

A New Species of Copepod Associated with *Pleurobranchaea californica*

(Gastropoda : Opisthobranchia)

with Discussion on *Anthessius* Associated with Notaspidean Sea Slugs

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(3 Text figures)

INTRODUCTION

MEMBERS OF THE COPEPOD GENUS *Anthessius* (Poecilostomatoida : Myicolidae) are largely associated with marine pelecypods and gastropods. Currently 34 nominal species are known in this genus with five of them occurring on the west coast of North America. Four of these North American species are: *A. navanacis* (Wilson) found on *Navanax inermis* (Cooper) (Gastropoda : Aglajidae), *A. nortoni* Illg on *Diodora aspera* (Rathke) (Gastropoda : Fissurellidae) and *Megathura crenulata* (Sowerby) (Gastropoda : Fissurellidae), and *A. fitchi* Illg in *Chaceia ovoidea* (Gould) (Pelecypoda : Pholadidae) and *Zirfaea pilsbryi* Lowe (Pelecypoda : Pholadidae) (ILLG, 1960; HUMES, 1981). The fifth species, "*Anthessius* sp. A.," is so far known only from a single male specimen discovered accidentally in the gill cavity of a surfperch caught in the same trawl in which fifteen species of gastropods and three species of pelecypods were also found (DOJIRI, 1977). The trawl was made off Huntington Beach in southern California.

Recently, Dr. F. G. Hochberg of Santa Barbara Museum of Natural History sent to me a collection of copepods containing five ovigerous females and one mature male of a species of copepod that were removed from a notaspidean sea slug, *Pleurobranchaea californica* MacFarland, that was trawled off the coast of Santa Barbara, California. A close examination of these copepods revealed that they are identifiable with DOJIRI's (1977) *Anthessius* sp. With the discovery of ovigerous females and its natural host, a full description of this incompletely known species of *Anthessius* is now in order. In the course of studying this new species, certain characters in common were discovered in five species of *Anthessius* that are normally associated with sea slugs of the Order Notaspidea. Therefore, a discussion on this matter will be given following the description of the new species.

I wish to thank Dr. F. G. Hochberg for placing the copepod associates of *Pleurobranchaea californica* at my disposal. The holotype (USNM 189057), allotype (USNM 189058), and two paratypes (USNM 189059) have been deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Anthessius obtusispina Ho, spec. nov.

(Figures 1 through 3)

Female: The body (Figure 1A) measures 3.79 (3.63-3.90) mm long and 1.64 (1.57-1.71) mm wide. The fifth pedigerous somite (Figure 1B) is about as wide as long. The caudal ramus (Fig. 1C) is 3 times as long as wide. The egg sac (Figure 1A) is large, carrying numerous small eggs of about 60 μ m in diameter.

The first antenna (Figure 1D) is 7-segmented; the armature on these segments is 4, 15 (7 + 8), 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. The second antenna (Figure 1E) is 4-segmented, with the 2 distal segments indistinctly separated; the formula for the armature is 1, 1, 3, and 4 + III. The labrum (Figure 1F) is broad, with a large central incision on the posterior margin; each spherical posterolateral plate carries a blunt inner process. The mandible (Figure 1G) is typical of *Anthessius*, but a short dentate lamella is added between the apical lash and the long setiform element (Figure 1H). The first maxilla (Figure 1I) is bilobed distally; the inner lobe bears only 1 short, stubby element. The second maxilla (Figure 2A) has 11 or 12 teeth on its terminal process. The maxilliped (Figure 2B) is indistinctly 3-segmented and greatly reduced; the pointed distal segment bears a small subterminal seta.

