Supplementary material.

A comparative assessment of the morphology of Profilicollis altmani (Acanthocephala: Polymorphidae) from crustaceans and shore birds in Peru, with special notes on hook elemental analysis (EDXA), SEM imaging, histopathology, and molecular profile.

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Molecular methods

A sequence of a specimen Profilicollis altmani recovered from the mole crab Emerita analoga from Redondo Beach, California, USA, was gathered as follows. The tissue sample was digested overnight at 55°C, and genomic DNA was isolated using a commercial extraction kit (Wizard® Genomic DNA Purification Kit, Promega, Madison, WI, USA). A fragment of the COI gene was amplified using the primers detailed by Folmer et al. [27] following the protocol of Amin et al. [16]. Amplicons were sequenced using an external sequencing service (Macrogen, Inc., Seoul, South Korea). The new DNA sequences was edited using Codon-Code (Codon Code Aligner, Dedham, MA, USA) and deposited in GenBank (OK094071; see Table S1).

The new COI sequence was aligned to a matrix with one representative of each haplotypic class of Profilicollis altmani and P. chasmagnathi found in both intermediate and definitive hosts from North and South America [33, 46, 57, 59, 60], P. novaezelandensis from the hairy-handed shore crabs Hemigrapsus crenulatus [34] and P. botulus from diverse intermediate and definitive hosts [29, 30]. These 23 sequences were downloaded from GenBank (Table S1). As such, a total of 24 sequences of Profilicollis
were analyzed. Sequences of *Polymorphus minutus* and *Arhythmorhynchus brevis*, which are closely related to *Profilicollis* [59], were used to form the outgroup.

Sequence alignment was done in Clustal as implemented in MEGA 7 [68] using the default parameter values. Observed genetic distances \( (p) \) between haplotype and sample pairs were calculated in MEGA 7. IQ-TREE [51] was used to select the model of nucleotide substitution (TPM3 + G4). Two methods of phylogenetic inference were implemented, maximum likelihood (ML) and Bayesian inference (BI). The ML analysis was conducted with IQ-TREE using the online implementation W-IQ-TREE (https://iqtree.cibiv.univie.ac.at; [72]), with perturbation strength set to 0.5 and stopping rule set to 100. Clade support was calculated with 1,000 ultrafast bootstrap pseudo-replications (BS). The BI analysis was conducted with MrBayes 3.1 [62] with two independent runs with four heated and one cold Markov chains each. Runs lasted 20 million generations and parameters and trees were sampled every 1,000 generations. Model parameters were estimated in MrBayes. Convergence to stable log-likelihood values was checked by plotting log-likelihood values against generation time. The first 25% of the trees sampled were discarded as burn-in; remaining trees, all from the convergence zone, were used to compute a 50% majority rule consensus tree and to obtain posterior probability (PP) values for each clade.

### Molecular results

The genealogical analysis showed that the sequence of the cystacanth recovered from a specimen of *E. analoga* collected at Redondo Beach, California, USA, falls in the *P. altmani* clade (PP = 0.89; BS = 100; Fig. S1). Haplotypes of *P. altmani* show low genetic variation; on average haplotype pairs differ by 1.2% (range 0–1.9%). Within this clade of
*P. altmani* no monophyletic group is formed by haplotypes recovered from each host, neither by developmental stage (cystacanths and adults; [33, 57, 59]). Similarly, the genetic variation of *P. altmani* is not geographically structured [33, 46, 57, 59, 60]. *Profilicollis altmani* is sister to *P. botulus* (PP = 1; BS = 88) in a relationship that has significant support only in the BI analysis (PP = 1; BS = 53; Fig. S1); both species differ on average by 15%. The clade of *P. botulus* is formed by cystacanths and adult worms extracted from brachyuran crabs, and adults from the Herring gull *Larus argentatus* Pontoppidan, 1763 and the Common eider *Somateria mollisima* (Linnaeus, 1758), collected in the Netherlands, Denmark and New Zealand. The average genetic *p*-distance between the clades of *P. altmani* and *P. botulus* was 0.47. *Profilicollis chasmagnathi* and *P. novaezelandensis* are sister to each other (PP = 1; BS = 100; Fig. S1). The average genetic *p*-distance between the clades of *P. altmani* and *P. chasmagnathi* was 0.35.
Table S1. Species of acanthocephalans, host (intermediate (I) and definitive (D)), location, and GenBank accession number of the sequences used in the phylogenetic analysis.

