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NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

A NEW MONOPLACOPHORAN LIMPET FROM THE CONTINENTAL SHELF OFF SOUTHERN CALIFORNIA

By James H. McLean

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Edward Ostermeyer
Editor

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CONTENTS

The *Science Bulletin* and *Contributions in Science* of the Natural History Museum of Los Angeles County were merged into a single imperial octavo serial, retaining the name *Contributions in Science* and beginning with Number 301.

This serial has been newly formatted for maximum use of typography and illustrations per page, and sized for maximum use of paper. All photography has been produced utilizing a 200-line screen for detail.

Since most institutions rebind *Contributions in Science* collectively into hardbound volumes, and many researchers using them desire to photocopy material, two new features have been incorporated into the new format. A suggested citation line provides the abbreviated serial title, year, number of publication, and total pagination, and appears in the lower left corner of each page; and pages of *Contributions in Science* have been printed off-center to provide a two-inch gutter between adjacent pages for easier accessibility in photocopying.

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Contributions in Science are articles in the earth and life sciences, presenting results of original research in Natural History. *Science Bulletin* (Numbers 1–30; 28 June 1965 to 10 April 1978) and *Contributions in Science* Numbers 1–300; 23 January 1957 to 16 June 1978) were merged into a single imperial octavo serial beginning with Number 301.

A NEW MONOPLACOPHORAN LIMPET FROM THE CONTINENTAL SHELF OFF SOUTHERN CALIFORNIA[1]

By James H. McLean[2]

ABSTRACT: A new subgenus and species of monoplacophoran, *Vema (Laevipilina) hyalina,* is described from specimens with a maximum length of 2.3 mm taken on rocks from depths between 174–388 m on the Santa Rosa-Cortes Ridge of the southern California continental borderland. The shell differs from other living neopilinids in being nearly transparent and lacking clathrate sculpture. As in the genus *Vema,* there are six pairs of gills and distinct postoral tentacles. *Vema,* on the basis of six pairs of gills is here regarded as generically distinct from *Neopilina,* which has five. On shell characters the new subgenus *Laevipilina* differs from *Vema* in lacking concentric sculpture and in having its structural prisms of a depth equal to their diameter rather than twice the diameter. Radular comparisons among neopilinids are here made for the first time; the radula of the new species differs from that of three other neopilinids in having a more prominent first lateral tooth. *Vema (Laevipilina) hyalina* is the first monoplacophoran to be verified as living on a rocky substratum and the first to be found at continental shelf depths. Living specimens are accessible, suggesting that much will soon be learned about its anatomy and life history.

INTRODUCTION

Until 1952 the monoplacophoran limpets were known only from the Paleozoic fossils. On shell characters they differ from modern gastropod limpets in having the muscle scar divided metamerically. Paleontologists had regarded the fossil genera as early patellaceans. No advance was made until 1938, when Wenz (1938: 59) suggested that the symmetrically paired muscle scars of the Silurian genus *Tryblidium* might correspond to the arrangement of muscles in chitons. At that point he separated them from the Patellacea and established the superfamily Tryblidiacea for the group. Two years later he developed his idea further by considering them to represent untorted gastropods and distinguished them from prosobranch gastropods at the subclass level (Wenz 1940). He was the first to mention the name Monoplacophora but did not use it in a formal sense, stating that N. H. Odhner had suggested the name to him (see Knight, Lemche, and Yochelson, 1958). Knight (1952) enlarged upon Wenz's theory and used Monoplacophora with ordinal rank equivalent to Polyplacophora, the chitons.

Dramatic proof that monoplacophorans were untorted limpets became available in 1952 when a living species was discovered by the Danish Galathea Expedition at abyssal depths in the eastern Pacific off Costa Rica. The announcement of the discovery took place five years later when the species was described by Lemche (1957) as *Neopilina galatheae.* Its anatomy was thoroughly monographed by Lemche and Wingstrand (1959). Additional anecdotes about the original discovery were given later (Lemche 1972).

Neopilina is an untorted limpet with a posterior anus and serially repeated muscles, gills, and other organs. *Neopilina* was the most exciting malacological discovery of the century, a living fossil — a relict of a once diverse group of mollusks. An additional living class of mollusks was recognized, now apparently surviving only in the deep sea.

Further finds of *Neopilina* since the original discovery proved that living monoplacophorans are more widely distributed than was originally assumed. In recent years five more species of *Neopilina* have been described and other records of unidentified species have been published, all found at abyssal or hadal depths. The second described species, *Neopilina ewingi* Clarke and Menzies 1959, from the Peru-Chile Trench, differed from *N. galatheae* in having six pairs of gills instead of the five pairs of *N. galatheae.* Because of this difference it was made the type species of the subgenus *Vema* Clarke and Menzies 1959. Further discoveries brought the number of described species of *Neopilina* to a total of five and those of *Vema* to two.

