

Cilia patterns and pores: Comparative external SEM examination of acochlidian opisthobranch gastropods

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INTRODUCTION

Acochlidian gastropods are a morphologically and biologically extremely diverse group of opisthobranch gastropods, ranging from mesopsammic “dwarfs” (1.0 - 5.0 mm) to limnic “giants” (up to 3.5 cm). Only limited information is available for the 27 valid species, concerning their anatomy, biology and reproduction, while their external morphology is fairly well described. Previous scanning electron microscopical (SEM) examinations of entire acochlidian gastropods, such as *Asperspina riseri* (Morse, 1976) or *Pontohedyle milaschewitchii* (Kowalevsky, 1901) by Morse (1976) and Wawra (1986) however indicated that body surface structures still offer a variety of new characters for phylogenetic and taxonomic analyses.

MATERIAL AND METHODS

Several specimens of 8 marine and 2 limnic species were dehydrated in graded ethanol followed by a graded acetone series. The specimens were critical-point-dried in 100% acetone in a Baltec CPD 030 and coated with gold in a Polaron Sputter Coater for 120 sec. SEM examinations were conducted using LEO 1430VP SEM at 10-15kV.

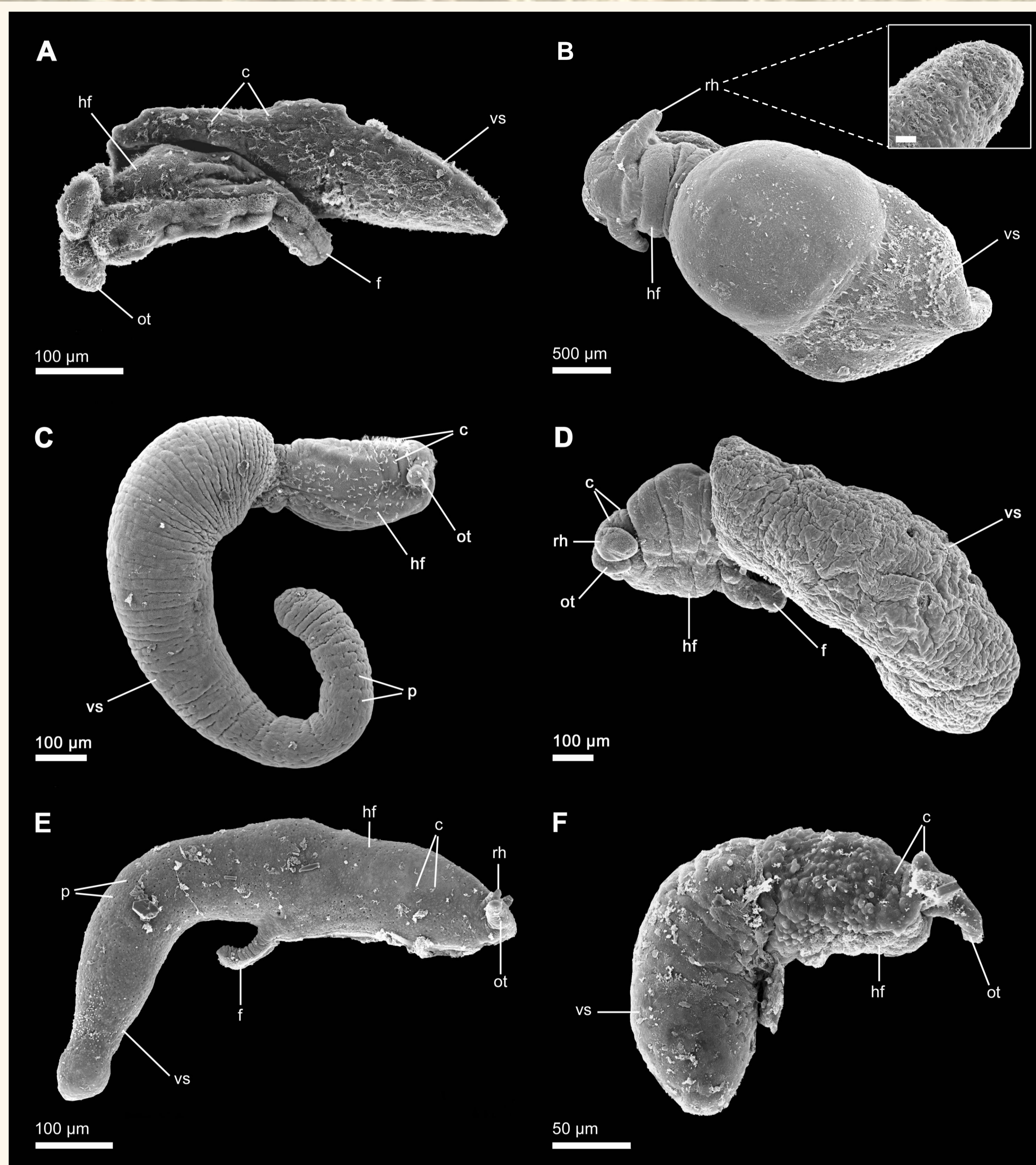


Figure 1: SEM-examination of entire acochlidian specimens showing the different general patterns in body surface structures. **A-B.** Dense overall ciliation on head-foot complex and visceral sac. **A.** *Hedylopsis spiculifera* (Kowalevsky, 1901) **B.** *Acochlidium fijiense* (Haynes and Kenchington, 1991); close-up of densely ciliated rhinophore (scale bar = 20 µm). **C-F.** Specific pattern of ciliation on head-foot complex and only few cilia on visceral hump. **C.** *Pontohedyle milaschewitchii* (Kowalevsky, 1901) with characteristic ciliation of head-foot complex and anterior region of visceral sac. **D.** *Asperspina murmanica* (Kudinskaya and Minichev, 1978) similar to C. but with some cilia distributed all over the visceral hump. **E.** *Paraganitus ellynae* (Challis, 1968) with only very few bundles of cilia on the head-foot complex and large and numerous pores on the visceral hump. **F.** *Parhedyle cryptophthalma* (Westheide and Wawra, 1974) with similar pattern as in E. but with fewer pores. **c** – cilia, **f** – foot, **hf** – head-foot-complex, **ot** – oral tentacle, **p** – pores, **rh** – rhinophore, **vs** – visceral sac.

