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Three new species of the antipatharian-inhabiting barnacle, of the genus *Conopea* (Arthropoda, Thecostraca, Balanomorpha), from the East China Sea and South China Sea, and a way of life for the genus

 Jie Li

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Three new species of the antipatharian-inhabiting barnacle, of the genus *Conopea* (Arthropoda, Thecostraca, Balanomorpha), from the East China Sea and South China Sea, and a way of life for the genus

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Abstract

Three new species of *Conopea* (Say 1822) are described from the East China Sea and South China Sea: *Conopea hongqi* sp.nov. collected from the East China Sea, trawled in 350-450 m. It has a shape that is significantly different from that of other species of the genus *Conopea*. *Conopea changdi* sp.nov. and *Conopea niuqv* sp.nov. collected from the South China Sea, local fishermen collect with crab nets in 20-25 m. *Conopea hongqi* and *Conopea niuqv* have a lifestyle that has not been previously observed in the genus.

Key words: Barnacle, *Conopea hongqi*, *Conopea changdi*, *Conopea niuqv*, East China Sea, morphology,

Introduction

The genus *Conopea* Say, 1822 is a group of symbiotic barnacles associated with gorgonian octocorals (Cnidaria) such as sea fans and sea whips or antipatharians (black corals). There are currently 20 described species of *Conopea*. They are almost completely covered by the host coenenchyma tissue. The basis of the barnacle shell clasps the axis of the host, with only the opercular opening exposed. *Conopea* is a widespread genus that is found in temperate and tropical oceans around the world from shallow subtidal to deep waters.

Say (1822) erected a new genus *Conopea* to accommodate a new species, *C. elongata*. Say describes *Conopea* as 'Shell sessile, fixed, composed of two cones joined by their bases, the lines of junction carinate each side: inferior cone entire, attached by its anterior side and tip to marine bodies; with an aperture at the summit, closed by a quadrivalved operculum.' Darwin (1854: 216) characterized these barnacles by "Parietes and basis sometimes permeated by pores, sometimes not; radii not permeated by pores, shell elongated in its rostrocarinal axis, basis boat-shaped, attached to Gorgoniae and Milleporae." Carrison-Stone et al. (2013) noted that "*Conopea* is not a well documented group.

There is very little data on host associations, species ranges are not well defined, and published descriptions are often incomplete and occasionally contain questionable information." Van Syoc et al. (2014) indicated that

"The acastine species living in gorgonians differ from *Conopea* species in several ways, the most obvious is the form of their attachment to the host. *Conopea* species are cemented directly, and firmly, to the surface of the gorgonian axis. The coenenchyme of the gorgonian overgrows the shell of *Conopea* species, but the proteinaceous axis generally does not. On the other hand, individuals of *Acastinae* become completely embedded in the proteinaceous axis rather than living attached to the surface of the gorgonian axis. The wall plates of most *Conopea* are heavily cemented to each other at the contact sutures, whereas those of acastines are loosely attached to each other and disarticulate very easily with handling or treatment in dilute sodium hypochlorite."

Although the genus has a global distribution in tropical and warm temperate seas, only four species are known from the seas around China. *Conopea* are found from the Yellow Sea to the South China Sea, living in the intertidal to shallow depth range. The four known species of *Conopea* in China are: *Conopea granulata* (Hiro, 1937), *Conopea sinensis* (Ren & Liu, 1978), *Conopea cymbiformis* (Darwin, 1854), *Conopea calceola* (Ellis, 1758). Of these four species, *C. granulata* inhabits *Antipathidae* in the

subtidal in the Taiwan Strait. *Conopea sinensis* also inhabits *Antipathidae* but lives in the intertidal to subtidal of the South China Sea. *Conopea cymbiformis* inhabits *Gorgonacea* living in the subtidal to shallow waters up to 450 meters deep in the South China Sea, while *C. calceola* also inhabit *Gorgonacea* but lives in the subtidal from the Yellow Sea to the South China Sea. This paper describes a new species of *Conopea* collected in the East China Sea and has a new way of life that has never been seen in *Conopea*.

