



Original Article

The genus *Pycnoclavella* (Ascidiacea: Aplousobranchia: Clavelinidae) new to Korea with two new records

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ABSTRACT

Two ascidians, *Pycnoclavella atlantica* Pérez-Portela, Duran & Turon, 2007 and *Pycnoclavella stolonialis* Pérez-Portela, Goodwin, Picton & Turon, 2010, are newly recorded from Korean waters. These present specimens were collected from subtidal zones of Jejudo Island. The genus *Pycnoclavella* Garstang, 1891 is also reported for the first time in Korean fauna. This study provides descriptions and ecological photographs of these species.

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Introduction

There are four genera [*Clavelina* Savigny, 1816; *Euclavella* Kott, 1990; *Nephtheis* Gould, 1856; and *Pycnoclavella* Garstang, 1891] in the family Clavelinidae Forbes and Hanley, 1848 (Shenkar et al. 2022). Traditionally, the genus *Pycnoclavella* had been included within the family Clavelinidae before 1990. The genus *Pycnoclavella* had been moved from Clavelinidae to a new family Pycnoclavellidae (Kott 1990). This new family could be distinguished from Clavelinidae by its small zooids, a replicative process involving horizontal division across the abdomen (demonstrate by Trason 1963), smaller gonads, a limited number of embryos, unique larval tubular adhesive organs and a reduced otolith (Kott 1990, 2003, 2005). However, argument has persisted over the validity of the genus *Pycnoclavella* and the family Pycnoclavellidae (Monniot 1988; Monniot and Monniot 1996; Monniot 1997; Monniot and Monniot 2001; Kott 2003, 2005). The phylogenetic study of Clavelinidae and Pycnoclavellidae has shown that *Pycnoclavella* and *Clavelina* appear in distinct clades but form a monophyletic group relative to representatives of the main families [Didemnidae Giard, 1872; Holozoidae Berrill, 1950; Polycitoridae Michaelsen, 1904; and Polyclinidae Milne Edwards, 1841] of the order Aplousobranchia

(Pérez-Portela et al. 2008). Thus the genus *Pycnoclavella* was valid and has belonged to the family Clavelinidae again.

To date, 24 valid species have been accepted in the genus *Pycnoclavella* worldwide (Shenkar et al. 2022). This genus is widely distributed in the Atlantic, Indian, Pacific Ocean, and Mediterranean Sea (Garstang 1891; Julin 1904; Sluiter 1904; Berrill and Abbott 1949; Millar 1953; Trason 1963; Monniot 1988; Kott 1990; Brunetti 1991; Goodbody 1996; Monniot and Monniot 1996; Monniot 1997; Monniot and Monniot 2001; Kott 2003, 2005; Pérez-Portela et al. 2007; Pérez-Portela and Turon 2008; Pérez-Portela et al. 2010). There were seven species [*Pycnoclavella detorta* (Sluiter, 1904); *P. diminuta* (Kott, 1957); *P. flava* (Monniot F, 1988); *P. kottae* Millar, 1960; *P. minuta* Millar, 1953; *P. stanleyi* Berrill & Abbott, 1949; *P. tabella* Kott, 1990] in the Pacific Ocean. Most of these species are distributed in the southern Pacific Ocean (Sluiter 1904; Berrill and Abbott 1949; Millar 1953; Kott 1957; Monniot 1988; Kott 1990; Monniot and Monniot 2001; Kott 2003). There is little research on the genus *Pycnoclavella* in the northern Pacific Ocean. In this study, the genus *Pycnoclavella* is reported for the first time in Korean fauna with two new records.

Material and methods

The specimens of *Pycnoclavella atlantica* and *Pycnoclavella stolonialis* examined in this study were collected from subtidal zones of Munseom Island, Jejudo Island, South Korea by SCUBA diving. After collecting, all living specimens were transferred into seawater in containers and then anesthetized with menthol powder for 5–6

