

The external morphology of the gill of *Patella caerulea* L. (Mollusca: Gastropoda)

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Abstract: Gross morphology of the gill was studied using a scanning electron microscope (SEM) in order to associate it with its function in genus *Patella*. Secondary gills consisted of a single layer of gill folds, which appear mostly as triangular leaflets in scanning electron micrographs. The lamellae showed a prominent thickening on the free margin and horizontal swellings, which bear a series of ciliary structures on the frontal surface, as well as disperse bunches. They differed from the discocilia and, because chemoreception has been attributed to them in the absence of an osphradium, they are thought to contribute to the primary respiratory role of the gills. These morphological characteristics are to be researched further, both in natural and experimental specimens of this genus.

Key words: *Patella*, gill, SEM, ciliary structures

Patella caerulea L. (Mollusca: Gastropoda) solungaçlarının dış morfolojisi

Özet: *Patella* genusunun genel solungaç morfolojisi, fonksiyonuyla ilişkilendirilerek taramalı elektron mikroskopunda incelenmiştir. İkincil solungaç katlantıları taramalı elektron mikroskopunda genellikle üçgenimsi yapraklar şeklinde görülen tek bir tabakadan oluşmaktadır. Herbir yaprağın serbest kenarlarında belirgin bir kalınlaşma ve ön yüzeyinde yatay kabartılarda bir dizi dağınık siller halinde bulunmaktadır. Bu demetler diskosiliadan farklıdır ve kimyasal algılayıcı osfradyumun olmaması nedeniyle, solungaçın birincil görevi solunuma katkıda bulunduğu düşünülmektedir. Bu genusun morfolojik karakterlerinin doğal ve deneysel koşullarda ayrıntılı olarak incelenmesinin gerektiği düşünülmektedir.

Anahtar sözcükler: *Patella*, solungaç, SEM, silli yapılar

In light of its gill structure, the genus *Patella* is one of the diverse members of Gastropoda. In Patellacea, the nuchal cavity, originally the mantle cavity, has a primary respiratory function, but transfers this function to the secondary gills in the pallial groove

(Purchon, 1977; de Villiers and Hodgson, 1987). In gills there is rapid water passage for oxygenation of the blood, and gills are also linked with feeding (Fretter and Graham, 1994). The gills consist of a single series of monobranchial folds, which are clearly

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seen in oblique sections (Aksit and Falakali Mutaf, 2007), although the ctenidium is well developed in other patellagastropods (Sasaki et al., 2006).

Here we provide a study of the external morphology of *P. caerulea* with the aim of contributing more information about one of the most common limpets found on the rocky shores of the Mediterranean.

Specimens of *Patella caerulea* were collected from the littoral zone of the rocky shore of Antalya Bay. Gills were dissected and fixed in 2.5% glutaraldehyde, postfixed in 1% osmium tetroxide (both in Sorensen's buffer; pH 7.3, 0.1 M), dehydrated in graded alcohol, and critical-point dried. Gills were mounted on aluminum stubs, sputter coated with gold-palladium, and studied at 15 kV using a Zeiss Leo 1430 scanning electron microscope (SEM) at the Akdeniz University Medical School EM Unit (TEMGA). Electron micrographs were taken.

The gill filaments, located in the circumference from the edge of the mantle, were typically broad triangular leaflets with a large respiratory surface, but much rounder at intervals (Figures 1 and 2). There was a thickening on the free margin of each lamella.

Visible horizontal swellings appeared near the upper portion of the frontal surface of the triangular leaflets but not on the rounder ones. The swellings bore a series of papillae or ciliary structures (Figure 3), a hallmark of gills involved in water current.

These were formed in arrays protruding from a very slight groove in the middle of the area. In

addition, they exhibited bulbous terminals and seemed to move in a ciliary action. The leaflets were lined by an epithelium whose cells exhibited a low and dense microvillus border (Figure 4). Additional clusters of about 50 cilia were seen scattered unevenly across the upper surface of each lamella (Figure 5).