Systematics

Class Thecostraca Gruvel, 1905

Subclass Cirripedia Burmeister, 1834

Infraclass Thoracica Darwin, 1854

Superorder Thoracicalcareia Gale, 2015

Order Balanomorpha Pilsbry, 1916

Superfamily Balanoidea Leach, 1817

Family Balanidae Leach, 1817

Subfamily Archaeobalaninae Newman & Ross, 1976

Genus *Conopea* Say, 1822

***Conopea hongqi* sp. nov.**

Figures 1-4&7,8

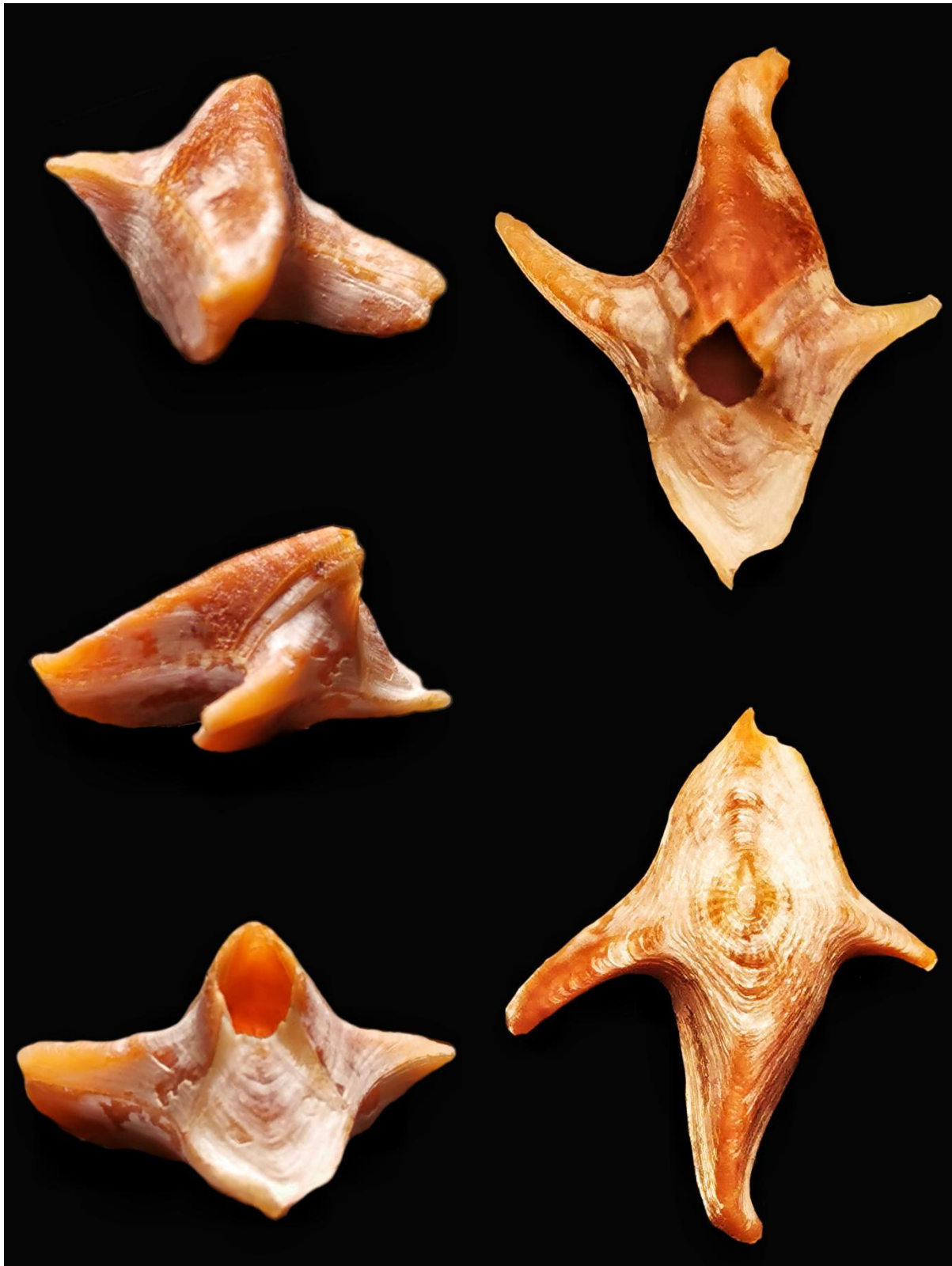


Figure 1. *Conopea. hongqi*, holotype.

Type locality: China. the East China Sea, sea area 1956, region near 30°N, 128°E, trawled in 350-450 m, May 2012, collected by local fishermen, on antipatharians.

Holotype is stored in National Zoological Museum of China.

Paratypes: 12 specimens, same data as holotype.

Diagnosis.—Shell elongated in basis, rostrum, and carina. Basis cruciform, basis center is pale purplish red and has a pale radial radiation pattern, margin purplish red with light spots. Carina gently sloping from summit to basal margin where it contacted the host axis and gradually thinned until a sharp edge was formed, purplish red with light spots near the lower edge. Rostrum pale purplish red to white, and the angle near the top decreases sharply, then gradually slows down until sharp edge was formed; rostrum wider than carina. The triangular area from the center to the basal margin of two lateral plates protrudes outwards, forming a long triangular pyramidal thorn, thorn sweeps back in the direction of carina, the end is sharp, and the thorn in the corresponding position of the basis is inverted with the thorn of lateral plate to form a long beak like a bird beak and they are hollow. The thickness of the ‘beak’ is greater than the width, and the width of the end in some individuals has been reduced to nothing, but the thickness is still there, making the end of the ‘beak’ a sharp ridge; the length is less than the length of the carina. The basis of *Conopea hongqi* does not wrap or mosaic the host protein axis. Instead, they extend the protein axis of the host into a yellow membrane that surrounds *Conopea hongqi*’s basis.



Figure 2. *Conopea hongqi*, paratypes 1 to 4, **A** top view **B** rostrum broken, **C** and **D** on the axis of the host.