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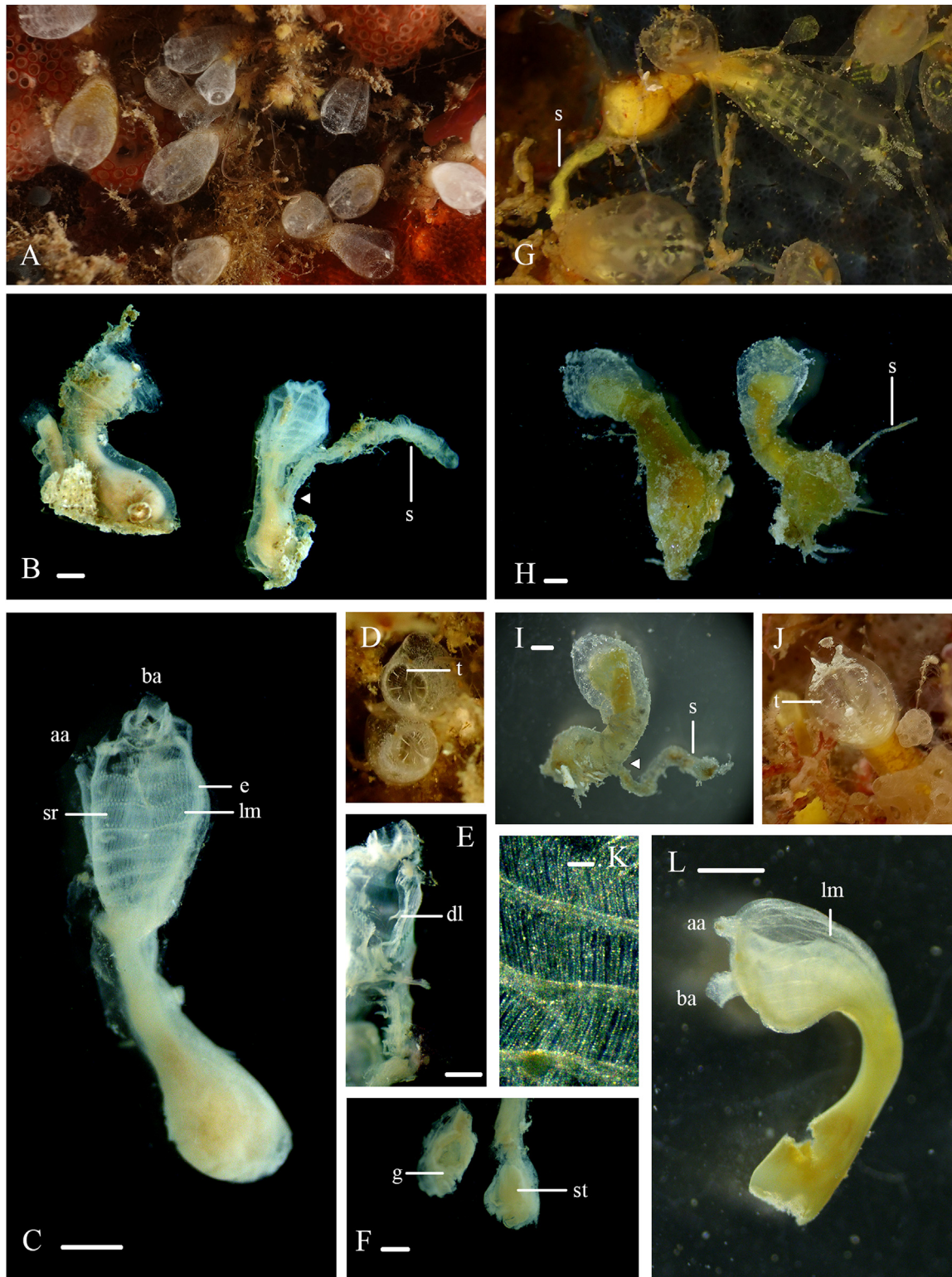


Figure 1. *Pycnoclavella atlantica* Pérez-Portela, Duran & Turon (A–F) and *P. stolonialis* Pérez-Portela, Goodwin, Picton & Turon (G–L): A, Colony in living; B, Zooid in preservative; C, Zooid with test removed; D, Tentacle in branchial aperture; E, Dorsal languet in thorax; F, Abdomen; G, Colony in living; H–I, Zooid in preservative; J, Tentacle in branchial aperture; K, Stigmata row; L, Zooid with test removed. aa, atrial aperture; ba, branchial aperture; dl, dorsal languet; e, endostyle; g, gonad; lm, longitudinal muscle; s, stolon; sr, stigmata row; st, stomach; t, tentacle. <scale bar: 10 mm (B, C, F, H, I, L); 5 mm (E); 1 mm (K)>

hours. Anesthetized specimens were fixed in 4% buffered formalin. For identification, each specimen was examined for morphological characteristics under a stereomicroscope SMZ 745T (Nikon, Tokyo, Japan). The images of these collected living specimens were taken

with a digital camera Tough TG-6 (Olympus, Tokyo, Japan) prior to fixation. The images of fixed specimens were taken with a stereomicroscope SMZ745T equipped with a camera UHCCD05000KPA (Touptek Photonics, Zhejiang, China). The size of zooid was

measured using an image analyzer Toupview 3.7 (Touptek Photonics) and a ruler. Specimens examined in this study were deposited at the National Marine Biodiversity Institute in Korea (MABIK IV00172831, IV00172832) and the Natural History Museum of Ewha Womans University in Korea (EWNHMAS3870, 3871, 4077, 4218, 4318, 4322, 4337, 4338).