There were sparse, balloon-like apices overhanging the margin of some lamella. In some cases, pits were observed on these inflated bodies; in other cases, the inflated bodies were elongated on the margin (Figure 6).

Patellids are common organisms in the Mediterranean (Cachia et al., 1991) and are well distributed in Turkish waters (Öztürk and Ergen, 1999).

Gill morphology has been used to define generic groups (Chitramvong et al., 2002). The family Patellidae resembles Lepetidae in having no ctenidia, but they possess secondary, adaptive pallial gills (Purchon, 1977).

Generally the gills follow the curvature of the mantle cavity, with the maximum possible surface area exposed to water flow. The SEM greatly simplified the interpretation of the 3-dimensional structure, revealing the architecture of the gill and contributing to our previous light-microscopic observations (Aksit and Falakali Mutaf, 2007). In those previous observations, the gills appeared to contain folds forming slender tubes with broadening tips that coincided with the thickening on the free

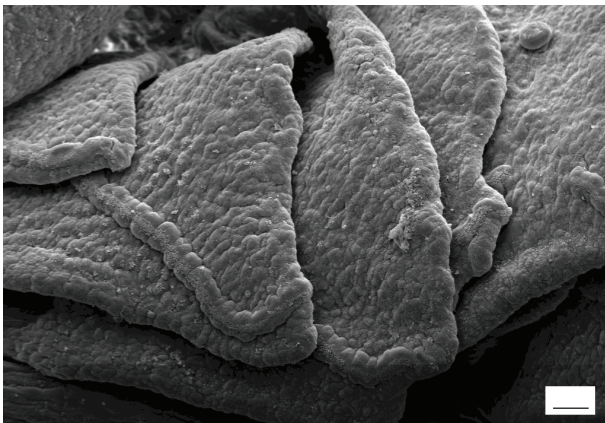


Figure 1. SEM of triangular leaflets of the pallial gills with free margin and horizontal swellings.

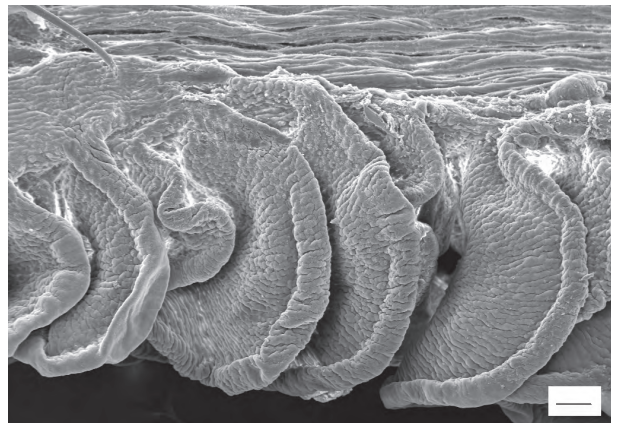


Figure 2. SEM of rounder leaflets with free margin but no horizontal swellings.

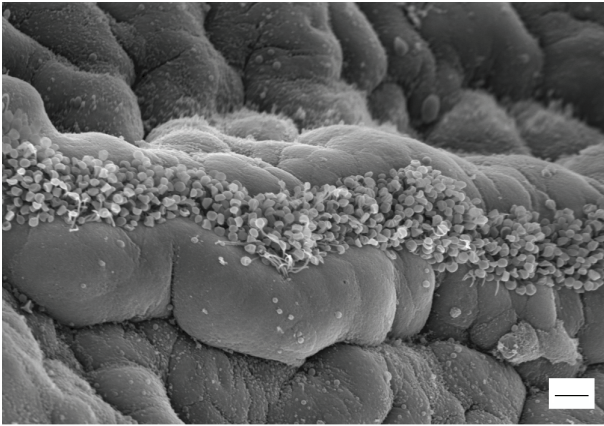


Figure 3. SEM of horizontal swellings, which bear a series of ciliary structures.

