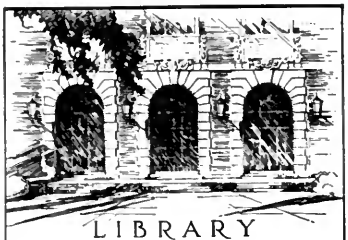

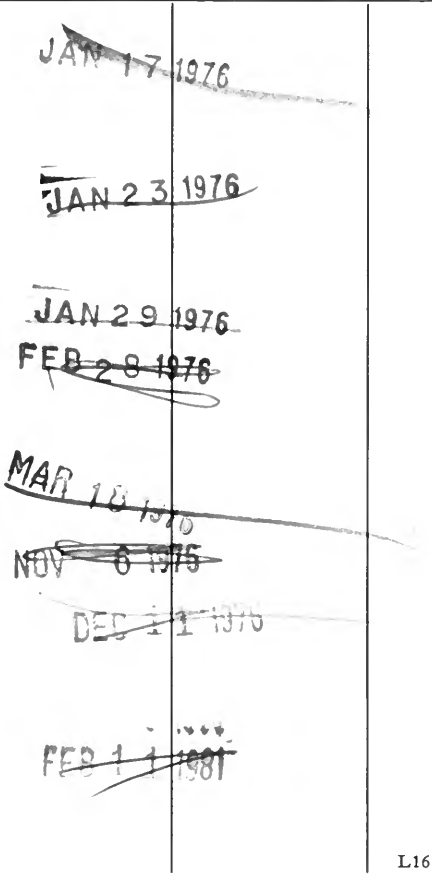

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MALACOLOGICAL NOTES—III

BY FRITZ HAAS
CURATOR OF LOWER INVERTEBRATES

Field studies on mollusks and other marine invertebrates of the California coast, in the interest of Field Museum's Division of Lower Invertebrates, were undertaken in April and May of 1941.

The observations and collections made in such a short time would have been impossible without the accommodations that the Scripps Institution of Oceanography at La Jolla and the Hopkins Marine Station at Pacific Grove kindly put at my disposition; I was further helped by the active aid of West Coast biologists, especially Miss Myra Keen of Stanford University, Dr. Joshua Baily of San Diego, and Mr. Paul S. Barnhart, Scripps Institution, La Jolla. Certain of the observations made, with the descriptions of two new species, are here reported, together with notes accumulated during my curatorial work at the Museum.

I am indebted to Mr. Percy S. Barnhart, of the Scripps Institution, for the new figure of the *Diplodonta* "nest" that had previously been figured by Johnson and Snook, and also for the figure of the shell of a *Diplodonta* within the shell of a *Callithaca*. These are from the Baker-Kelsey Collection. The San Diego Natural History Museum has kindly supplied two additional figures of *Diplodonta* nests. I am obliged to Mr. E. P. Chace, of San Pedro, California, who has communicated his observations of the nest-building habits of the *Diplodonta* to me; my data agree closely with his. The figure of *Cooperella*, supplied through the courtesy of Miss Myra Keen, Stanford University, is from a shell collected by Mr. and Mrs. T. S. Oldroyd, Stanford University Paleontological Type Collection No. 6982.

TWO NEW SPECIES OF MINUTE CALIFORNIA MARINE SHELLS

While a guest of the Hopkins Marine Station at Pacific Grove, California, I engaged in straining sand from a tidepool at Point

Pinos, Monterey Peninsula. Some apparently undescribed species were found among many other minute but well-known species. The drawings accompanying the descriptions were made by Mr. John Janecek, Staff Illustrator.

Alvania (Willetia) microglypta sp. nov. Fig. 1, *a*, *b*, *c*.

Type from Point Pinos, Monterey Peninsula, California; washed from sand in a tide-pool. No. 17028 Field Museum of Natural History. Collected May 19, 1941, by Fritz Haas.

Diagnosis.—A very minute species of the rissoid genus *Alvania*, subgenus *Willetia*, characterized by its extreme smallness, by a wide, subglobular nucleus of one and one-half whorls, by a solid shell strongly spirally keeled and by having only the slightest indications of intersecting axial sculpture.

Comparisons.—The new form cannot be easily compared to any other known species, since it combines features thought to be characteristic of the subgenus *Willetia* with features to be found in other West Coast species, e.g. in *A. bakeri* Bartsch; these points will be discussed below.

Description of type.—Shell elongate, conic, creamy white, solid, minute, with four and one-half rather rapidly increasing whorls. Nuclear whorls about one and one-half, voluminous, globular, smooth (fig. 1, *c*), with the apex sunk below the level of the last half. Post-nuclear whorls three, spirally keeled, separated by a distinct, though by no means very deep suture. Three rather obtuse keels are present on the first post-nuclear whorl, which become more defined on the second whorl, and which assume almost fantastic features on the last post-nuclear whorl, where nodular excrescences are developing on them and where secondary keels intercalate between the original ones or originate below the lowest one. The whorls are rather slender, not swollen, distinctly shouldered, the upper keel forming the angle of the shoulder. Down to the first post-nuclear whorl there is no trace of axial sculpture, but, starting on the second, axial grooves are seen which regularly intersect the space between the suture and the upper keel, carving this into low ridges and furrows of about equal length; the furrows correspond to the axial grooves of the space above the keel. The middle and the lower keels on the second post-nuclear whorl show only indistinct traces of such crossing of an axial sculpture. Finally, on the last post-nuclear whorl, the cutting of the keels into knobs is not traceable to axial sculpture, but has

become quite irregular; while the marginal knobs of the middle and the lower keels are moderately small and homogeneous, those on the upper keel—by far the thickest of the three—are irregular as to shape and size (fig. 1, *a*, *b*). In an analogous way the space between

