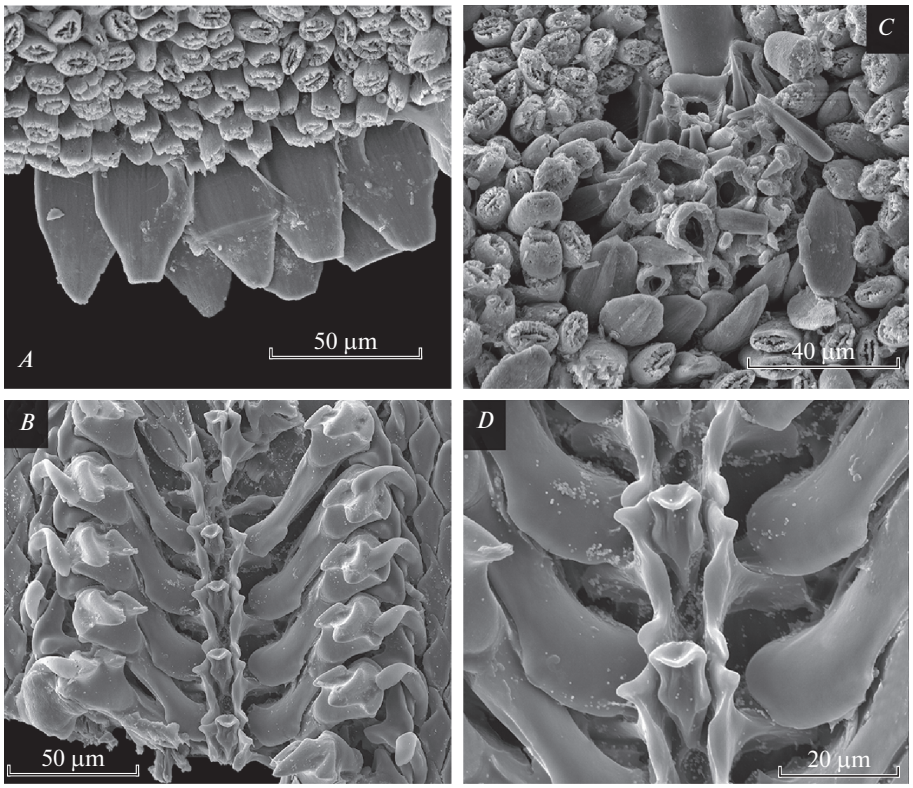

Fig. 5. *Sulcichiton anseeuwi* gen. n. et sp. n. South China Sea, Spratly Islands, holotype (ZISP 2382) BL – 3.4 mm: *A* – dorsal spicules and marginal scales; *B* – part of radula; *C* – needle of tuft, chitinous cups, scales and dorsal spicules; *D* – central part of radula.