My involvement in the study of monoplacophorans began in 1966, when, in connection with my interest in gastropod limpets, I was given the opportunity to work upon two small specimens in the S. Stillman Berry Collection. The specimens, not exceeding 2.3 mm in length, had been taken on rocks snagged on hook and

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line by a fisherman, Louis Zermatten, in the vicinity of the Cortes Bank, due west of San Diego, California, in 1965. One was from a depth of 95 fathoms (174 meters) and the other from 125 fathoms (229 meters). The rocks bearing the limpets were saved for John E. Fitch of the California Department of Fish and Game. He removed the associated mollusks and gave them to S. Stillman Berry of Redlands, California.

The dried animal of the first specimen was sacrificed for a radula preparation. Initial study of the radula (Figs. 20, 21) suggested a new group in the Patellidae, with a radula characterized by a narrow rachidian, three pairs of laterals and two pairs of flaring marginals. A minute, deep water representative of the Patellidae, otherwise known from robust intertidal forms, was unexpected, but it seemed clearly to be the case, based on the radular evidence. In the hope that more specimens would eventually be found, I delayed further work on this remarkable find. Nine years passed but no additional material came to light.

In 1975 I again turned my attention to the specimens on hand. Only then did I closely examine the specimen that still contained the dried animal. Through the dorsal surface of the nearly transparent shell I noted the circularly coiled intestine that is one of the hallmarks of the described species of *Neopilina* (Fig. 1). Then other monoplacophoran features such as metamerically paired shell muscles and a posterior anus were observed. Upon rehydrating the animal and examining it in fluid, the shell became more transparent and its structural prisms visible (Figs. 2, 3). It thereupon became clear to me that this was a monoplacophoran limpet. Contrary to all previous expectations for the group, it had come from a rocky substratum in relatively shallow water.

FIGURE 1. *Vema (Laevipilina) hyalina* new species. LACM 19149, 2.16 mm in length, dorsal view prior to rehydration of the soft parts and prior to removal of encrustations from the shell surface. The anterior apex is visible near the top and the intestine with four coils is seen through the nearly transparent shell slightly posterior to the midpoint. Photograph by Solis.

The rehydration of the specimen containing the dried animal did not fully restore the features of the ventral surface. Structures recognized were the head, mouth, velum extending laterally and posteriorly to the head, radiating pedal retractor muscles, and the posterior anus. There seemed to be no sign of gills or of postoral tentacles that also characterize the group. Moreover, the true shape of the foot could not be discerned. It seemed that it was partially missing with nothing remaining but a stump in the central area. An S-shaped structure that was clearly visible was interpreted as the radular sac, considering that the radula extracted from the other specimen was more than half the length of the shell. The shell appeared completely smooth, devoid of all traces of clathrate sculpture seen in the described species of *Neopilina*. The radula also seemed to differ considerably from that of *N. galatheae*, the only species for which a radula had been illustrated.

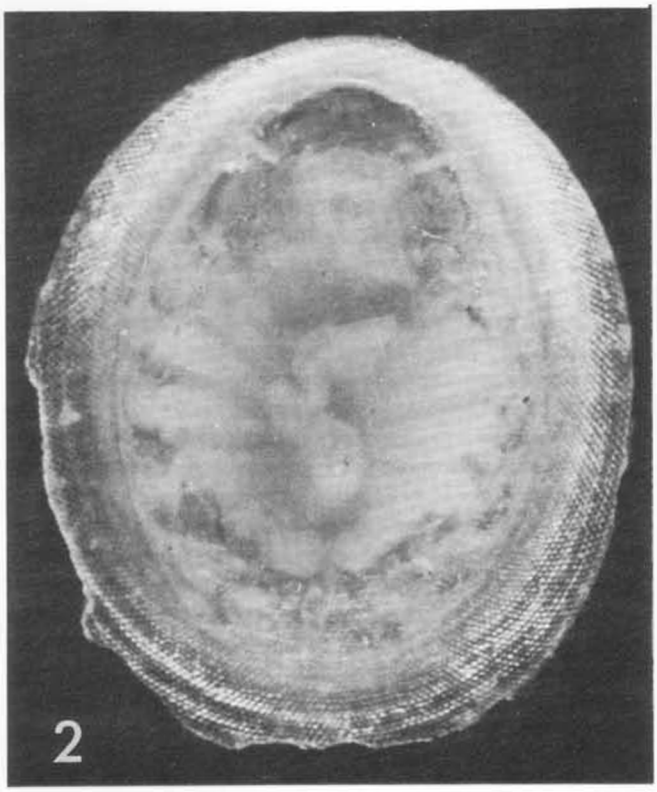
At that point in my studies I presented the preliminary findings to the American Malacological Union — Western Society of Malacologists joint meeting in San Diego, June 1975. Based on the smooth shell, radular differences, and apparent absence of gills, I considered that a new genus was indicated for the newly discovered species, and so announced an intention to propose one. The abstract resulting from my presentation was published 30 January 1976 (McLean 1976).