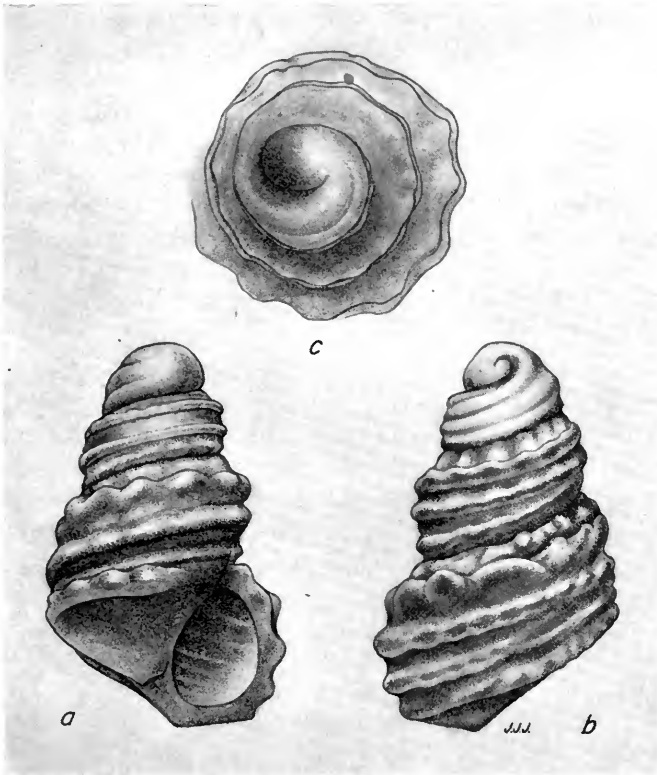


FIG. 1. *Alvania* (*Willetia*) *microglypta* sp. nov. Field Mus. No. 17028. *a*, from front; × 50. *b*, from back; × 50. *c*, from top; × 75.

the upper keel and the suture is irregularly beset with nodules, the furrows between which correspond to those dividing the knobs of the upper keel. The aperture is oval, doubly lipped, showing the external spiral sculpture weakly within; the inner lip is thin, smooth, much appressed, and the outer one is thicker, showing the keels at its outer margin. No umbilical chink is discernible. Base of the shell rather flat, smooth, and shiny.

Measurements.—Height 0.97 mm., width 0.6 mm., height of aperture 0.41 mm.

Remarks.—Only a single specimen of this form was found, and this is somewhat abnormal. Figure 1, *a*, plainly shows that the uninjured shell must have had about another one-half whorl, so that the total number of whorls amounted to five and one-half; after an injury of some kind, the snail rebuilt the aperture of its shell one-half whorl back from its original position. The keel seen in figure 1, *a*, left of the aperture, is the rest of the lost half whorl, and beneath it a coat of shiny enamel covers the surface of the shell, corresponding to the smooth original inner surface of the lost aperture; this coat of whitish enamel is truncated at the right lower extremity, perhaps covering up the umbilical chink so that no trace of it can be seen in the present specimen. Except for these apertural features, the shell is intact, and its most distinctive characters lie in the character of the whorls of the spire. It is probable that the description of the aperture, as given here, will have to be modified.

Discussion.—The new species described does not exactly match the definition of the West Coast subgenus *Willetia*. None of the species of *Alvania* referred to this subgenus shows the broad, globular nucleus and the preponderant spiral sculpture by which *microglypta* is characterized. It shares these features with some other West Coast alvanias which form a group with *A. castanella* Dall or *A. bakeri* Bartsch, but its sculpture is much heavier than that of this group of species, and its lip is much more developed; typical species of *Willetia*, on the other hand, often show such strong spiral ribs and such a broad, even double lip of the aperture. Thus *Alvania microglypta* is intermediate between these apparently well-distinguished groups, and the original definition of the subgenus *Willetia* may have to be correspondingly modified. My reference is therefore tentative.

Chrysallida (Chrysallida) ornatissima sp. nov. Fig. 2, *a*, *b*, *c*.

Type from Point Pinos, Monterey Peninsula, California; washed from sand in a tide-pool. No. 17029 Field Museum of Natural History. Collected May 19, 1941, by Fritz Haas.

Diagnosis.—A medium-sized species of the typical subgenus of the pyramidellid genus *Chrysallida*, characterized by a slender conic shell, an upper constriction of the whorls, and a peculiar pattern of shell sculpture.

Comparisons.—The presence of only three keels on the nuclear whorls suggests a closer relation to species like *C. oregonensis* Dall

and Bartsch, but the sculptural pattern of the post-nuclear whorls is quite different from that present in the group mentioned. It closely resembles the pattern seen in species like *C. oldroydi* Dall and Bartsch, but these differ in having five keels developed on their

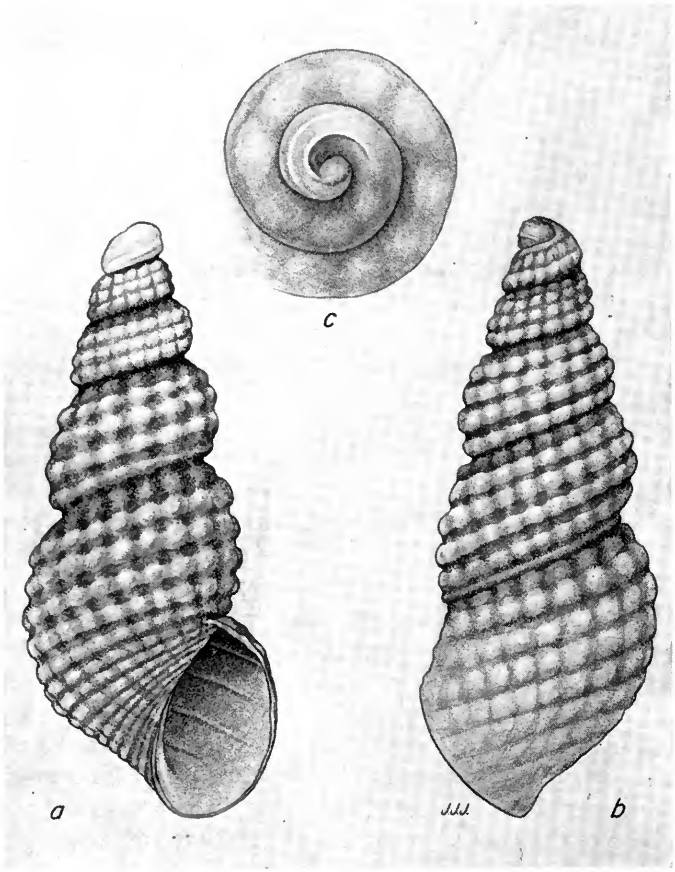


FIG. 2. *Chrysallida* (*Chrysallida*) *ornatissima* sp. nov. Field Mus. No. 17029. *a*, from front; × 25. *b*, from back; × 25. *c*, from top; × 50.

nuclear whorls. The classification of the species of *Chrysallida* is still rather artificial, being based on unstable characters, such as the mutual relation of spiral or axial sculptural elements, and the preponderance of one or the other, so that the relation of the new form with any of the many congeneric species can not yet be stated.