Legs 1-4 (Figures 2C-H) are biramous, with each ramus being 3-segmented. The spine (Roman numerals) and setal

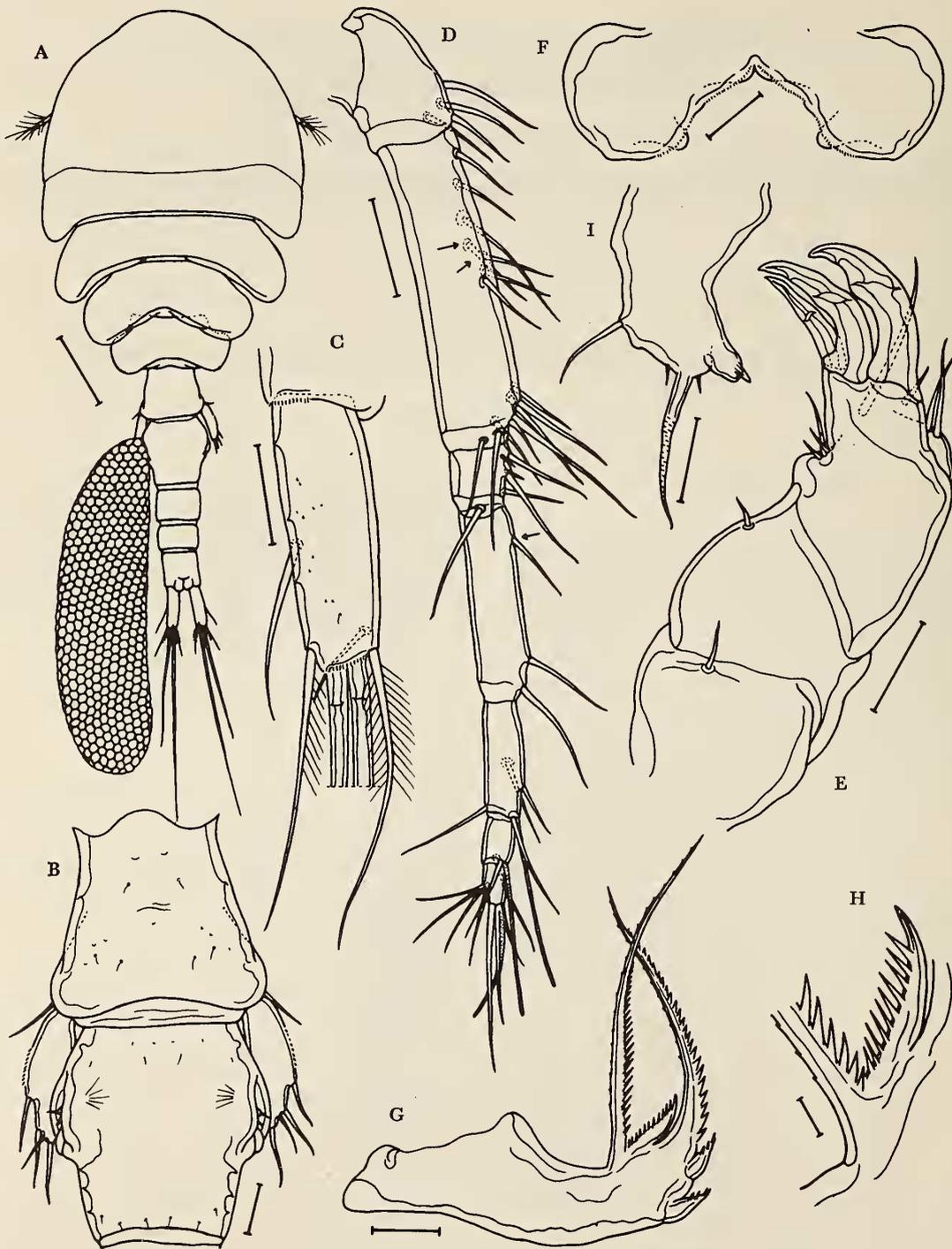


Figure 1

Anthessius obtusispina Ho, spec. nov. Female: A, habitus, dorsal; B, fifth pedigerous somite and genital somite, dorsal; C, caudal ramus, ventral; D, first antenna (arrows indicate positions of added aesthetes in the male); E, second antenna; F, labrum; G, mandible; H, dentate lamella on mandible; I, first maxilla