Systematic accounts

Class Ascidiacea Blainville, 1824

Order Aplousobranchia Lahille, 1886

Family Clavelinidae Forbes & Hanley, 1848

Diagnosis. Small zooids, a replicative process involving horizontal division across the abdomen, smaller gonads, a limited number of embryos, two or three larval tubular adhesive organs

Genus *Pycnoclavella* Garstang, 1891 (꼬마곤봉멍게속)

Archiascidia **Julin, 1904**: 489. TS: *Archiascidia neapolitana* **Julin, 1904**.

Pycnoclavella **Garstang, 1891**: 265. TS: *Pycnoclavella aurilucens* **Garstang, 1891**.

***Pycnoclavella atlantica* Pérez-Portela, Duran & Turon, 2007** (안개곤봉멍게)

(Figure 1A–F)

Pycnoclavella atlantica Pérez-Portela, Duran and Turon, 2007: 195. TL: Atlantic Ocean, Spain. Depository: Center of Biodiversity Resources of the University of Barcelona.; Pérez-Portela et al. 2010: 58.

Colonies are found in the cluster of hydrozoans, colonial ascidians, bryozoans, algae, small shell's fragment, and other detritus. Colony of *Pycnoclavella atlantica* sometimes mixed with other unreported *Pycnoclavella* species from Korea. Colonies consist of several to dozens of zooids. Thorax region in living zooid is whitish because white pigments diffused on transparent test (Figure 1A). Abdomen region is yellowish-white, semi-translucent, and attached fragments of other organisms or debris frequently. Zooids are connected by stolon right next to or at a distance or by the adherence of the posterior part of abdominal test. Stolon is about 0.6 mm thick. Replicative process involves horizontal division across the abdomen (Figure 1B).

Zooids are very small. In preserved specimens, zooids are about 8.3 mm long on average. Thorax is about 3.4 mm long and abdomen is about 4.9 mm long on average (Figure 1C). The length of thorax is about twice as long as the widest width of thorax in living zooids. Zooidal test is fragile, while the test of stalk is somewhat tough. Strong muscles 9–10 on thoracic test of zooid and extend along the length of thorax. Branchial apertures are open at the upper terminal of thorax. Atrial aperture obliquely opens at the top of thorax. Both apertures are smooth rimmed. Tentacles in branchial apertures are simple, 10–12 and alternately large and small (Figure 1D). Neural gland opening is simple. Dorsal languet is a fine-pointed tongue shape (Figure 1E). Seven stigmata rows of 19–29 stigmata. Transverse vessels are provided each with developed membrane. Esophageal neck is more or less long, narrow, and occupies about two-thirds of the total length of abdomen in zooid. Stomach is situated at the posterior end of descending limb of gut loop. Stomach is pear-shaped with a smooth surface. Thick rectum forms ascending limb of gut loop. Anus opens at level as high as posterior lowest stigmata row. Atrial apertures have smooth border. Small gonad in gut loop is posterior to stomach and consists of male follicles and few oocytes. Male follicles cover posterior part of gut loop (Figure 1F). One embryo is in the lower part of peribranchial cavity and larvae absent in specimens collected in May.

Material examined. [South Korea] 2 colonies, Munseom (33°13'39"N, 126°34'10"E), Seogwipo-si, Jeju Island, 13 v 2021 (SW Park and SH Cho), MABIK IV00172831, EWNHMAS3870; 1 colony, Munseom

(33°13'40"N, 126°34'36"E), Seogwipo-si, Jeju Island, 3 v 2021 (SW Park and SH Cho), EWNHMAS3871; 1 colony, Munseom (33°13'40"N, 126°34'36"E), Seogwipo-si, Jeju Island, 9 v 2022 (SW Park and SH Cho), EWNHMAS4322.

Distribution. Korea (Jeju Island), Spain (Ria de Ferrol), Portugal (São Vicente).