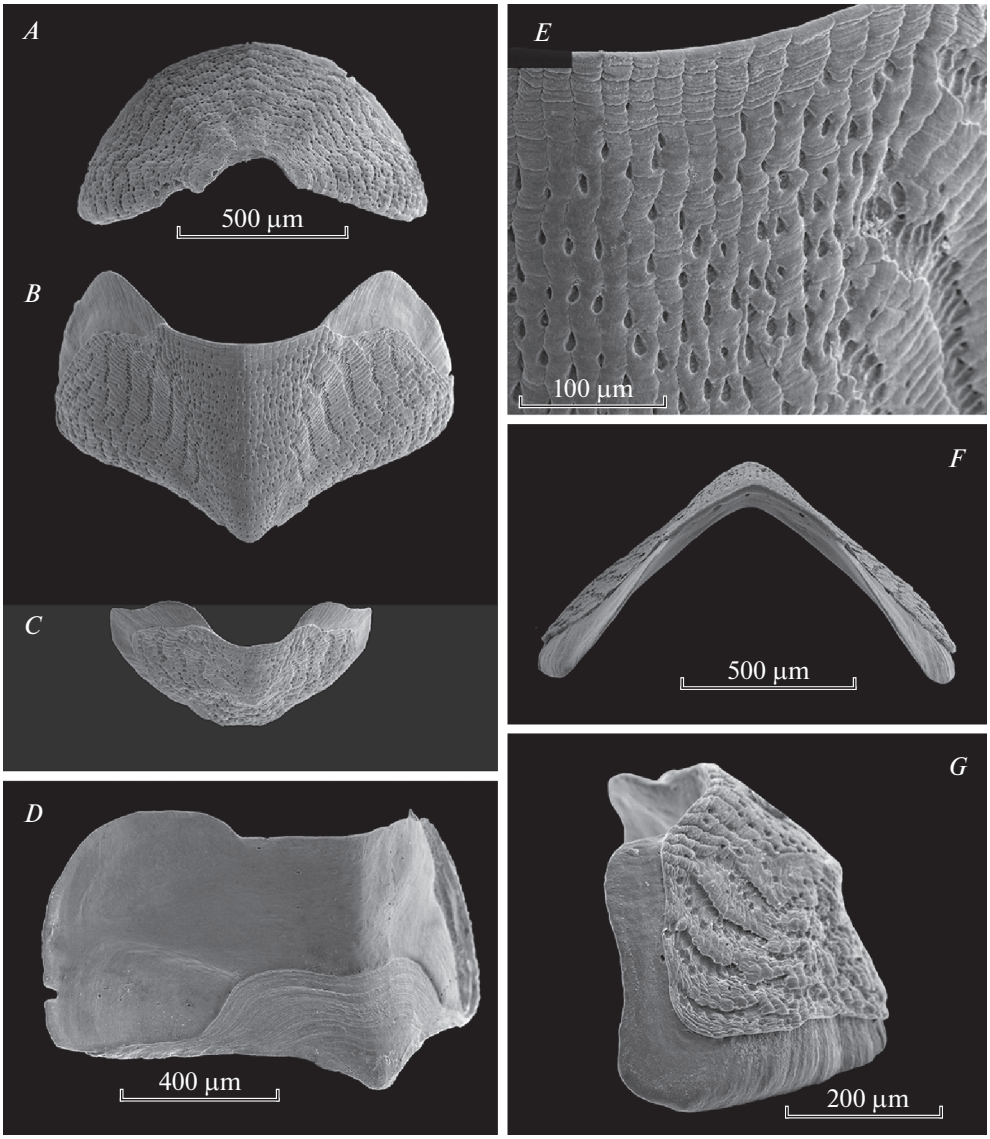

Fig. 6. *Sulcichiton anseeuwi* gen. n. et sp. n. Vanuatu, paratype (MNHN-IM-2007-32003) BL – 3.0 mm: *A* – valve I, dorsal view; *B* – valve V, dorsal view; *C* – valve VIII, dorsal view; *D*– valve V, ventral view; *E* – valve V, tegmentum sculpture in jugal and pleural areas; *F* – valve V, rostral view; *G* – valve VIII, lateral view.

pores under jugum. Apophyses triangular in intermediate valves and trapezoidal in tail valve. Slit formula 5/1/4. Slit rays clearly indicated by rows of rare pores.

Girdle narrow, white around of sutural tufts, bended with brown streaks between tufts. Dorsal side of girdle beset with minute 25 × 11 μm, oval in profile smooth spicules with destroyed top alternating with rare, larger, up to 32 × 17 μm round-top spicules; 20 tufts of needles around shell, each tuft with about 10 long, straight or slightly bent smooth needles 230–500 × 19–20 μm rising from a chitinous cup; tufts surrounded by flat, sharply pointed, smooth scales 31 × × 15 μm with one longitudinal rib. There is a marginal fringe of longitudinally ribbed, feather-like sculptured spines 118 × 24 μm and two rows of flat, sharply pointed, smooth, large, scales 78 × 35 μm. Ventral spicules narrow, peaky, small 35–40 × 11 μm.

Radula of the holotype 0.7 mm long, with 28 transverse rows of mature teeth. Central tooth elongate tulip-shaped, with central cavity in top, thick semicircular blade and small keel at basal half; first lateral tooth with thickened antero-dorsal corner; major lateral tooth with tricuspid head; cusps pointed, somewhat thickened; central cusp longer than others; there are grooves between cusps, major uncinal teeth with undulating edge of top.

Holotype has 3 gills on each side. The dry paratype (MNHN-IM-2013-67051) with BL 3.5 mm from Philippines has 2 or 3 gills on each side (It was difficult to see), arranged between valve VII and valve VIII.