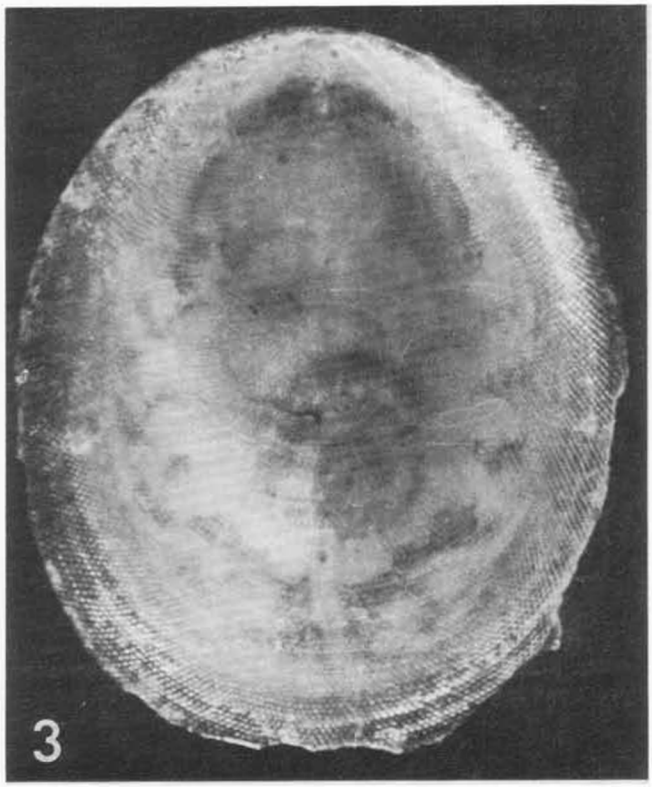
In the fall of 1975 an intensive offshore sampling program was initiated by the U.S. Bureau of Land Management (BLM) on the continental shelf of southern California, coinciding with the leasing of offshore tracts for oil exploitation. A group of biologists headed by Gilbert F. Jones of the University of Southern California contracted to do the biological portion of the work. Although most of the stations were made on soft bottoms, there were some box core stations from rocky areas. Sorters and technicians were alerted to watch for the new microscopic monoplacophoran, but after six months of sampling none were found.

Meanwhile, early in 1976 I decided to publish my preliminary description of the species in the hope that this notice would stimulate efforts to find other specimens. After more closely scrutinizing the rehydrated specimen with improved optics I noted swellings on the mantle margin in the position where gills could be expected. Contrary to my earlier observations, six pairs of gills seemed to be present, although no clear configuration could be seen.

No radular descriptions had been published on any monoplacophoran species since the initial monograph of Lemche and Wingstrand (1959). I was able to obtain specimens of two other neopilinid species for radular comparisons. The results, discussed herein, indicated that the two other species bridged the gap between the radula of the new form and that of *N. galatheae*.

Although many questions remained unanswered, a draft of the manuscript was completed and circulated for review. As I was preparing to submit the paper for publication, two freshly collected specimens were found in sediment from one of the BLM stations. One had been picked from the residue by the sorters and subsequently recognized by Patrick I. LaFollette, a member of the BLM project. He reexamined the residue and found another. This was the breakthrough I had hoped would occur, for I now





FIGURES 2, 3. *Vema (Laevipilina) hyalina* new species. LACM 19149, 2.16 mm in length, rehydrated and photographed in alcohol. FIGURE 2, ventral view; FIGURE 3, dorsal view. Shell prisms show at the margin, arranged in curved rows; lighter and darker concentric rings represent growth lines. Head with mouth near top center. Below the head is the S-shaped radular sac and foot stump. Tubular rectum at bottom center. Seven pairs of pedal retractor muscles radiate from the center; the first pair is narrow, the second, third, fourth and fifth pairs are long and broad, the sixth and seventh pairs are short. Beyond the lateral terminations of all but the first pair of retractor muscles are 6 pairs of gills visible as swellings that blur the shell prisms. The dorsal view shows four dark coils to the intestine in lower center. In the dorsal view, the light areas encircling the central visceral area are the terminations of the broad bands of the pedal retractor muscles. Gills represented by the blurred lighter areas between the edge of the shell and the pedal muscle terminations. Photographs by Draper.

had preserved specimens showing the true condition of the foot and the clear presence of gills (Figs. 4, 5).