Description.—Shell elongated in basis, rostrum, and carina; basis cruciform, basis center is pale purplish red and has a pale radial radiation pattern and concentric circular pattern, the edge is folded up to connect with the wall plates that are purplish red with pale spots, the basis center has greatest depth and the upper edge falls to the tips along the axis of rostrum-carina, a raised ridge is present beneath carina; carina gently sloping from summit to basal margin where it contacts host axis and gradually thins out until sharp edge was formed, purplish red with pale spots near the lower edge; rostrum pale purplish red to white, height near the top decreases sharply, then gradually slopes until sharp end was formed, rostrum wider than carina. Carino-latus broader at basal margin, narrowing to summit, purplish red with pale spots arranged longitudinally; latus rostral margin and carina lateral margin long and sloped, radii with oblique downward pale stripes, closed at basal margin, broadening toward summit; the triangular area from the center to the basal margin of two lateral plates protrudes outward, forming a long triangular pyramidal thorn, thorn sweeps back in the direction of carina, the end is sharp, and the same thorn in the corresponding position of the basis is inverted with the thorn of lateral plate to form a long thorn. The thickness of the thorn is greater than the width, and the width of the end of the thorn in some individuals has been reduced to nothing, but the thickness is still there, making the end of the thorn a sharp ridge, the length of thorn is less than carina. This structure has not been seen in any *Conopea* species before. Wall plates surface is smooth. The top margin of carinal latus is the same width as basal margin, there is a white dura mater, sometimes covering the entire wall plates. The wall plates are heavily cemented to each other at the contact sutures, orifice that is not dentate but smooth or even, radii with summits parallel to the basal margin of the parietes and denticulated sutural margins. The basis of *Conopea hongqi* does not wrap or mosaic the host protein axis. Instead, they extend the protein axis of the host into a yellow membrane that surrounds *Conopea hongqi* basis.

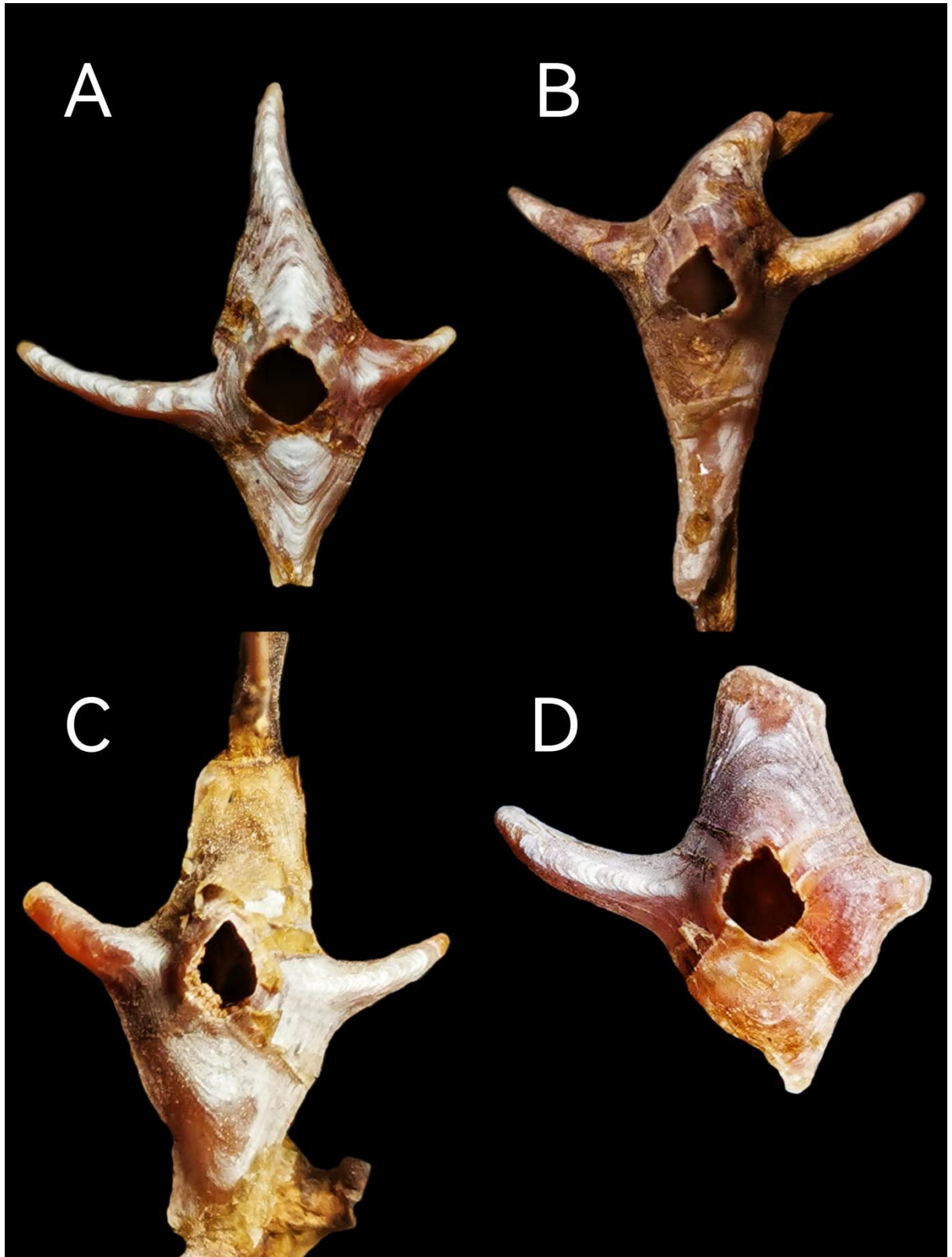


Figure 3. *Conopea hongqi*, paratypes 5 to 8, **B** and **C**, on the axis of the host.