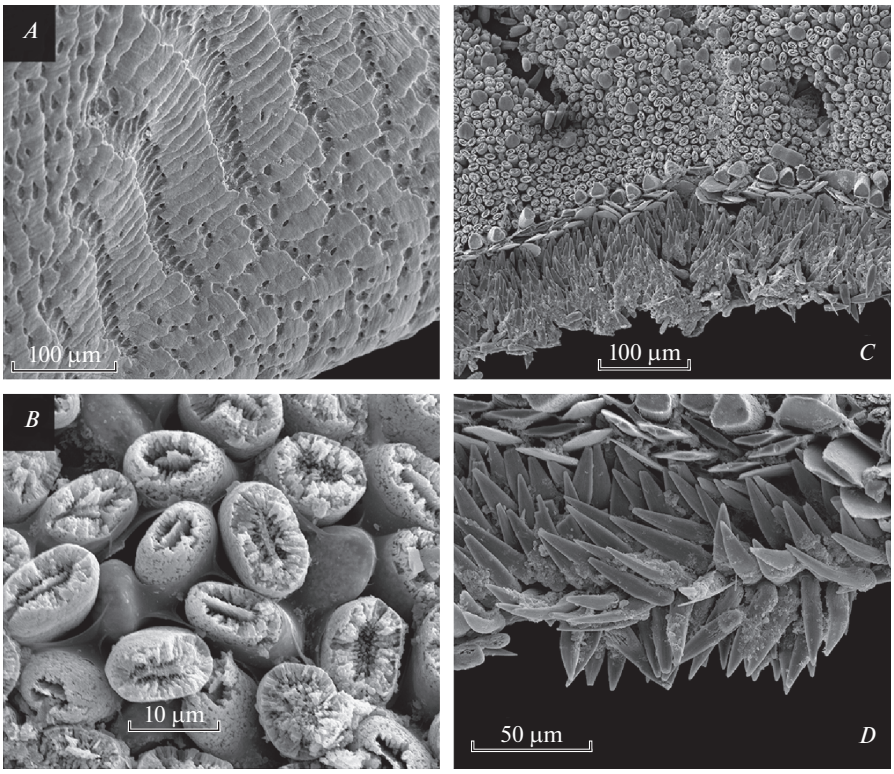

Fig. 7. *Sulcichiton anseeuwi* gen. n. et sp. n. Vanuatu, paratype (MNHN-IM-2007-32003) BL – 3.0 mm: *A* – valve V, tegmentum sculpture in jugal, pleural and lateral areas; *B* – dorsal spicules; *C* – dorsal spicules, marginal spines and scales and ventral spicules; *D* – marginal spines and scales and ventral spicules.

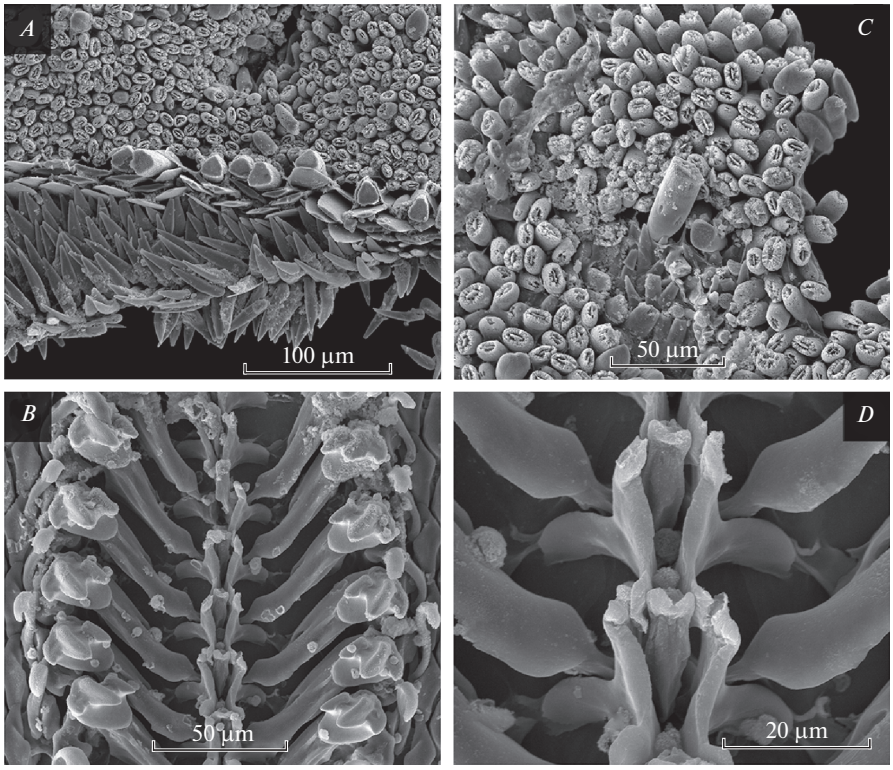

Fig. 8. *Sulcichiton anseeuwi* gen. n. et sp. n. Vanuatu, paratype (MNHN-IM-2007-32003) BL – 3.0 mm: *A* – dorsal spicules, marginal spines and scales and ventral spicules; *B* – part of radula; *C* – dorsal spicules and two fragments of needles of tuft; *D* – central and first lateral teeth of radula.