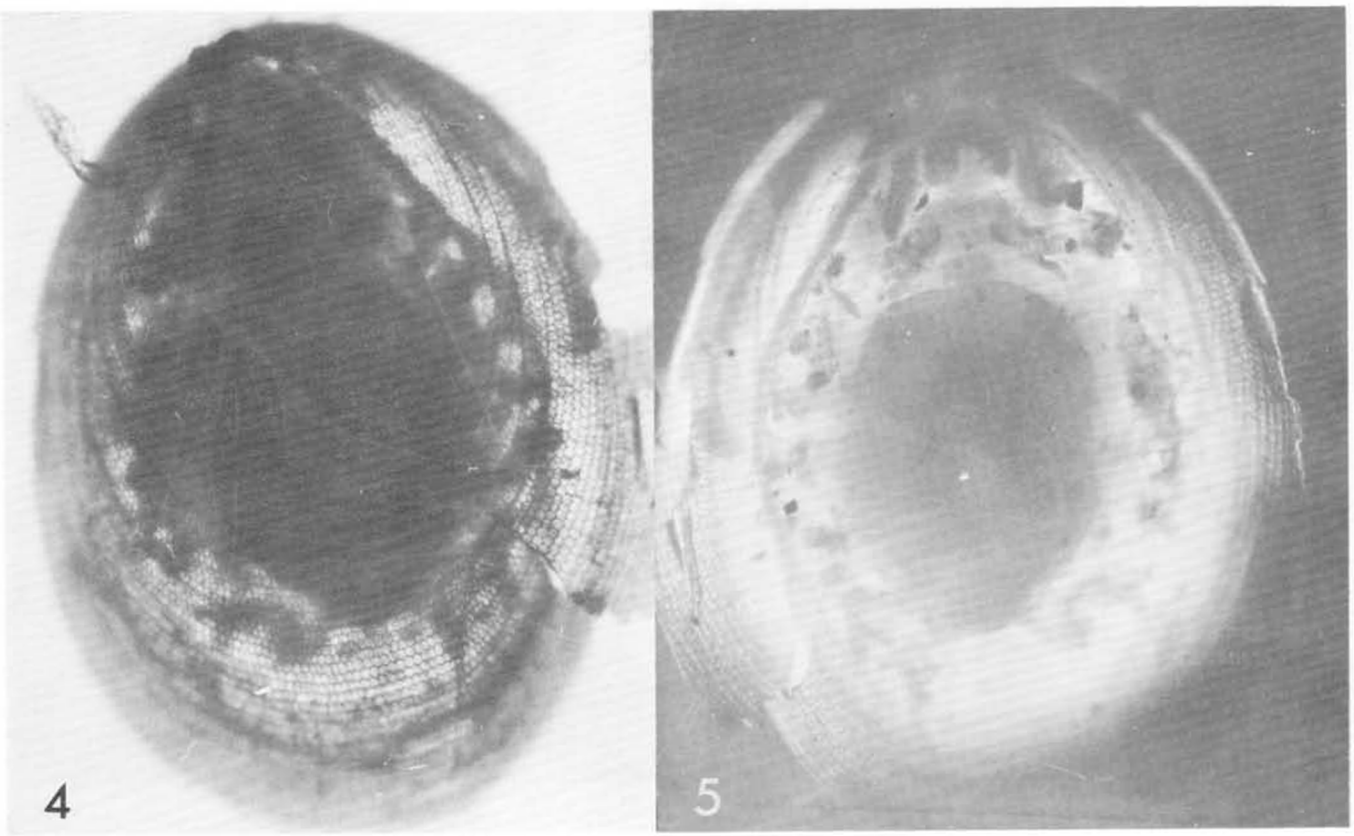
The two fresh specimens were somewhat smaller than the original two, with a maximum length of 1.75 mm. They came from a box core station on the Santa Rosa-Cortes Ridge between San Nicolas and Tanner Basins, at a depth of 388 m. Efforts to find more specimens in sediment residues from other unprocessed BLM stations from rock bottoms were unsuccessful.