Description of type.—Shell elongate-conic, slender, shiny white, composed of five and one-half whorls which increase gradually.

Nuclear whorls one and one-half, with three keels, the upper of which forms a sharp edge (fig. 2, *c*); the first half of the nuclear whorls is immersed (fig. 2, *b*). The four post-nuclear whorls are a little inflated, the two upper ones with almost straight sides, the two lower ones with rounded sides. They are separated by a deeply incised suture. The upper part of every post-nuclear whorl shows a narrow but decided and almost concave constriction. The shell is highly ornamented by a sculpture in which axial and spiral elements are almost equal; only on the base of the last whorl does the spiral element preponderate. There are three spiral cords on the first and on the second post-nuclear whorls, four on the third, and five on the fourth, while the base of the shell shows about seven. All these cords are separated by sharply incised furrows about one-half as wide as the cords themselves; on the base of the shell only, these incised lines are much narrower in proportion to the cords. This system of revolving cords is crossed by axial furrows approximately as wide as the incised spiral furrows, but not as deep as these; this means that the points of crossing of spiral cords and axial furrows are at a higher level than the bottom of the incised lines. The consequence of this intersection of both spiral and axial elements is a meshwork presenting the edges of the cords cut into almost square, but obtuse-angled, raised knobs. The lower cords of every whorl are less heavily carved than the upper ones; thus the fourth on the third whorl and the fifth on the fourth whorl are practically intact and have only a somewhat wavy outline, while the cords on the base exhibit almost no intersecting furrows. The aperture of the shell is comparatively small, oval, and simple; its right upper margin, close to the insertion, is somewhat damaged in the type. In the interior of the aperture, the external shell sculpture is somewhat visible. The base of the aperture is decidedly effuse; its left margin is so closely appressed to the base of the shell that no trace of a secondary umbilical chink can be seen. The columella presents a very faint, hardly visible fold.

Measurements.—Height 2.7 mm., width 1.25 mm., height of aperture 1 mm.

Notes on the paratype.—No. 17030 Field Museum of Natural History. Same locality, same date and same collector as the type. Its measurements are height 2.9 mm., width 1.3 mm., height of aperture 1.1 mm. The paratype matches the description of the type perfectly, with the exception that, being higher, it has an additional fraction of a whorl (about one-fourth). Its aperture is a little damaged, somewhat more so than in the type.

Discussion.—The West Coast species of *Chrysallida,* whose number was fifty when Dall and Bartsch wrote their *Monograph of the West American Pyramidellid Mollusks,* may be double that number now. The species are generally easily recognized, since the respective sculptural patterns offer distinctive features together with differences in the general shape of the shell. It has not yet been possible to split this mass of species into natural groups, the characters used for specific distinction being, apparently, either unstable or of only secondary value. The number of keels on the phylogenetically oldest part of the shell, the nuclear whorls, might prove to be a useful means for defining natural groups. In *Chrysallida ornatissima* the pattern of sculpture closely resembles, in a general way, that of *C. oregonensis* Dall and Bartsch, except that the raised parts in *ornatissima* are impressed in *oregonensis,* and vice versa. Three main features characterize *ornatissima:* the presence of three keels on the nuclear whorls, the slender, constricted shape of the whole shell, and the type of meshwork pattern of the sculpture. No other species of *Chrysallida* appears to possess this combination, though the separate features, or combinations of two of them, occur in numerous species.

THE BORING OF LITHOPHAGA[1]

At the 1940 meeting of the American Malacological Union at Philadelphia, Dr. B. R. Bales reported on his observations on Florida boring mussels and he touched on the problem as to how a bivalve with as soft and as smooth a shell as *Lithophaga* could successfully attack hard rock. In this connection, I then could refer to Kühnelt's (1930) experimental work with Mediterranean lithophagas, in which he proved that the carbonic acid produced by the animal's mantle edges is the solvent agent; this shows that *Lithophaga* is not a mechanical borer, as are the teredinids and pholadids, but a chemical one. This explanation of its boring powers is, of course, only true in the case of limestone rocks, and all the *Lithophaga* holes in the Mediterranean and the Florida regions were indeed bored into calcareous rocks.

On the California coast, I collected *Lithophaga plumula* Hanley at La Jolla. To my great astonishment, this species had perforated what seemed to be a coarse sandstone, but how could a siliceous

[1] A paper incorporating the following three notes was presented in somewhat condensed form at the Eleventh Annual Meeting of the American Malacological Union at Rockland, Maine, August 27, 1941, and was published, without illustrations, in the Nautilus, **55**, No. 4, pp. 109–113, 1942, and **56**, No. 1, pp. 30–33, 1942.

rock be attacked by a chemical borer, with an acid no stronger than carbonic acid? A chemical and petrographical analysis made it clear later that while the rock in question is composed of medium to coarse grains of quartz and feldspar these components are cemented together by calcium carbonate. This accounts for the possibility of its being drilled by *Lithophaga*. The cementing lime is first dissolved by the action of the carbonic acid, and the loosened grains of quartz and feldspar are then washed out by the water currents produced by the bivalve. The borehole is constantly lined with a thin layer of amorphous calcium carbonate.