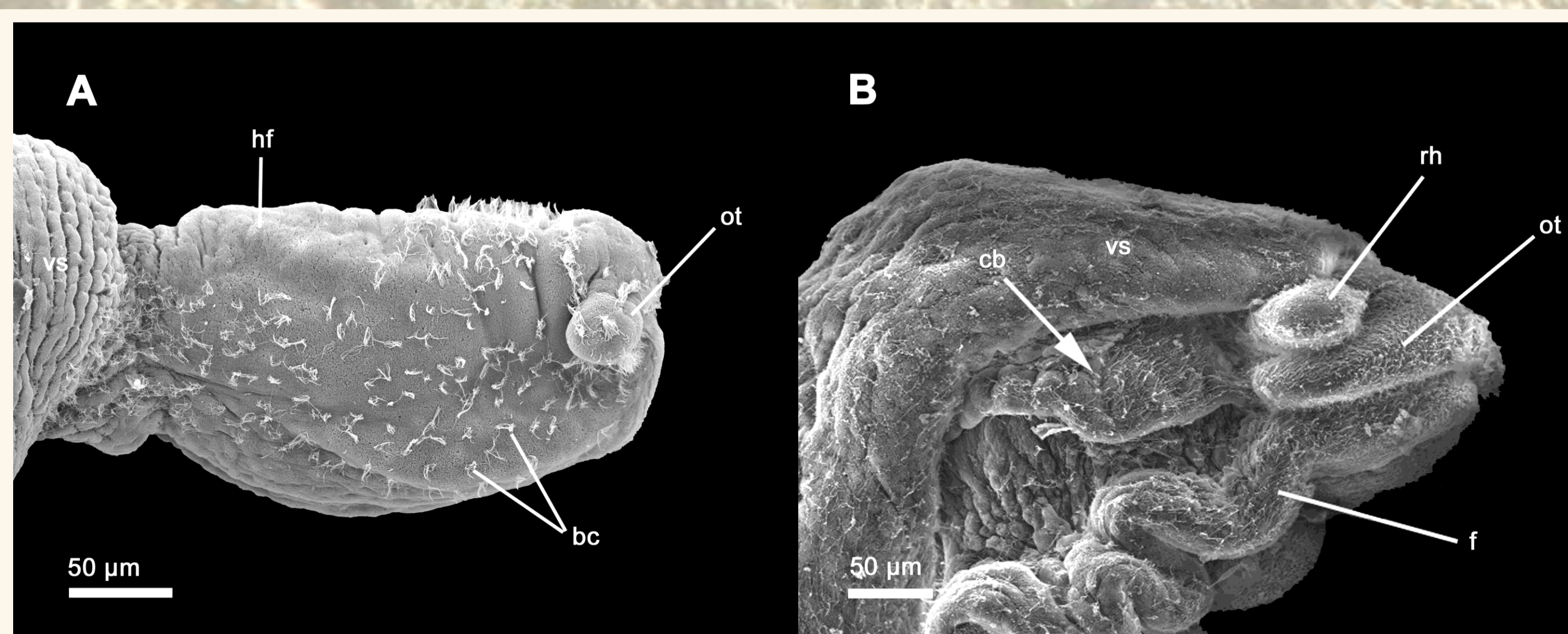


Figure 2: Characteristic patterns of cilia distribution and special ciliary structures **A.** Pattern of ciliation on head-foot complex of *Pontohedyle milaschewitchii*: lacking cilia in the posterior dorsal part. **B.** Ciliary band originating from the gonopore in *Hedylopsis ballantinei* (Sommerfeldt and Schrödl, 2005) from Sommerfeldt and Schrödl (2005: fig. 2A). **bc** – bundles of cilia, **cb** – ciliary band, **f** – foot, **hf** – head-foot-complex, **ot** – oral tentacle, **rh** – rhinophore, **vs** – visceral sac