Scutum height greater than width; lateral depressor muscle pits and adductor muscle pits shallow, lateral depressor muscle pits is open to basal margin; the height of articular ridge is about half that of tergal margin, external parallel horizontal growth ridges on the outside and parallel to the basal margin, no radial ridges; apex acute, light purplish red, shows growth ridges internally; interior surface lightly textured; basal margin curved, tergal and occludent margins relatively straight, tergal margin is shorter than occludent margin, occludent margin has dentate structure. Tergum width similar to height, width slightly longer; external horizontal growth ridges are parallel on the outside and to the basal margin; apex acute, white, some areas translucent, spur wider than long, slightly less than half the width of the basal margin, has a flat end and a very small length, about one-quarter of the height of tergum, lateral depressor ridge, spur furrow shallow, broad; lateral depressor ridge shallow, generally of six articles, basiscutal angle obtuse, articular furrow wide; articular ridge minimal, like a small arc, scutal margin straight, carinal margin slightly convex. The soft part of the specimen is completely damaged and cannot be described.

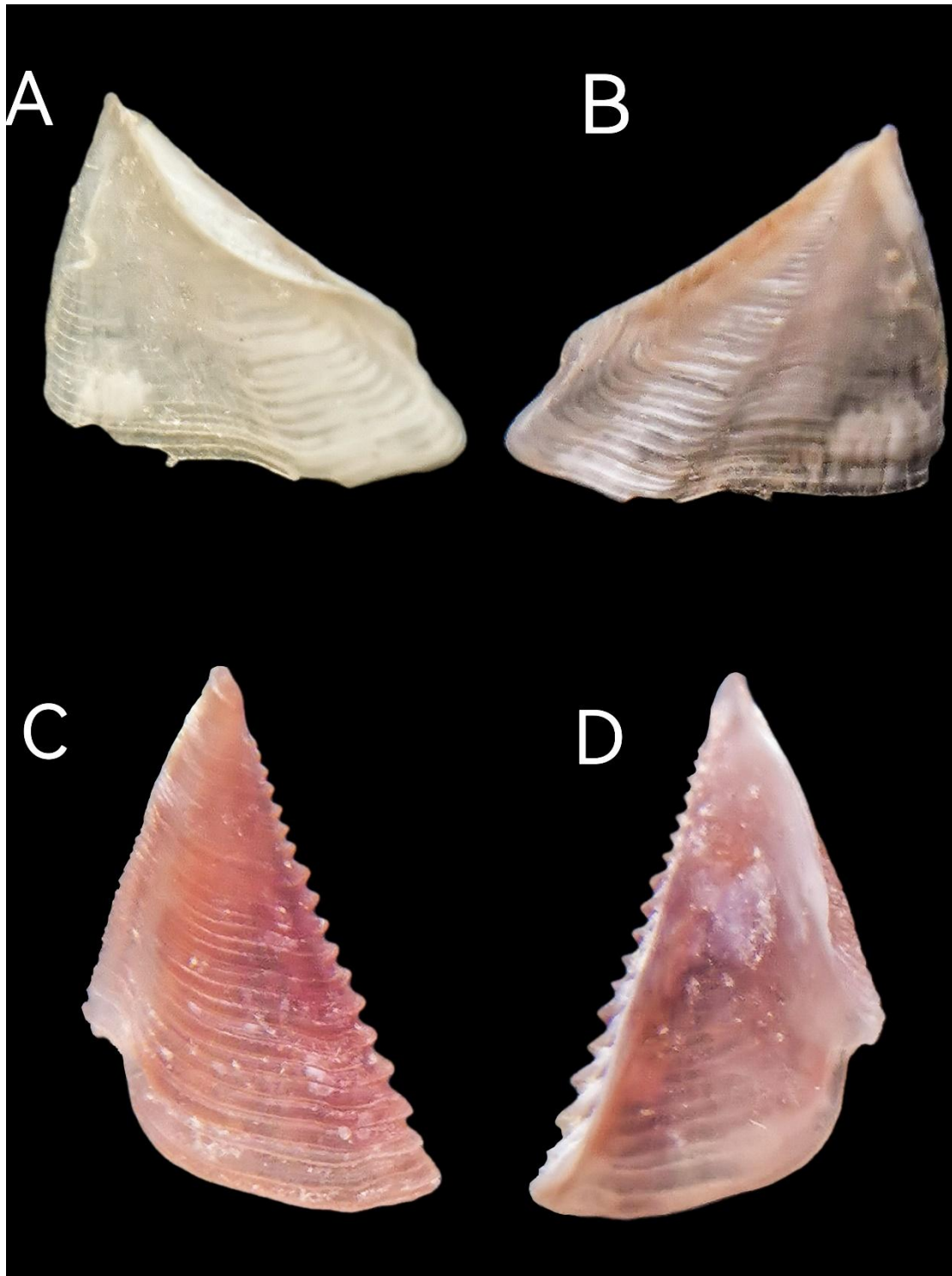


Figure 4. *Conopea hongqi*, opercular plates of paratypes. **A** tergum interior; **B** tergum exterior; **C** scutum exterior; **D** scutum interior.

Etymology.— This species is named in honor of Hongqi Chen (陈鸿琪), my grandfather.

Remarks.—All specimens were from the same antipatharians. Fishermen do not freeze antipatharians after catching it. It will take a long time for fishing boats—depending on whether they go fishing in other areas—to return to the harbor from area 1956. This leads to the decay of all the soft parts of barnacles, and the loss of tergum and scutum in most barnacles.