The assumption that chemical boring is the only means of attacking a rock, even a sandstone like that described, is thus not contradicted, and is even further supported. But it utterly fails to explain how *Lithophaga* can drill holes in argillaceous shale. I found this kind of rock, which does not contain a trace of soluble lime, settled upon and perforated by *Lithophaga plumula*, both at La Jolla and at Pacific Grove. Chemical boring is completely out of the question in this case; mechanical drilling, by rotation of the shell, cannot be proven and is improbable, since the exterior surface of the *Lithophaga* shell does not exhibit any vestige of being worn or ground. As in bore-holes drilled in other kinds of rocks, those in the shale are lined out with amorphous calcium carbonate. The fact that *Lithophaga* can drill holes in non-calcareous argillaceous rocks is thus established, but it cannot yet be explained in any way.

Lithophaga plumula is accompanied, in this shale, both by mechanical borers, such as *Venerupis lamellifera*, some pholadids and *Petricola carditoides*, and by a bivalve apparently unfit for boring, *Botula californiensis*, which probably bores by the same unknown means as *Lithophaga plumula*.

PROTECTIVE COVERINGS BUILT BY TWO WEST COAST BIVALVES

Very little is known about nest-building habits of bivalves. Textbooks, even the most recent ones, mention only the case of limids, which construct a kind of camouflaged nest from byssus-threads and shell fragments or stones, and that of juvenile mytilids, which occasionally have a similar habit. There are, however, other examples of this habit, as I had the occasion to learn on the California coast, where nest cases built by *Diplodonta orbella* Gould and by the myid *Cooperella subdiaphana* Carpenter are known.

Diplodonta orbella is rather common, and almost every shell collector on the West Coast knows that it has the habit of building

a "nest," as they call the protective covering. Notwithstanding this knowledge, there are scarcely any hints in the literature referring to this nest-building habit. None of the textbooks mention it and only scanty, insufficient remarks in rather obscure places give evidence that the fact has been observed. I tried to trace back the literature on this subject and found, as the oldest quotation, a collecting notice of I. M. Shepard (1895) in which *Diplodonta orbella* is reported to have been collected "with nests"; the way these "nests" are mentioned seems to allude to a matter of common knowledge. Josiah Keep, in the first edition of *West Coast Shells* (1893), does not say a word about the nest of our bivalve; so the first source of concise information on the subject is Dall (1901), who says (p. 795) that "it is the habit of the animal to form a sort of nest of sand and adventitious matter, cemented by mucus, with long tubular openings, the whole of irregular form, but completely concealing the inmate." No picture is given. Josiah Keep, in the later editions of the *West Coast Shells* (1904, 1911, and 1935 [revised by Dr. Joshua Baily]), repeats this statement in almost identical words, adding the words "for the siphons," so that Dall's original description now reads, "with long tubular openings for the siphons." Charles R. Orcutt's *Molluscan World* (1915), which contains so many valuable observations on molluscan life, does not mention the *Diplodonta* nest.

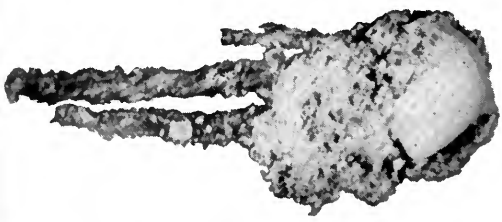


FIG. 3. Nest of *Diplodonta orbella* Gould; × 1. Courtesy Scripps Institution.

The first picture of such a *Diplodonta* covering appeared in 1927 in Johnson and Snook's *Seashore Animals of the Pacific Coast;* the text accompanying figure 416, on page 438, states that "this species forms a protecting covering of sand cemented by mucus. The covering has long tube-like extensions in which the siphons lie, so that the mollusk is quite hidden." The second edition of the *Seashore Animals of the Pacific Coast* (1935) repeats this statement literally. Keen and Frizzell (1939) mention only "nests" in connection with *Diplodonta orbella.* No further literature on this subject has come to my knowledge.

Thus, our knowledge of the *Diplodonta* nest consists of a rather vague description and of a single picture representing a specimen

now in the museum of the Scripps Institution of Oceanography at La Jolla. But what does this picture show? In figure 3, which represents the same specimen, the partly broken covering exhibits two long posterior extensions in which, according to the descriptions given by Keep and by Johnson and Snook, the siphons lie. But this explanation cannot be correct, at least concerning the specimen shown, for a close inspection reveals a third though shorter posterior extension, and no bivalve with three siphons is known! A still

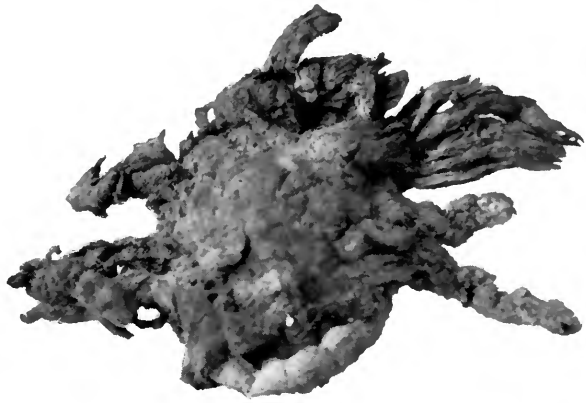


FIG. 4. Nest of *Diplodonta orbella* from Terminal Island, San Pedro, California. San Diego Mus. No. 23852. × 1. Courtesy San Diego Museum.

closer inspection of the specimen reveals the fact that the three extensions are not hollow tubes at all, but incrusted stalks of seaweeds; therefore, they cannot be protective coverings of the siphon. They may be regarded as mooring ropes of the shell-covering, as a kind of protection against the shifting action of the waves. Nests with this structure (fig. 4) constitute the most abundant type; they all exhibit extensions, variable in number and of variable length, which either still contain the stalks of seaweed or are hollow, when their original axis of vegetable matter has become disintegrated. This type of nest is built from a felt-like material containing practically no mineral particles and consisting probably of disintegrated plant fibers, kept together by a cementing secretion of the animal. This type of nest may be found loose in holes and crevices of rocks or in empty bivalve shells in which they practically fill out the whole space between the living *Diplodonta* and the dead shell used as a shelter (fig. 5).