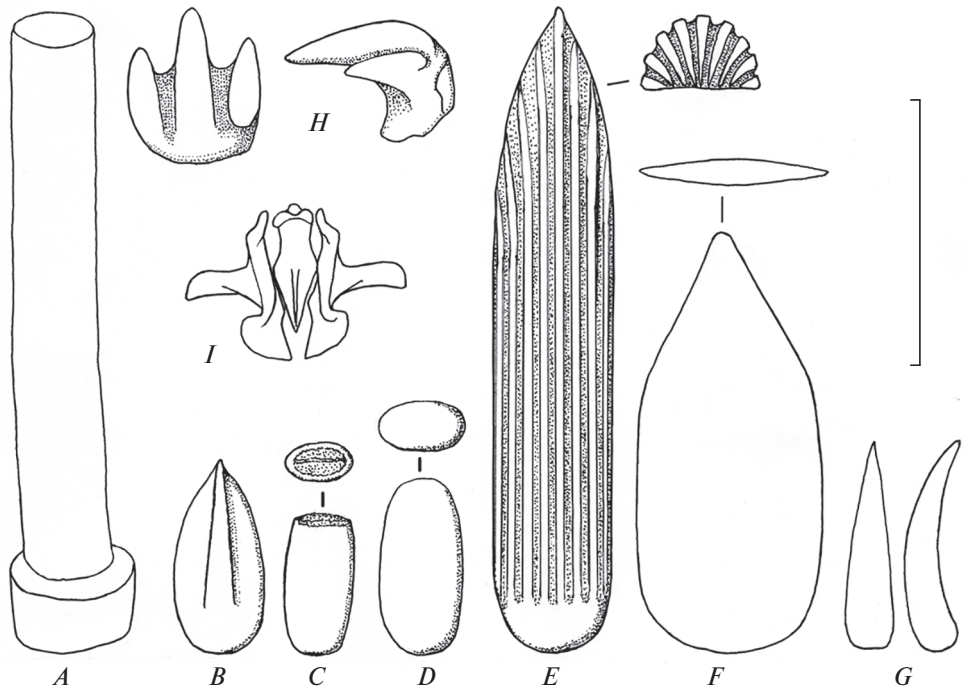

Fig. 9. *Sulcichiton anseeuwi* gen. n. et sp. n. South China Sea, Spratly Islands, holotype (ZISP 2382) BL – 3.4 mm: *A* –tuft needles rising from a chitinous cup; *B* – scale around tuft of needles; *C*, *D* – dorsal spicules; *E* – marginal feather-like sculptured spine; *F* – marginal scale; *G* – ventral spicules; *H* – heads of major lateral teeth of radula; *I* – central and first lateral teeth; Scale bar: 50 μm.

Other specimens was dry, curved and it was not possible to count their gills.

All the studied paratypes collected from the Philippines, Vanuatu and the Spratly Islands have features that do not differ from those of the holotype. The only difference was the thin partitions at the bottom of the tegmentum grooves in a small paratype from Vanuatu, which can be explained by age variability.

Distinctive diagnosis. The new species is similar to several species of the genus *Acanthochitona* (*A. saitoi* Sirenko 2012, *A. savinkini* Sirenko 2012, *A. lanae* Sirenko et Saito 2017, *A. nigra* Sirenko et Saito 2017, and *A. ostreaphila* Sirenko et Saito 2017) from studied areas by having small dorsal spicules in girdle, but differs from them by having unique sculpture of tegmentum, in the presence of a small number of gills, and by the absence of pustules on tegmentum.

Distribution. Spratly Islands (Truong Sa), Vietnam in South China Sea (9–48 m), off Philippines (30–90 m) and Vanuatu (75–80 m).

Etymology. Named after my colleague Bruno Anseeuw (Royal Belgium Institute of Natural Sciences, Merelbeke, Belgium), who first made the assumption that this species belongs to a new genus.

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SULCICHITON ANSEEUWI GEN. N. ET SP. N. (MOLLUSCA, POLYPLACOPHORA, ACANTHOCHITONIDAE) ИЗ ТРОПИЧЕСКИХ ВОД ЗАПАДНОЙ ЧАСТИ ТИХОГО ОКЕАНА

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Описаны новый род *Sulcichiton* gen. n. и новый вид *S. anseeuwi* sp. n. семейства Acanthochitonidae из тропических вод западной части Тихого океана. Новый род, в отличие от других родов семейства, имеет 5 полей тегментума на промежуточных щитках (югальное, 2 плевральных и 2 латеральных), а не 3 (югальное и 2 плевро-латеральных) как обычно в этом семействе. Новый род имеет на плевральных полях продольные желобки с узкими перегородками. У нового рода отсутствуют пустулы на тегментуме, которые являются типичными для других родов семейства. Кроме того, у нового рода зубцы имеют значительные утолщения наконечника крючковой пластинки радулы и отделены друг от друга желобками. Наконец, новый род имеет только 3 жабры на каждой стороне. Проведены сравнения между скульптурой тегментума нового рода и двух других родов *Bassethulia* и *Pseudotonicia*, которые также имеют желобки на тегментуме.

Ключевые слова: хитон, таксономия, новый род, новый вид, о-ва Спратли, Тихий океан