***Conopea changdi* sp. nov.**

Figure 5

Type locality: China, the South China Sea, near Danzhou in the Beibu Gulf, 20–25 m, local fishermen use crab nets collected, on antipatharians.

Holotype is stored in National Zoological Museum of China.

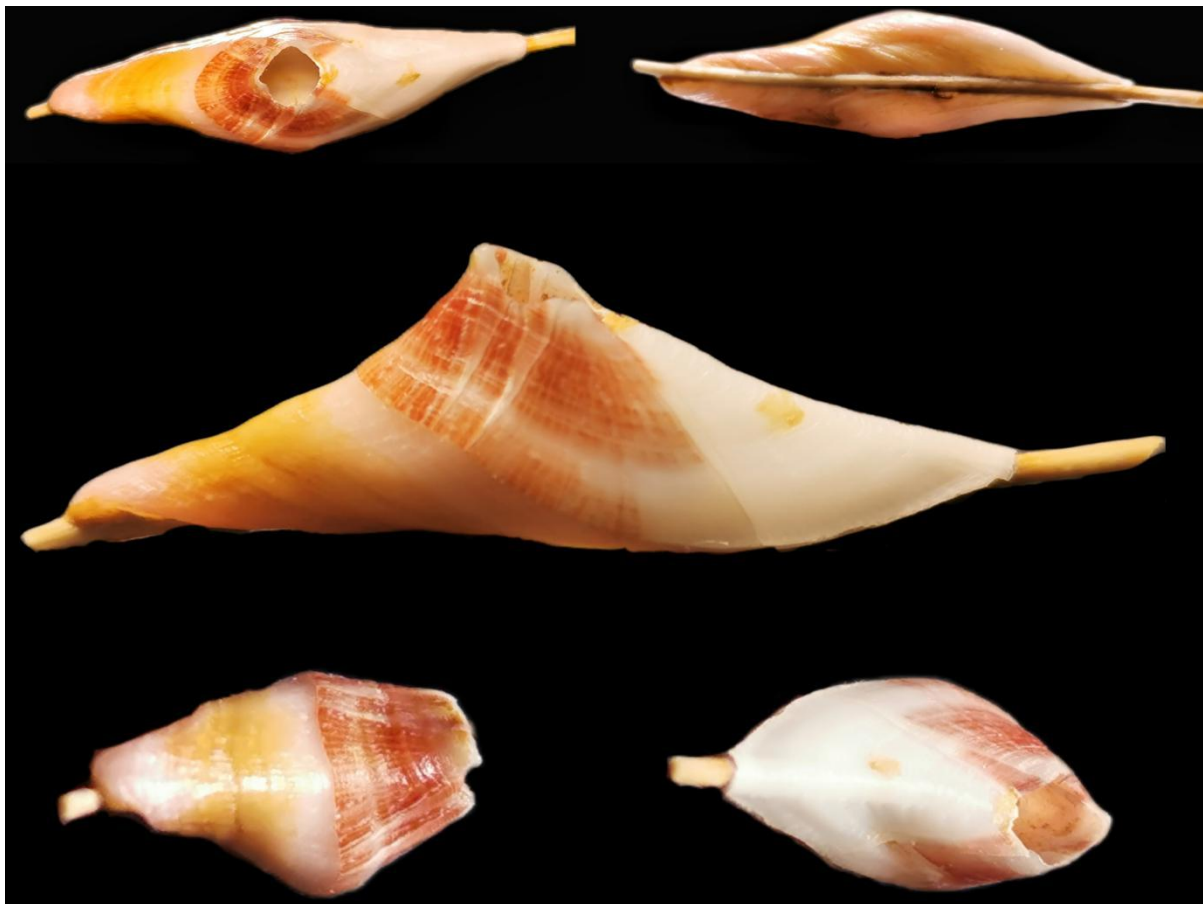


Figure 5. *Conopea changdi*, holotype.

Diagnosis.—Shell elongated in basis and rostrum. Basis narrow diamond, basis is pale pink with yellowish broad stripes. There is a groove in the center that embeds half of the host's protein axis into the basis. The basis has the lowest and horizontal edge at the rostrum position, then rises along the rostral latus, lateral plate, carinal latus curve and is the highest at the carina position. This makes the edge of the basis look like part of a hyperbola from the side. The length of Basis is much longer than , which allows basis to extend about 1/3 barnacles behind the carina, forming a sharp angle similar to rostrum and keeping the bottom of the entire barnacle in a plane. Carina, rostral latus, lateral plate and carinal latus have longitudinal purplish red fine stripes and white stripes parallel to the edge of basis. The color of the rostral latus near the rostrum gradually fades. Rostrum is white. The position of the connection between carina and basis is very smooth and there is no obvious angle. The height of the rostrum decreases very gently, with a ridge in the middle corresponding to the axis of the host.

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cemented to each other at the contact sutures, orifice that is not dentate but smooth or even.

Remarks.—For the same reason as *Conopea hongqi*, its software and tergum and scutum are completely missing.

Etymology.— changdi(长底) means long basis in Chinese.

***Conopea niuqv* sp. nov.**

Figures 6-7



Figure 6. *Conopea niuqv* , holotype.

Type locality: China.the South China Sea, near Danzhou in the Beibu Gulf, 20-25 m, local fishermen use crab nets collected, on antipatharians.

Holotype is stored in National Zoological Museum of China.