In all the cases which came under my observation, the *Diplodonta* covering of this type seems to consist of two halves corresponding

to the two valves of the shell, opening at the ventral side and united at the dorsal side of the animal.

Besides the type of *Diplodonta* nest just described, a rarer one may be found which corresponds more closely to the descriptions cited. Figure 6 shows a specimen of *Diplodonta orbella* in a covering of cemented sand, exhibiting two long posterior extensions which correspond in position with the siphons of the enclosed animal. These extensions, however, are not hollow either, or at least are not originally hollow but most certainly are incrustations of stalks of plant material also! Thus the explanation of these extensions as siphon coverings, originated by Keep and carried along by Johnson and Snook, cannot be maintained and has to be given up in favor of their tentative explanation as anchoring ropes, as a protection against the action of the waves.

FIG. 5. Nest of *Diplodonta orbella* in empty shell of *Callithaca staminea* Conrad. × 1. Courtesy Scripps Institution.

My conclusions had come thus far, when it occurred to me that some information about the length and the general structure of the *Diplodonta* siphons might be important. It certainly *was* important, for the information I found, in Dall's words (1901, p. 795), is as follows: "There are two entire siphonal orifices, without siphons." Where there are no siphons, no siphonal coverings are needed; thus the explanation of the nest extensions as siphonal tubes is entirely baseless.

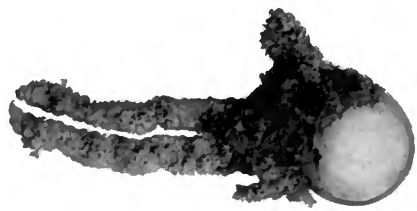
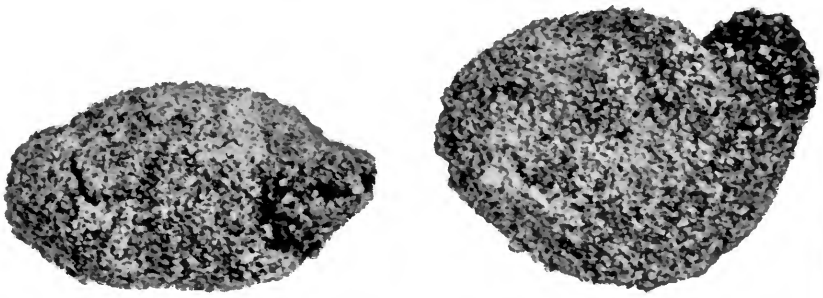


FIG. 6. Nest of *Diplodonta orbella*, from La Jolla, California. San Diego Mus. No. 1083. × 1. Courtesy San Diego Museum.

Nothing is known as yet of the way in which *Diplodonta orbella* constructs its two kinds of coverings, though it ought not be too difficult to watch its construction in an aquarium. It is hoped that

my paper may stimulate some West Coast malacologist to study this interesting problem.

I mentioned above that the myid bivalve *Cooperella subdiaphana* Carpenter also has the habit of constructing a protective covering. I have not found one myself, but I saw specimens both in the Los Angeles Museum and in the Stanford University Paleontological Collection; the latter is shown in figure 7. To the best of my knowledge, Keen and Frizzell (1939, p. 23) are the first to mention the *Cooperella* covering, describing it as a "nest of agglutinated



a *b*

FIG. 7. Nest of *Cooperella subdiaphana* Carpenter from Alamitos Bay, San Pedro, California. × 2. *a*, from side; *b*, from beneath. Courtesy Stanford University.

sand"; but no picture of the object has ever been published. The dried covering is rather solid; it is closed all around, leaving only two slits on the posterior extremity open for the communication of the inmate with the outer world.

ON SOME MEMBERS OF THE MYTILUS CALIFORNIANUS ASSOCIATION

The California mussel certainly is one of the commonest, if not the commonest bivalve of the West Coast. Thanks to a comparatively heavy shell and to strong byssus threads, the species is enabled to maintain itself even in habitats which, because of the heavy surf which beats them, would be uninhabitable for other mollusks. Wharf-piles and cliffs which otherwise would be almost destitute of an epifauna, may have a pad of mussels packed side by side and mostly covering the substratum. Other organisms which are not so perfectly protected against the surf action invariably settle on and between the California mussels and since the composition of this accompanying fauna is locally rather constant, we are entitled to speak of a well-defined "*Mytilus californianus* association," or, as

it has also been termed, of a "*Pisaster–Mytilus–Mitella* association." (Ricketts and Calvin, 1939, p. 119.) I referred above to the species of the *Mytilus californianus* association as "locally constant"; this means that within the wide range of *Mytilus californianus*, which is only slightly affected by varying water temperature, its associated forms vary according to the great difference of the water temperature south and north of Point Conception. Some of these forms accompany the *Mytilus* in almost its whole range and some have their northern limit at Point Conception; on the other hand, northern species generally do not occur south of this point.

This association is interesting for its complexity, but only one of the many problems involved is to be considered here, namely, the problem of settling. The union of so many animal species into the association with *Mytilus californianus* does not necessarily mean that its members cannot exist in other associations, without settling on or among *Mytilus*, ignoring at present the existence of relations between the California mussel and its associates so intimate as to suggest a tendency toward symbiosis or commensalism. To all the *Mytilus* dwellers, as we might call this epifauna, the mussel is nothing more than a rock, a substratum offering a place to settle on or offering crevices to hide in. This being so, we cannot expect to find in this association species other than those occurring on rocks either on the surf-beaten face or in sheltered recesses and crevices, according to their respective habits of life. The only sensible advantage derived by the *Mytilus californianus* epifauna from its living substratum is the increased amount of settling places in an appropriate environment. This has been discussed before, but it needs more detailed explanation.