Scale: 500 μ m in A;
100 μ m in B, C, D, E; 50 μ m in F, G, I; 10 μ m in H



Figure 2

Anthessius obtusispina Ho, spec. nov. Female: A, second maxilla; B, maxilliped; C, terminal segment of leg 1 exopod; D, leg 1 endopod; E, distal half of leg 2 endopod; F, distal half of leg 3 endopod; G, terminal segment of leg 4 exopod; H, distal half of leg 4 endopod; I, leg 5. Scale: 50 μ m in all drawings

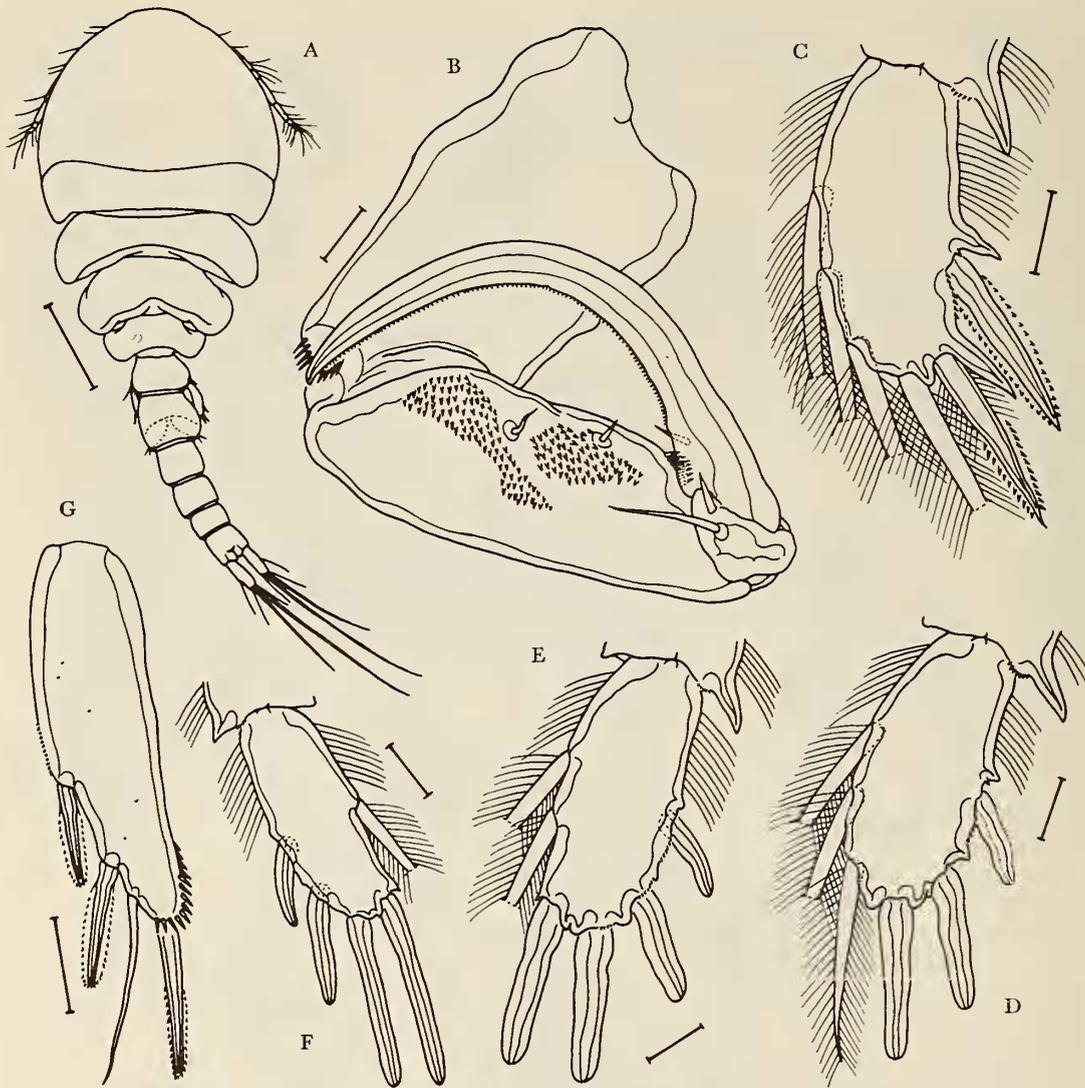


Figure 3

Anthessius obtusispina Ho, spec. nov. Male: A, habitus, dorsal; B, maxilliped; C, distal half of leg 1 endopod; D, distal half of leg 2 endopod; E, distal half of leg 3 endopod; F, distal half of leg 4 endopod; G, free segment of leg 5. Scale: 500 μ m in A; 50 μ m in B through G