Paratypes:4 specimens, same data as holotype.

Diagnosis.—Shell elongated in basis and rostrum. The center of the barnacle is always at the bifurcation of the twigs of the antipatharians. This causes basis to bend upward with the host branch as it extends toward rostrum and carina, with a V-shaped bottom edge rather than a straight line like *Conopea hongqi* or *Conopea changdi*. The basis is very high, accounting for half the height of the barnacle, including the basis below the rostrum. (in *Conopea hongqi*, the basis below the rostrum has almost no height, and in *Conopea changdi*, the basis below the rostrum has no height at all.) the basis below the carina is not closely connected to the host axis, and the basis under the rostrum wraps all or almost all of the host axis. This causes the basis below the rostrum to distort with the distortion of the host's axis, and distorts the rostrum to some extent. There is a broad purplish red band parallel to the lower edge of wall plates in the middle of carina, rostral latus, lateral plate and carinal latus, and the rest , rostrum and rostrum white.

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axis. This causes the basis below the rostrum to distort with the distortion of the host's axis, and distorts the rostrum to some extent. There is a broad purplish red band parallel to the lower edge of wall plates in the middle of Carina, rostral latus, lateral plate and carinal latus, and the rest, radius and rostrum white. The upper edge of rostrum is almost horizontal, and the upper edge of carina drops gently. Wall plates surface is smooth heavily cemented to each other at the contact sutures, orifice that is not dentate but smooth or even.

Remarks.—For the same reason as *Conopea hongqi*, its software and tergum and scutum are completely missing.

Etymology.— niuqv (扭曲) means twist in Chinese. Because the basis and rostrum of this barnacle bend as the host axis bends.

Discussion

In addition to the genus *Conopea*, a few species of the subfamily Acastinae are symbionts of antipatharians or gorgonians. There are several obvious differences between Acastinae species and *Conopea* species: the wall plates of most *Conopea* are heavily cemented to each other at the contact sutures, whereas those of *Acastinae* are loosely attached to each other. The shape of *Conopea* is slender, the axis of rostrum-carina is obviously elongated, while in species of the Acastinae it is more rounded, the axis of rostrum-carina is not particularly elongated. *Conopea* has an orifice that is not dentate but smooth or even, radii with summits parallel to the basal margin of the parietes, and denticulated sutural margins, Acastinae has a dentate orifice, and radii with oblique summits. *Conopea hongqi* has all the features *Conopea* and is attached to antipatharians. Of the 20 species of *Conopea*, only *C. cornuta* from the Gulf of Guinea in Africa has a special structure similar to *C. hongqi*, with two sharp corners extending from the side to the side. But *C. hongqi* is thinner and longer than *C. cornuta*, and the thorns protruding to the left and right sides of lateral plate and basis are much longer than those of *C. cornuta*. The axis of the basis

of *C. cornuta* is an obvious arc, nearly semicircular, while the axis of *C. hongqi* is a straight line. *Conopea cornuta*'s wall plates are red, yellow, and white, and *C. hongqi* is fuchsia. The scutum of *C. cornuta* is distinctly convex, with rather prominent growth ridges. The basal margin is sinuous. The articular ridge occupies two thirds of the length of the tergal margin, and is reflexed, but narrow. The adductor ridge is confluent with the articular ridge in the upper part and quite indistinct in the lower part. The tergum has its apex pointed but not extended. There is no longitudinal furrow, and the spur, the width of which is approximately half that of the whole valve, is low and obliquely rounded. The scutal margin is nearly straight; there is hardly any distance between the basi-scutal angle and the spur. The basal margin is slightly hollowed (see Hoek 1913) The scutum of *C. hongqi* is relatively flat, the height of the articular ridge is approximately half that of tergal margin, spur wider than long, slightly less than half the width of the basal margin; it has a flat end and is very short, approximately one-quarter of the height of tergum, the scutal margin straight, and the carinal margin is slightly convex.

The habitats of *C. hongqi* and *C. cornuta* are also different: *C. cornuta* was collected from the Gulf of Guinea, Africa, 32 meters deep, attached to gorgonians, while *C. hongqi* comes from the 1956 area of the East China Sea, 350–450 m deep, attached to antipatharians.

The shape of the *Conopea changdi* is similar to that of the *Conopea titani* or *Conopea margaretae*, slender, like a canoe, and with a smooth upper edge. However, apart from the differences in color, growing environment, and host species, the most significant difference is that the upper edge of *Conopea titani* and *Conopea margaretae* is smooth because their carina extends very long to the end of the barnacle, in contact with the host axis. The upper edge of *Conopea changdi* is smooth because the connection between basis and carina is very smooth. Carina of *Conopea changdi* is very short, and barnacle has about a third of its length purely basis. In this 1/3, the upper margin merging of basis plays the role of both basis and carina. This structure is closer to *Conopea exothobasis*. But there is an obvious angle between the joints of *Conopea exothobasis*'s basis and carina. And the other aspects

of the two kinds of barnacles are also different, such as color, environment and host.

Van Syoc et al. (2014) indicated that "The acastine species living in gorgonians differ from *Conopea* species in several ways, the most obvious is the form of their attachment to the host. *Conopea* species are cemented directly, and firmly, to the surface of the gorgonian axis. The coenenchyme of the gorgonian overgrows the shell of *Conopea* species, but the proteinaceous axis generally does not. On the other hand, individuals of Acastinae become completely embedded in the proteinaceous axis rather than living attached to the surface of the gorgonian axis. The wall plates of most *Conopea* are heavily cemented to each other at the contact sutures, whereas those of acastines are loosely attached to each other and disarticulate very easily with handling or treatment in dilute sodium hypochlorite."