On sandy beaches, the larvae of sedentary animals, such as barnacles or pleurothetic bivalves, often cannot find a suitable place to settle at the end of their planktonic stage. Wharf-piles and occasional pieces of rock fallen from the distant edge of the cliffs will soon be covered by such forms, leaving no more space for later comers; but if *Mytilus californianus* has settled in such biotopes, their clusters will increase the available rock-like surface and permit additional larvae to metamorphose, which otherwise would have had to perish. The more thickly the forms that can stand the heavy surf cover the *Mytilus* substratum, the more recesses and quiet nooks between them come into existence, making a niche even for animals of the quiet water behind rocks. Thus most of the inhabitants of the tidal pools or of the protected coast may be found in the

Mytilus californianus association, the small species as adult specimens, the larger ones, like crabs, as juveniles. Even in the case of mussels exposed to the full force of the incoming tide, the life conditions of the epifauna and the equally prospering epiflora of green and red algae may become so favorable that delicate forms characteristic of very quiet water, such as planarians or annelids, may be present, as we shall see from the list below.

By way of a summary it may be stated that the California mussel association transfers the conditions of life of the tide-pools and the quiet recesses of the coast to those parts of open, shelterless beaches where *Mytilus* can find a primary station.

The following list does not presume to give a complete enumeration of the epifauna of the California mussel; it shows the variety of animal life found on one single specimen (Field Museum No. 16595) of *Mytilus* (*Aulacomya*) *californianus* Conrad, of a length of 73 mm., collected April, 1941, on the seaward face of a pile of the pier at La Jolla, California:

Planaria
Prosthiostomum sp.

Actinia
Cribrina xanthogrammatica Brandt

Annelida
Nereis vexillosa Grube
Eupomatus sp.

Bryozoa
Retepora pacifica Robertson

Cirripedia
Mitella polymera Sowerby (young)
Chthamalus fissus Darwin

Isopoda
Cirolana harfordi Lockington

Anomura
Pagurus hirsutiusculus Dana
Petrolisthes cinctipes Randall (young)
Petrolisthes eriomerus Stimpson (young)

Brachyura
Hemigrapsus oregonensis Dana (young)

Mollusca
Ostrea (*Ostreola*) *lurida* Carpenter
Mytilus (*Aulacomya*) *californianus* Conrad (young)
Brachidontes (*Hormomya*) *adamsianus* Dunker (young)
Lasaea subviridis Dall
Littorina (*Melaraphe*) *planaxis* Philippi
Acmaea (*Collisella*) *scabra* Reeve
Acmaea (*Collisella*) *asmi* Middendorff
Nuttallina scabra Reeve

The number of species listed is not high compared with that which Carpenter (1857, p. 154) found on one single upper valve of *Spondylus calcifer* from Mazatlan, which included 102 species of mollusks alone! But *S. calcifer* is a much larger bivalve than our California mussel and it has a very thick shell into which part of the members of its epifauna drill their holes. Nor can the above list compete with that published by Perry (1936) enumerating the animals found on one *Atrina rigida* shell from the Gulf waters of

Florida, which contained no less than 25 species belonging to eight different phyla of animals and represented by more than 100 individuals; but though the *Atrina* shell is even thinner than that of *Mytilus californianus*, the higher number of epizoan forms on the former is due to its greater surface, amounting to nearly 150 sq. cm.

The species enumerated in our list are by no means the only *Mytilus* dwellers, for on or among other specimens of the California mussel from La Jolla, I collected the following species; and I am fully aware that a great many more species, almost the whole of the still-water fauna, have escaped my attention and are not listed here.

Hydroidea

Orthopyxis compressa Clark

Mollusca

Haminea (Haminea) virescens Sowerby
Mitromorpha filosa Carpenter
Crepidula (Janacus) nummaria Gould
Cythara (Mangelia) cesta Dall
Columbella (Alia) gausapata Gould
Acmaea (Collisella) persona Eschscholtz
Scala (Globiscala) orcuttiana Dall
Lasaea cistula Keen
Septifer bifurcatus Conrad

Annelida

Eunice biannulata Moore
Halosydna californica Johnson

Echinodermata

Pisaster ochraceus Brandt
Amphipholis pugetana Lyman

As has been pointed out, the settlement of the *Mytilus* substratum, i.e., the formation of the *Mytilus californianus* association, takes place in two steps. The first step is represented by the settling of sedentary animals—barnacles, oysters, bryozoans, etc.—on the previously uninhabited mussel shells. The second step is characterized by the arrival of free-living, non-sessile animals such as annelids, isopods, crabs, etc., in the corners and nooks between the first series of arrivals. The creatures belonging to these two different groups of *Mytilus* dwellers have very different habits of life and their behavior toward each other is not that of friendly neighbors. For while the members of the first, the sedentary group, are all of them plankton feeders, those of the second, the roving group, are predaceous animals, preying on each other and on their sessile neighbors. The starfish, especially, are the deadly enemies of the California mussel.

The plankton feeders, though they do not devour each other, are nevertheless competitors for food. Where, in a given association, there are two or more layers of such sessile creatures, the lower, the original and older, may be starved by the upper ones, which gather all the nutritive particles contained in the sea water before it reaches the lower stratum. In addition to such starvation, the

forms of the lower layers may be choked to death by the weight of the later settlers.

Thus the *Mytilus californianus* association is by no means a community of beings respecting each other, but a community like every other, with competition for food, and with certain death for the weaker. In other words, it is a typical biocenosis, in which only the strongest or the best-protected individuals survive.

In southern California, the most obvious mollusk accompanying this association is another mytilid, characterized by a radiating sculpture on its shell. Its name is *Mytilus* (*Hormomya*) *adamsianus* Dunker, but it is often quoted in the literature as *Mytilus multiformis* Dunker or *Mytilus stearnsii* Pilsbry and Raymond; it is not a true *Mytilus*, but has to be placed in the subgenus *Hormomya* Moerch, whose type species is the Atlantic *Mytilus exustus* Linnaeus. Intermixed with the *Mytilus adamsianus* in the same association, but generally in much inferior numbers, lives another sculptured mytilid, very similar to *adamsianus* in size and shape, but actually very different: *Septifer bifurcatus* Conrad.