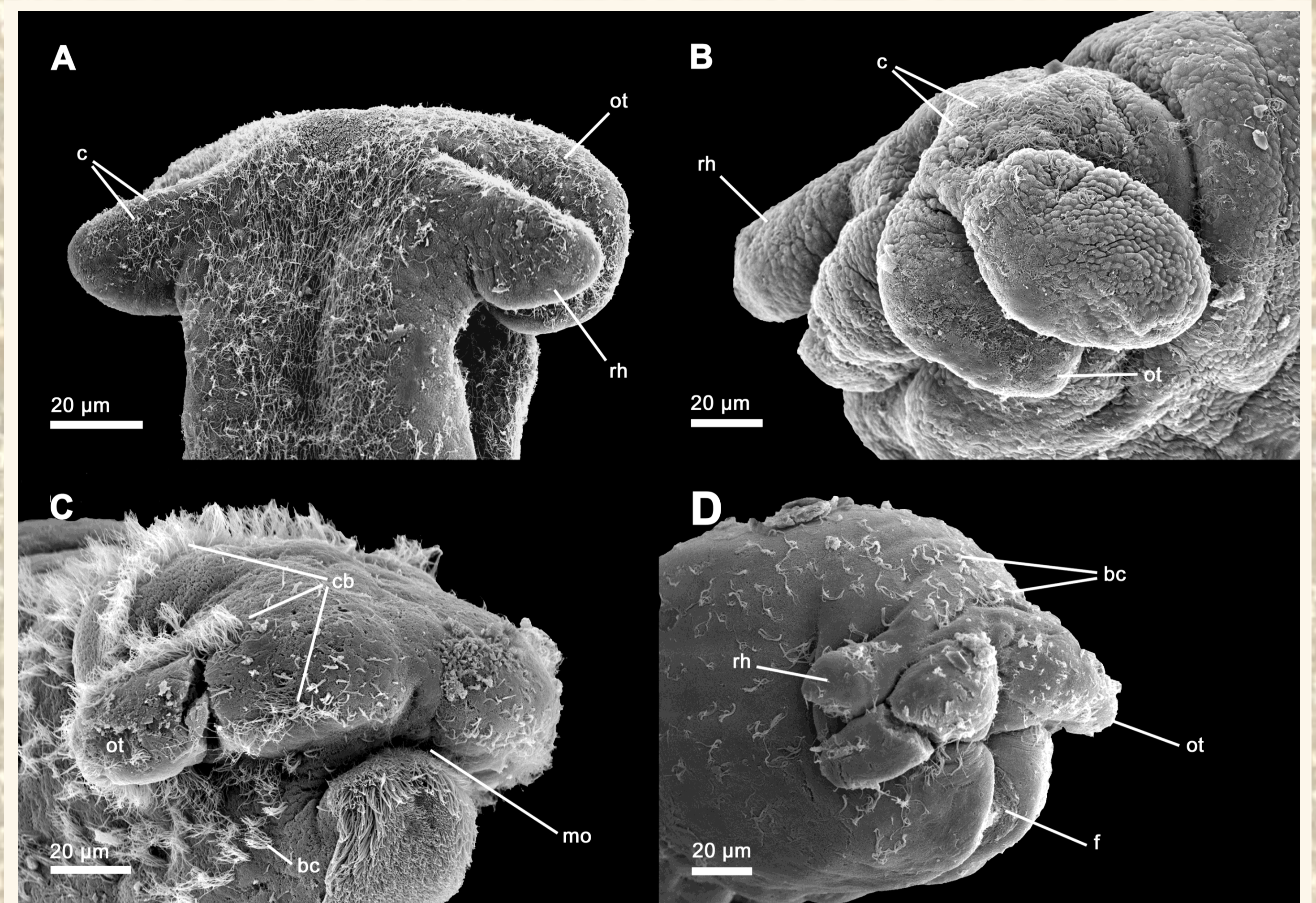


Figure 3: Ciliation pattern on head and head appendages. **A.** *Hedylopsis spiculifera* with a constant overall ciliation. **B.** *Asperspina murmanica* with dense ciliation on the dorsal head region and less dense on the head appendages. **C.** *Pontohedyle milaschewitchii* with two defined ciliary bands on the oral tentacles and a third one crossing the head transversally. **D.** *Microhedyle glandulifera* (Kowalevsky, 1901) with only scattered bundles of cilia. **bc** – bundles of cilia, **c** – cilia, **cb** – ciliary bands, **f** – foot, **mo** – mouth opening, **ot** – oral tentacle, **rh** – rhinophore