Remarks. This species is easily recognizable by the white pigments diffused on transparent test in living. The present specimens are distinctly different from *Pycnoclavella* species is reported from the northern Pacific Ocean. *Pycnoclavella detorta*, which is distributed in Indonesia and Philippine, can be distinguished by the situation of atrial aperture and the disposition of the thoracic muscles (Sluiter 1904; Millar 1953; Monniot and Monniot 2001). *Pycnoclavella stanleyi*, which was reported from California, can be distinguished by having the matrix of colony covered with sand grains, zooids are partially embedded in the common test, and bright orange color in the emergent thoracic region (Berrill and Abbott 1949). The present specimens resemble *Pycnoclavella communis* Pérez-Portela, Duran & Turon, 2007 in the thorax length, numbers of stigmata rows, and number of thoracic muscles. However, they differ in the colony formation and the pigment distribution. In the present species, zooids connected by stolon and white pigments diffused on test. However, in *P. communis*, proximal part of zooids embedded in common basal test and pigments diffused, with concentrations on the endostyle and the transverse membrane of branchial sac (Pérez-Portela et al. 2007).

***Pycnoclavella stolonialis* Pérez-Portela, Goodwin, Picton & Turon, 2010** (흰얼룩곤봉멍게)

(Figure 1G–L)

Pycnoclavella stolonialis Pérez-Portela et al. 2010: 551. TL: Atlantic Ocean, Northern Ireland. Depository: Ulster Museum.

Colonies live on other ascidians (*Herdmania momus*, *Didemnum* sp.), annelid's tube, porifera, hydrozoa, and algae. Several to dozens of zooids consist of colony. Zooids are connected to each other by thick tunic stolon or by slender and elongated stolon (Figure 1G–I). Replicative process involves horizontal division across the abdomen (Figure 1I). In living zooids, thorax is transparent with white-yellowish and cross-shaped patch between branchial apertures and atrial aperture (Figure 1J, 1L). Abdomen is semi-translucent, somewhat tough, and other organism or debris attached.

Zooids are very small. In preserved specimens, zooids severely contracted and about 4.6–8.9 mm long. Thorax is 1.9–3.6 mm long and abdomen is 3.2–6.3 mm long according to contraction conditions (Figure 1H). Thorax is shorter than abdomen in both extended and contracted zooids. The length of thorax is about twice as long as the widest width of thorax in living zooids. Branchial apertures are open at upper terminal of thorax. Atrial aperture is obliquely open at the top of thorax. Both apertures are smooth rimmed. Longitudinal muscles 8–9, along the length of thorax and some split into two branches (Figure 1L). Simple tentacles are about 10–12 in branchial apertures (Figure 1J). Neural gland opening is simple and broad C-shaped. Dorsal languet is fine-pointed tongue shape. Six to eight stigmata rows of 12–16 stigmata. Stigmata long oval slit (Figure 1K). Transverse vessels are provided each with rather narrow membrane. Esophageal neck is long, narrow, and occupy about half of abdomen's length in preserved zooid. Pear-shaped stomach has smooth surface, and occurs at the posterior end of descending limb of gut loop. Mid-intestine is situated in the bottom end of abdomen. Thick rectum forms ascending limb of gut loop. Anus opens at level as high as posterior lowest stigmata row. Atrial apertures have smooth border. Gonads comprise few oocytes and male follicles in gut loop posterior to stomach. Male follicles spill out over posterior end of gut loop. Embryo and larvae are absent in collections of May and July.

Material examined. [South Korea] 2 colonies, Munseom (33°13'40"N, 126°34'07"E), Seogwipo-si, Jejudo Island, 16 viii 2021 (SW Park and SH Cho), MABIK IV00172832, EWNHMAS4077; 1 colony, Munseom (33°13'45"N, 126°30'60"E), Seogwipo-si, Jejudo Island, 9 v 2022 (SW Park and SH Cho), EWNHMAS 4318.

Distribution. Korea (Jejudo Island), Ireland (Kerry, Rathlin Island), Scotland (Maidens).

Remarks. This species is easily recognizable by the white patch on the upper part of zooids in living. The white-yellowish and cross-shaped patch on the top of the living zooids was observed in the ecological photograph taken during collection. This species is different from *P. detorta* and *P. stanleyi*, which reported from the northern Pacific Ocean. Characteristically, *P. detorta* has detorted thorax, and *P. stanleyi* has bright yellow thorax and common test (Sluiter 1904; Berrill and Abbott 1949; Millar 1953; Monniot and Monniot 2001). The present specimens in preservation resemble *Pycnoclavella nana* (Lahille 1890) in zooid size and numbers of stigmata rows. However, the present specimen with stolon different from *P. nana* which has basal test mass. This species is similar to *P. atlantica* in stolonial colony and incubation in peribranchial cavity. However, the latter can be distinguished by white pigments diffusion, nine to ten muscles in thoracic test, and otolith in larvae (Pérez-Portela et al. 2007, 2010).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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