At the present time, only *Mytilus adamsianus* interests us, since, at La Jolla, it is the host shell of two probably commensal bivalves of the genus *Lasaea*, *L. cistula* Keen and *L. subviridis* Dall. Both species are rather common at La Jolla, and I found them there exclusively on the shell or the byssus of *Mytilus* (*Hormomya*) *adamsianus;* not a single specimen lived on *Septifer* or, with one restriction to be pointed out immediately, on the much more abundant *Mytilus* (*Aulacomya*) *californianus!* This statement fully agrees with an earlier observation made by Charles R. Orcutt who, according to a notice on a label in the San Diego Museum, collected *Lasaea* on *Mytilus adamsianus*. Several lasaeas, however, were detected in dead *Donax* shells or in cups of *Balanus*, or even on *Mytilus californianus*, but on these objects one or several specimens of *Mytilus adamsianus* had fastened their byssus, so that even in these seemingly aberrant habitats the close relation with this mytilid is maintained.

An association analogous to that of the California mussel is developed in Peruvian waters, where *Mytilus californianus* is replaced by its close relative, *M. magellanicus* Chemnitz, and *Mytilus adamsianus* by the almost identical *Mytilus granulatus* Hanley. In a thick bunch of a *Mytilus magellanicus* association scraped off from rocks at Chincha Norte Island, Peru, by Mr. William Vogt, *Mytilus granulatus* was represented by a fair number of specimens and on them, and exclusively on them, some lasaeas were found which I

have provisionally classified as *Lasaea miliaris* Philippi, though they are practically inseparable from the North American *Lasaea cistula* Keen; the specific name, however, is of no importance relative to the fact that in this Peruvian locality a species of *Lasaea* restricts its habitat to a mytilid which constitutes only a minority among the leading species of the association.

In spite of this supporting case from Peru, the observation made in southern California, at La Jolla, that *Lasaea* does not live in close community with the commonest mytilid, but only with an accompanying species, cannot be generalized. North of Point Conception, *Mytilus adamsianus* does not occur, its place in the *Mytilus californianus* association being vacant. But both the species of *Lasaea* are found north of Point Conception, and at Pacific Grove, the only locality north of this point where I collected, I found them on the shell and on the byssus of the dominant *Mytilus californianus* itself! The only possible explanation of this strange behavior is that while the lasaeas prefer *adamsianus* to all other host shells, *Mytilus californianus* is a second choice, to which they attach themselves when no *adamsianus* is available; but the details of their supposedly commensalistic relation to these mytilids are still entirely unknown. Yet the fact that *Lasaea* in European waters is known as a commensal of sea-urchins and snails makes it more than probable that northwestern American lasaeas may also enter into commensalistic relations.

For the sake of completeness, it must be mentioned that at Pacific Grove I washed out both species of *Lasaea* from fastholds of kelp, where they cannot have led a commensalistic life and where they must have retired for protection only. My failure to detect free-living lasaeas in similar habitats at La Jolla by no means proves that they cannot occur there.

A RECORD OF ALABA INTERRUPTELINEATA

Alaba interruptelineata is the most recently described species of a genus indiscriminately attributed either to the family Cerithiidae or to the Litiopidae (Pilsbry and Lowe, 1932, p. 81) and has been known only from San Juan del Sur, Nicaragua, the type locality. A specimen of this species (Field Museum No. 16562) was found by Loren P. Woods, Assistant Curator of Fishes, in the mouth of a sparid fish collected at Guaymas, Sonora, Mexico, by Messrs. Kenneth Curtis and John Clay. This Guaymas specimen fits the original description of the species perfectly, except for being 6 mm.

long instead of 7; the number of whorls is identical with that of the figured type.

RECORDS OF MOLLUSKS FROM FLORIDA

Mr. Alfred C. Weed, formerly Curator of Fishes, brought home from his Florida trip in 1939, among other mollusk material, two species of shells which have not often been recorded from that state.

Notarchus (Aclesia) pleii Rang

This Antillean opisthobranch snail is apparently recorded only from the following Florida localities:

Little Gasparilla Bay, Charlotte County, collected by Wilcox and Heilprin, quoted from Pilsbry's *Manual of Conchology*, (1), **16**, p. 148, 1896.

Marco, Collier County, (C. W. Johnson), Proc. Bost. Soc. Nat. Hist., **40**, p. 150, 1934.

I am indebted to Mr. T. Van Hyning, Director of the Florida State Museum, Gainesville, Florida, for the following records:

Cedar Key, Levy County; St. Petersburg, Pinellas County; Lake Worth, Palm Beach County; South Lake Worth Inlet, Palm Beach County.

Mr. Weed collected this species in various parts of Lemon Bay near Englewood, Charlotte County, Florida, in the vicinity of the Bass Laboratory (Field Museum No. 17020).

Auriculastra pellucens Menke

This species is apparently restricted to the Caribbean region. It has been recorded from Demerara, British Guiana, the Lesser Antilles, and Florida. In Florida it has been found frequently on the Gulf shore of the peninsula as far as Cedar Keys, while, to the best of my knowledge, it has been mentioned only once from the Florida east coast, where S. N. Rhoades collected it near Miami (Nautilus, **13**, p. 47, 1899).

Field Museum recently received two dead shells of *A. pellucens* (Field Museum No. 16339), collected in 1938 at North Miami Beach by Mr. Weed, who describes the locality where he picked up the specimens as a former salt marsh close to the beach, now reclaimed by a low levee. Two species of land gastropods, *Polygyra* (*Daedalocheila*) *uvulifera bicornuta* Pilsbry, and *Polygyra* (*Polygyra*) *cereolus septemvolva* Say, were associated with it.

Mr. T. Van Hyning has kindly forwarded his list of localities prepared for his own forthcoming catalogue of Florida Mollusca for

my examination. His list confirms the scarcity of *A. pellucens* on the Atlantic coast.

ADDITIONS TO THE MOLLUSK FAUNA OF BERMUDA

Since the appearance of my "Additions to the Mollusk Fauna of Bermuda" (1941, p. 171), some additional material collected by T. H. Bean in the course of the Field Museum Expedition to Bermuda in 1905 has come to hand, the classification of which has brought to light various species of marine mollusks hitherto not recorded, or only doubtfully recorded, from the Bermuda Islands.