(Arabic numerals) formulae on these rami are as follows:

	Exopod	Endopod
Leg 1	I-0; I-0; III,I,4	0-1; 0-1; I,5
Leg 2	I-0; I-0; III,I,5	0-1; 0-2; III,3
Leg 3	I-0; I-0; III,I,5	0-1; 0-2; IV,2
Leg 4	I-0; I-0; III,I,5	0-1; 0-2; IV,1

The free segment of leg 5 (Figure 2I) is about 2.9 times as long as wide; it is armed with 3 slender setiform spines and 1 simple seta. Leg 6 is represented by 2 small setae in the area of egg sac attachment on the genital somite.

Male: The body (Figure 3A) is only slightly smaller than the female, measuring 3.26mm long and 1.23mm wide.

The first antenna is armed slightly differently from that of the female in adding 2 aesthetes to the second segment and another aesthete to the fourth segment (indicated with an arrow in Figure 1D). The maxilliped (Figure 3B) is 4-segmented and armed as in many species of *Anthessius*. The endopod of leg 1 (Figure 3C) is armed in the terminal segment with 2 denticulate spines and 4 plumose setae. The spines on the terminal segment of the endopod of leg 2 (Figure 3D), leg 3 (Figure 3E), and leg 4 (Figure 3F) are characteristically smooth and obtuse. The spines on the free segment of leg 5 (Figure 3G) are different from those of the female in being strong and denticulate.

Etymology: The specific name *obtusispina*, from Latin *obtusus* = blunt and *spina* = having spines, alludes to the characteristic obtuse spines on the endopod of leg 2 through leg 4 in the male.

Remarks: A close comparison with DOJIRI's (1977) description of *Anthessius* sp. has led me to believe that the single male specimen found in the gill cavity of a surfperch off Huntington Beach is a member of *A. obtusispina*. My belief is further supported by the fact that the natural opisthobranchiate host, *Pleurobranchaea californica* MacFarland, was on the list of gastropods that were captured in the same trawl with the surfperch that carried the copepod.

The present new species bears the closest resemblance to *Anthessius concinnus* (A. Scott), which was found in the plankton sample (2 females and 8 males) collected during the Siboga Expedition to the East Indies. When compared with A. SCOTT's (1909) description, the new species differs from *A. concinnus* mainly in the shape of the fifth pedigerous somite and the free segment of leg 5. Since the male of *A. concinnus* was hardly described in A. SCOTT's original work, it was reexamined and partially redescribed by STOCK, HUMES & GOODING (1963), when they reported *Anthessius* associates of West Indian invertebrates. Based on their redescription, the male of *A. obtusispina* is different from that of *A. concinnus* in the structure of leg 5.

Anthessius Associated with Notaspidea

The genus *Anthessius* was established by DELLA VALLE (1880) based on two species of copepods that were found in Naples, Italy, in association with a pelecypod, *Solenocurtus strigilatus* (Linnaeus), and a gastropod, *Pleurobranchaea meckeli* (Blainville), respectively. He gave a rather detailed description for *A. solenocurti* but only one paragraph and three drawings for *A. pleurobrancheae*. However, he did point out that these two species were markedly different in the number of teeth on the second maxilla, while there were only four teeth in *A. solenocurti*, *A. pleurobrancheae* had more than ten.