But *C. hongqi* and *C. niuqv* appeared the above two life styles at the same time-*C. hongqi*, which lives on the finer antipatharians branches, only attached to the surface of the branches, was covered by coenenchyme, and was not embedded in the protein axis of antipatharians. On the other hand, *C. hongqi*, which lives on the thicker antipatharians branch, is embedded in the protein axis of antipatharians, showing only the opening.

It should be noted that although *C. hongqi* and *C. niuqv* exhibits the same morphology-that is, it is wrapped by the protein axis of the host-the causes of the two are probably not the same. The basis of *C. hongqi* does not wrap the protein axis of the host. On the contrary, the protein axis of the host forms a yellow membrane that wraps the basis of *C. hongqi*. This means that the completely wrapped *C. hongqi* may be just an extreme example of the first way of life-the host's membrane is so long and thick that it wraps not only the basis of *C. hongqi*, but also the rest of *C. hongqi*, leaving only an opening for cirrus to stretch. For *C. hongqi*, this means that being wrapped in the axis of the host is a normal state of life, and the wrapped *C. hongqi* can still live well. There are several pieces of evidence to prove this-all fully wrapped *C. hongqi* have openings for cirrus to stretch. The lateral spines of two fully wrapped *C. hongqi* punctured the protein axis, and the other part wrapped it with a crack. This means that the three barnacles are still alive and well after being wrapped, and even

grow up to destroy the axis that wraps them. Traces of physical decay were found in more than one completely wrapped *C. hongqi*.

For *C. niuqv*, its basis will be embedded or even completely wrapped around the host axis. This means that being wrapped in the host's axis is unlikely to be a continuation of its first way of life. At the same time, all the wrapped *C. niuqv* were completely wrapped, not even leaving an opening protruding from the total cirrus. This means that the fully wrapped *C. niuqv* will either starve to death-if they haven't died before-or be forced to get nutrition entirely from the host. Considering that none of the other species of *Conopea* found this way of feeding, and none of the axes of the packaged *C. niuqv* showed any sign of being broken-which means they didn't grow up at all after being wrapped-so all the wrapped *C. niuqv* are probably dead. This may be a way for antipatharians to get rid of its parasites.