| Species      | Host                      | Location             | GenBank access COI | References                     |
|--------------|---------------------------|----------------------|--------------------|--------------------------------|
| *Profilicollis altmani* | *Emerita brasiliensis* (I) | South–Atlantic, Uruguay | KU928255           | Rodríguez and D’Elía [57]      |
| *Profilicollis altmani* | *Emerita talpoida* (I)    | Gulf, USA            | KF835300           | Goulding and Cohen [33]        |
| *Profilicollis altmani* | *Emerita analoga* (I)     | North–Pacific, USA   | OK094071           | This study                     |
| *Profilicollis altmani* | *Enhydra lutris* (D)      | North–Pacific, USA   | DQ089720           | García-Varela and Nadler [28]  |
| *Profilicollis altmani* | *Melanitta perspicillata* (D) | North–Pacific, USA   | EF467863           | García-Varela and Ponce de León [29] |
| *Profilicollis altmani* | *Emerita rathbunae* (I)   | North–Pacific, Panama| KF835293           | Goulding and Cohen [33]        |
| *Profilicollis altmani* | *Emerita talpoida* (I)    | North–Atlantic, USA  | KX702254           | Rodríguez et al. [59]          |
| *Profilicollis altmani* | *Chroicocephalus maculipennis* (D) | South–Pacific, Chile | KX702244           | Rodríguez et al. [59]          |
| *Profilicollis altmani* | *Leucophaeus modestus* (D) | South–Pacific, Chile | KX646796           | Rodríguez et al. [59]          |
| *Profilicollis altmani* | *Leucophaeus pipixcan* (D) | South–Pacific, Chile | KF835292           | Goulding and Cohen [33]        |
| *Profilicollis altmani* | *Larus dominicanus* (D)   | South–Pacific, Chile | KX702251           | Rodríguez et al. [59]          |
| *Profilicollis botulus*  | *Somateria mollissima* (D) | Denmark              | EF467862           | García-Varela and Ponce de León [29] |
| *Profilicollis botulus*  | *Carcinus maenas* (I)     | Netherlands          | KX279933           | Goedknegt et al. [30]          |
| *Profilicollis botulus*  | *Larus argentatus* (D)    | Netherlands          | KX279894           | Goedknegt et al. [30]          |
| *Profilicollis botulus*  | *Hemigrapsus takanoi* (I) | Netherlands          | KX279918           | Goedknegt et al. [30]          |
| *Profilicollis botulus*  | *Hemigrapsus sanguineus* (I) | Netherlands          | KX279903           | Goedknegt et al. [30]          |
| *Profilicollis chasmagnathi* | *Cyrtograpsus altimanus* (I) | South–Atlantic, Argentina | KY292510          | Rodríguez et al. [60]          |
| *Profilicollis chasmagnathi* | *Hemigrapsus crenulatus* (I) | South–Pacific, Chile | KU928251          | Rodríguez and D’Elía [57]      |
| *Profilicollis Neohelice* |                          | South–Atlantic,     | KY292513           | Rodríguez et al.               |
| Genus                  | Species                      | Location                     | Accession Number | Reference                      |
|-----------------------|------------------------------|------------------------------|------------------|--------------------------------|
| Profilicollis         | chasmagnathi                | Uruguay                     | KX646756         | Rodríguez et al. [59]          |
|                       |                              | South–Pacific, Chile        |                  |                                |
|                       |                              | South–Atlantic, Chile       | KY291517         | Rodríguez et al. [60]          |
|                       |                              | South–Atlantic, Uruguay     | MG859266         | Lorenti et al. [46]            |
|                       |                              | South–Atlantic, Argentina   |                  |                                |
|                       | Profilicollis               | novaezelandensis             | MG602435         | Hay et al. [34]                |
|                       | Hemigrapsus                 | crenulatus (I)              |                  |                                |
|                       |                              | New Zealand                 |                  |                                |
| Polymorphus           | minutus                      | Gammarus pulex (I)          | EF467865         | García-Varela and Ponce de León [29] |
|                       | Arhythmorhynchus brevis     | Egretta thula (D)           | EF467861         | García-Varela and Ponce de León [29] |