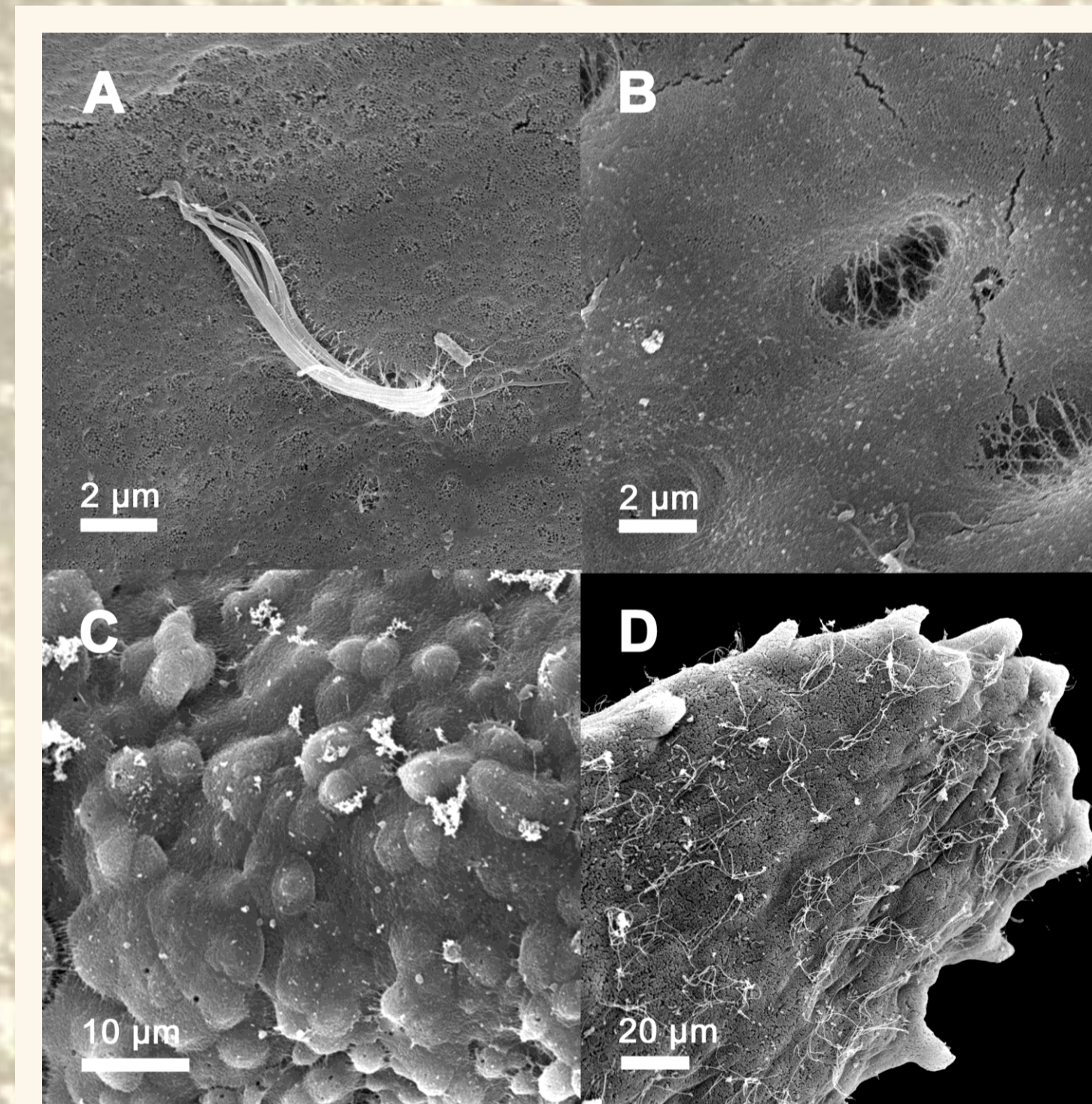


Figure 4: True and artificial body surface structures in acochlidian gastropods. **A-B.** True body surface structures. **A.** Bundle of cilia in *Microhedyle glandulifera*. **B.** Pore of epidermal gland cell in *Pontohedyle milaschewitchii*. **C-D.** Artificial body surface structures probably caused by intra- or sub-epidermal calcareous spicules. **C.** „Bumpy“ body surface of the head-foot-complex in *Parhedyle cryptophthalma* caused by oval intra-epidermal spicules. **D.** „Spiny“ appearance of the visceral sac in *Hedylopsis spiculifera* caused by monoaxone, sub-epidermal spicules.

CONCLUSIONS

- 1) Preliminary results of SEM-examination indicate a species specific pattern in cilia distribution and pores on the body wall, even though the density of cilia may vary between individuals.
- 2) Two general patterns of cilia distribution can be identified: 1) dense overall ciliation on head-foot complex and visceral sac (e.g. *Hedylopsis spiculifera*, *Hedylopsis ballantinei*, *Acochlidium fijiense*); 2) specific pattern of ciliation on head-foot complex and only few cilia on visceral sac (e.g. *Pontohedyle milaschewitchii*, *Microhedyle glandulifera*, *Paraganitus ellynae*, *Parhedyle cryptophthalma*).
- 3) Next to the general pattern of ciliation, special ciliated structures such as ciliated bands on head and head appendages and originating from the gonopore can be determined and offer additional characters for phylogenetic analyses.
- 4) A correlation between the body surface structures and the inhabited ecological niche could not be determined as a dense pattern of ciliation occurs in mesopsammic, marine species (e.g. *Hedylopsis ballantinei*) as in benthic, limnic species (e.g. *Acochlidium fijiense*).

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