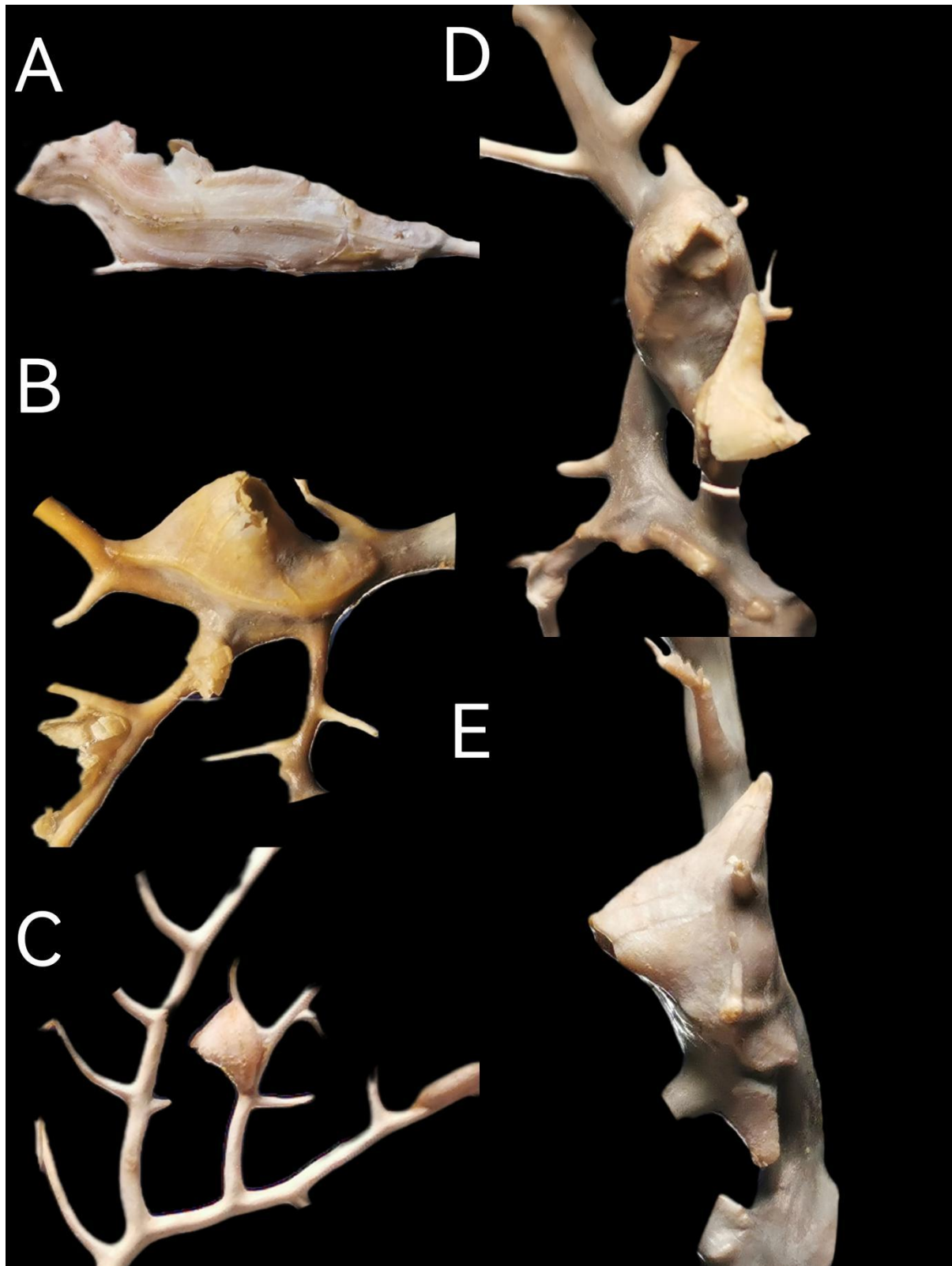


Figure 6. *Conopea niuqv* , paratypes 1 to 4, **A** Breakage **C** larva, **B**, **D** and **E** in the axis of the host, **D** and **E** is the same specimen, **D** can see that the opening for cirrus stretching is sealed.



Figure 7. *Conopea. hongqi*, paratypes 9 to 12, in the axis of the host.

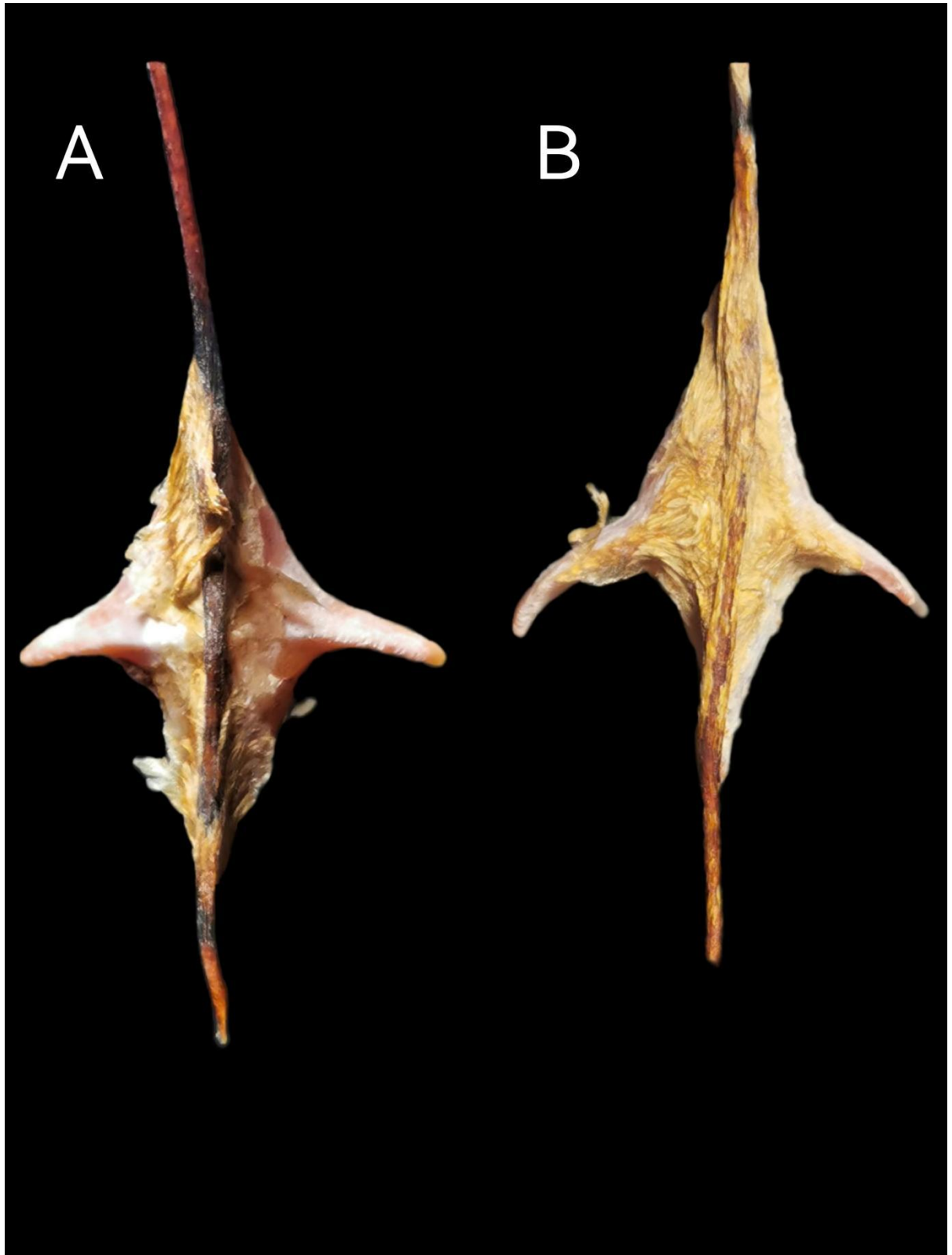


Figure 8. *Conopea. hongqi*, paratypes 3-4 In the back view, the basis that extends from the host axis and wraps the barnacle.

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