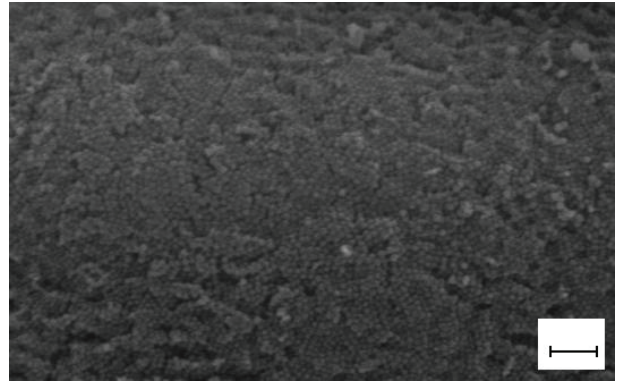


Figure 4. SEM of the epithelial cover of the gills with the microvillar cells bearing low and dense microvilli.

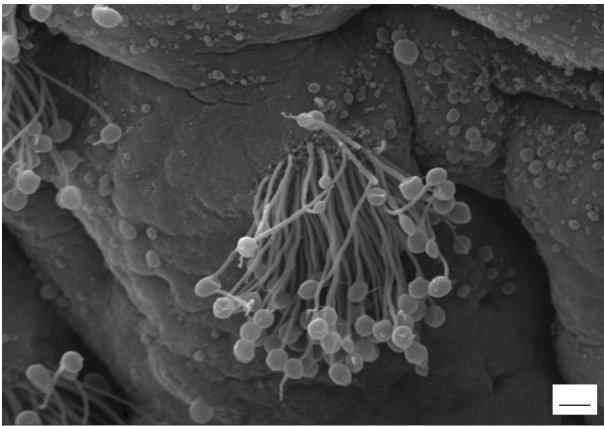


Figure 5. SEM of clusters of discocilia on the upper surface of the leaflets.

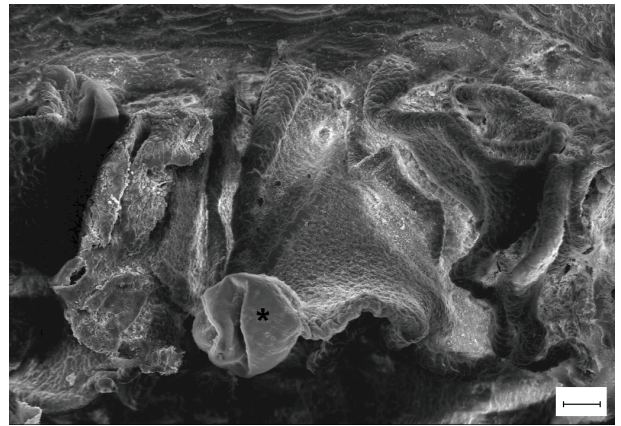


Figure 6. SEM of aberrations (*) on the free margin of the lamellae.

margin of each lamella in the SEM images. The horizontal swellings near the upper portion of the frontal surface corresponded to the puffs in columnar cell groups discovered in earlier observations.

The osphradium is associated with the ctenidia in some aquatic Gastropoda and is used to test the quality of water before it flows through the gills to oxygenate the blood (Purchon, 1977; Chitramvong et al., 2002). It is thought to serve as a chemoreceptor in certain genera (Haszprunar, 1985), but has been lost in the Patellacea (Yonge, 1947).

Structures differed from the discocilia described in previous studies, however, (Matera and Davies, 1982; Short and Tamm, 1991) and functions that increase the effectiveness of water current and

feeding capacity or act as chemoreceptors could have been similarly proposed.

Although there is no direct evidence, it may be deduced from the existence of the ciliary structures on the surface of the gill lamellae that they might aid in the creation of strong water currents for gas exchange. They might also have a role in chemoreception before feeding. Ciliary activity seems to enhance the functional status of the gill leaflets.

The inflated bodies on the margins of some lamellae do not seem to be involved in water pumping, and they may only provide a means of expelling particles that should be rejected. No records of similar structures have been found so far in the existing literature.

In conclusion, our findings have demonstrated some differences in the morphological characteristics of this type of gill. These characteristics are to be researched further in both natural and experimental specimens of this genus in order to clarify their functional role.

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