Publication of the paper was withheld until I could learn more about the anatomy of the species. Although the specimens had not been fixed for histologic sectioning, it was hoped that sectioning would be possible. I asked the help of M. Patricia Morse at Northeastern University in Nahant, Massachusetts, who along with her associate, Nathan W. Riser, had work already underway on *Neopilina ewingi*.

Once again the material had limitations due to the lack of proper fixation. Many sections made by Morse and Riser from the smaller of the two specimens did not hold together and the results were disappointing. However, they prepared the larger specimen (Figs. 4, 5) by critical-point drying for viewing with a scanning electron microscope (SEM). That effort produced some highly satisfactory pictures on 11 February 1977, which are reproduced here (Figs. 6–8, 11).

In February 1977 further specimens were collected on a three day cruise of the *VELERO* led by Heinz A. Lowenstam of the California Institute of Technology, and assisted by LaFollette, now a member of the Malacology Section of the Museum. Efforts to recover the species with rock dredges and box cores were successful at the same locality as the earlier BLM station. Six living specimens attached to their rock substratum were obtained. The animals survived for several weeks at ambient water temperatures (Lowenstam 1977, abstract). A report on the behavior, ecology, and shell ultrastructure will be published elsewhere by Lowenstam. One of the living specimens was fixed for histologic sectioning to be done by Morse and Riser, who will also report separately on their results.

The rocks obtained on the cruise were examined aboard ship for living specimens and then preserved in 70% ethanol. Further examination of the rocks by LaFollette produced four more specimens that became the type lot. One of these specimens (Fig. 9), designated the holotype, is in excellent condition and shows most of the features now attributed to the species.



FIGURES 4, 5. *Vema (Laevipilina) hyalina* new species. LACM 19150, 1.75 mm in length. FIGURE 4, dorsal view, showing the regularity of the shell prisms, gills darkly outlined. FIGURE 5, ventral view, showing the 6 pairs of gills, U-shaped anterior lip of the mouth, the postoral tentacles clearly visible between the mouth and the foot. Photographs by Morse and Riser, light microscope, 4 X objective.

SUPRASPECIFIC CLASSIFICATION OF LIVING MONOPLACOPHORANS

The Monoplacophora have been recognized as a separate class of mollusks for a relatively short period. A revised classification of the Paleozoic fossil representatives was given by Knight and Yochelson (1958). Starobogatov (1970), and more recently, Runnegar and Jell (1976), have offered other versions.[3]

These classifications have been based largely upon shell form and the count and configuration of muscle attachment scars on the shell. The modern monoplacophorans have thin shells that lack readily visible muscle scars. Unfortunately, details of the musculature are known only for *Neopilina galatheae* as given by Lemche and Wingstrand (1959). There is therefore a poor basis upon which to compare diversity in the living species with the considerable diversity indicated in the fossil record.

When Lemche (1957) proposed *Neopilina galatheae* he placed it in the family Tryblidiidae, a group otherwise unknown since the Devonian. Knight and Yochelson (1958) established the subfamily Neopilininae for the species. Subsequent authors followed this scheme until Starobogatov (1970) disassociated the group from the Tryblidiacea altogether by recognizing both a separate family Neopilinidae and superfamily Neopilinoidea. However, Runnegar and Jell (1976) retained *Neopilina* in the Tryblidiidae.

A consideration of the overall classification of Monoplacophora is not within the scope of this paper; there are evidently some controversial aspects that will not readily be settled. Certainly a Recent family Neopilinidae may be justified on grounds in addition to the great disparity in age. The shells of neopilinids are thin and lack the massive development of the nacreous layer of the Devonian Triblidiidae (Erben, Flajs and Siehl 1968).

Generic criteria within the Neopilinidae are also lacking a sound basis for comparison. *Vema* Clarke and Menzies 1959, type species *Neopilina (Vema) ewingi* Clarke and Menzies 1959, was proposed as a subgenus of *Neopilina* chiefly on the presence of six pairs of gills, rather than five of *Neopilina*.

In the 18 years that have passed since the first two species were proposed, four more species of *Neopilina (Neopilina)* have been described, along with one more species of *Vema*. The number of gill pairs has proven to be a consistent character in species of each group regardless of size or growth stage. The supplementary criteria for *Vema*, thinner shell and thinner periostracum,

[3]While this paper was in its final stage of preparation, I received a useful review paper on the Recent monoplacophorans (Cesari and Guidastri 1976). The article, in Italian, contains an extensive bibliography that includes many titles omitted here. Also, an obituary of the late Henning Lemche (Knudsen 1977) includes references to other papers by Lemche on *Neopilinia* and its affinities.