There are now four species of *Anthessius* known to be associated with notaspidean sea slugs. In addition to the aforementioned Italian species and the above described Californian species, there are *A. hawaiiensis* (Wilson) found on *Pleurobranchus* sp. in Hawaii (WILSON, 1921; ILLG, 1960) and *A. ovalipes* Stock, Humes & Gooding from *Pleurobranchus areolatus* Mitchell in the West Indies (STOCK, HUMES & GOODING, 1963). A comparison of the appendages of *Anthessius* has revealed that the notaspidean associates have five features in common that collectively distinguish them from the rest of the *Anthessius*. *A. concinnus* (A. Scott) should be included in this group although its host is still unknown.

The five common characteristics of these five species of *Anthessius* are: 1) a second antenna armed with three terminal spines, 2) a mandible bearing a short dentate lamella between the bases of the apical lash and the setiform element, 3) a second maxilla armed with a large number of teeth (at least ten) in the terminal process, 4) the last segment of leg 4 exopod having a formula of III,I,5 and 5) the endopods of legs 2 through 4 in the male bearing obtuse and smooth (instead of pointed and denticulate) spines. The property of mandible and the male endopods appear to be unique to these notaspidean associates. In view of the importance of the mandible in the modern taxonomy of the copepods associated with the marine invertebrates (HUMES & STOCK, 1973), I have thought of removing these five species from the genus *Anthessius*. However, since three of these five species are still incompletely known and the copepod associates of both *Pleurobranchaea* and *Pleurobranchus* from many parts of the world are yet to be discovered, it was concluded not to erect a new genus before more information is available for a better assessment of their character state.

It is interesting to note that two monotypic genera of Mycolidae, *Katanthessius* and *Neanthessius*, have the same kind of dentate lamella in their mandibles; *K. delamarei* Stock was found in association with *Marionia blainvillea* Risso (Nudibranchia: Tritoniidae) at Banyuls, France (STOCK, 1960) and *N. renicolis* Izawa was reported from the renal sac of *Pleuroploca trapezium audouini* (Jonas) and of probably *Fusinus nigrirostratus* (Smith) (Prosobranchia: Fasciolaridae) at Seto, Japan (IZAWA, 1976). However, both species are distinguishable from the notaspidean associates in the armature of the legs.

Two species of *Anthessius*, *A. pectinis* Tanaka and *A. pinctadae* Humes, are also worthy of mentioning. Both species were found in the mantle cavities of Pelecypoda (*Pecten laqueatus* Sowerby and *Pinctada margaritifera* Linnaeus, respectively) and they are, like the five species of notaspidean associates, armed with three terminal spines in the second antenna, carrying a high number of teeth (15 in *A. pectinis* and 8 in *A. pinctadae*) on the terminal process of the second

maxilla, and bearing a formula of III,I,5 in the last segment of leg 4 exopod (TANAKA, 1961; HUMES, 1973). Taking into consideration the fact that more than half of the known species of *Anthessius* are associated with Pelecypoda, it seems very likely that the modern mycolid copepods associated with the notaspidean sea slugs have evolved from the species of *Anthessius* or *Anthessius*-like copepods that was once associated with bivalves but succeeded in shifting its host preference to the Notaspidea. If this is really the case, then, the dentate lamella in the mandible and the transformation of spines in the male endopods are some apomorphic characters that were developed through the adaptation of life on the notaspidean sea slugs. Furthermore, *Katanthessius* and *Neanthessius* may represent two lines of further host-shifting among the copepod associates of the Notaspidea, with the former being adapted to live on the nudibranch and the latter, in the snail.

SUMMARY

A new species of poecilostomatoid copepod, *Anthessius obtusispina*, is described based on specimens recovered from a sea slug, *Pleurobranchaea californica* McFarland, caught at Santa Barbara, California. Five species of *Anthessius*: *A. concinnus* (A. Scott), *A. hawaiiensis* (Wilson), *A. obtusispina* Ho, *A. ovalipes* Stock, Humes & Gooding, and *A. pleurobranchae* Della Valle, that have five characters in common, are discussed and speculated to have originated from those *Anthessius* or *Anthessius*-like copepods that were once asso-

ciated with bivalves but had subsequently shifted to live on the gastropods of the Order Notaspidea.

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