Musculus (Gregariella) coralliophagus Gmelin

A single specimen of this species, referred to as *divaricata* Philippi in most faunal lists, from the Challenger Bank, 28 fms. Field Museum No. 16430.

Pecten (Nodipecten) antillarum Recluz

A single valve from the Challenger Bank, 28 fms., corresponding in all details with the description of this species. Field Museum No. 16445.

Arca (Barbatia) reticulata Gmelin

Three species from the Flats. Field Museum No. 16442.

A single valve from Mullet Bay, St. George's Island. Field Museum No. 16441.

Chama (Chama) congregata Conrad

One specimen from Challenger Bank, 28 fms. Field Museum No. 16428.

Peile (1926, p. 96) mentions *Chama lingua felis* Reeve with a hint that it may be a young *macerophylla* Gmelin; in a personal note he writes me that probably it is *C. congregata* that is meant.

Gastrochaena (Gastrochaena) hians Chemnitz

A dead shell from the Challenger Bank, 28 fms. Field Museum No. 16436.

One specimen collected alive at Pegg's Island, St. George's Harbor, still in the piece of rock. Field Museum No. 16437.

These records support the doubtful quotation of this species by Peile, under the name of *G. cuneiformis*, which rested solely on Dall's authority.

Erosaria (Ocellaria) spurca Linnaeus

Two specimens from the Challenger Bank, 28 fms. Field Museum No. 16482.

WHAT IS EXILIBERUS JACKSONI IREDALE?

Under the above name Iredale (1942) recently has described a land snail from the Libyan Desert that he believed to stand quite isolated in the Egyptian fauna. From his description (unfortunately not accompanied by a figure) it is evident that the shell in question belongs to that keeled and wrinkled phase of the helicid genus *Eremina* Pfeiffer of which *E. zitteli* Boettger is the classical representative (see Boettger, 1899; Kobelt, 1900, 1902). This phase is so strikingly different from typical *Eremina* with its keelless, smoothish shell that its subgeneric separation, under a special name, might be justified, in which case the name *Exiliberus* would be acceptable. But the sharp-keeled and the keelless phases are linked together by insensible intergradations, as demonstrated by Kaltenbach (1934) who thus proved *Eremina zitteli* to be only an extremely modified form of *E. hasselquisti* Ehrenberg. This chain of forms has a complete analogon in the Spanish *Iberus alonensis* Férussac, whose globular, smooth and rounded shell locally passes gently and almost insensibly into that of the lens-shaped, sharply keeled and wrinkled *Iberus gualtierianus* Linnaeus (see Kobelt, 1910). In the latter series, the anatomy supports the conchological judgment, whereas in *Eremina* the keeled phase has not yet been dissected; the shell characters, however, are sufficient to keep the *zitteli* phase, to which Iredale's *Exiliberus jacksoni* belongs, within the genus *Eremina* proper. *Exiliberus* is thus a synonym of *Eremina*.

As to the species *jacksoni*, it cannot properly be allocated without more material and a more exact type locality than "Libyan Desert." It may be typical *zitteli* or one of the transitory forms passing into *zitteli;* it may represent a valid form worthy of nomenclatorial distinction.

A HIRSUTE PHASE OF POLYGYRA (DAEDALOCHEILA) IMPLICATA MARTENS

Among other valuable shells collected by Mr. David W. Bergstrom in Mexico during the summer of 1941, some specimens of *Polygyra* (*Daedalocheila*) *implicata* Martens are especially noteworthy. They were collected near Tamazunchale, five miles south of that city, and ten miles south of the city of San Luis Potosí, in the state of San Luis Potosí; they are recorded in Field Museum Collection under the numbers 17802–17804. Though otherwise quite

typical, these specimens differ from existing descriptions and figures by the short but distinct hairs on their shell surface; figure 8, about five times actual size, demonstrates this feature.[1]

Such hairiness is a feature not unknown in the family Polygyridae and is even normal in some daedalocheilas; the whole section *Lobosculum* Pilsbry for instance is hirsute. J. K. Strecker (1908, p. 66) mentioned the discovery of a hairy "variety" of *P.* (*Daedalocheila*) *mooreana* W. G. Binney in a stone pit near Waco, Texas. Pilsbry (1940, p. 624) suggests a possible confusion with the normally hirsute *P.* (*Lobosculum*) *leporina* Gould. Perhaps my own report of a hairy phase of *P.* (*Daedalocheila implicata* gives additional support to Strecker's statement.

FIG. 8. *Polygyra* (*Daedalocheila*) *implicata* Martens, hirsute phase. Field Mus. No. 17803. × 5.

The question as to whether the hairy phases of daedalocheilas occur only in isolated populations or side by side with smooth specimens, cannot, at present, be solved; thus the secondary question as to whether these hairy forms are entitled to nomenclatorial distinction as subspecies, though relevant, cannot yet be settled.

In a somewhat analogous European case, that of the helicid snail *Helicigona* (*Chilostoma*) *desmoulinsi* Farines with its hirsute phase *acrotricha* Fischer, the ranges of the two phases do not overlap or overlap only slightly. Thus, typical *desmoulinsi* becomes the representative in the Pyrenean region in general, with the exception of the massive of the central Pyrenees, where *H.* (*Chilostoma*) *desmoulinsi acrotricha* occurs exclusively.

Further research may reveal similar relations in other families of land snails, so, for instance, in some other helicigonines of Europe, in the Asiatic pleurodontid genus *Chloritis*, or in the likewise Asiatic ariophantid genus *Hemitrichia*.

From an evolutionary point of view, the possession of hairs seems to be a primitive character in snails, and where there are hirsute and naked phases in the same species or group of species, the unhaired phase is, probably, the younger and the more advanced, as in some other helicigonines of Europe, in the pleurodontid Asiatic genus *Chloritis*, or in the likewise Asiatic ariophantid genus *Hemitrichia*.

[1] I am indebted to Mr. John Bayalis for the photograph of this specimen.

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