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THE GREEN ABALONE
Haliotis fulgens, page 242

West Coast Shells

(Revised Edition)

A DESCRIPTION OF THE PRINCIPAL MARINE MOLLUSKS
LIVING ON THE WEST COAST OF THE UNITED
STATES, AND OF THE LAND SHELLS
OF THE ADJACENT REGION

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Also a Chapter on the Fresh Water Mollusks of the Pacific Slope

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PREFACE

The last quarter of a century has been an important period for the science of Conchology. While many private collectors have been gathering specimens of all kinds, and incidentally making many new discoveries, the universities have been establishing seaside laboratories, the Government sending out exploring vessels, and the learned societies putting forth many publications. Especially has the National Museum at Washington been issuing its valuable bulletins, embodying the conclusions of its painstaking investigators, and making available the results of much labor.

This activity has resulted in the accumulation of much new material, and incidentally the changing of many old names. The latter work is an ungracious piece of business at best, and has seldom been indulged in wantonly. But new views on the subject of classification, new researches into former systems of nomenclature, and an enlarged knowledge of the fossil progenitors of existing species, have compelled the readjustment of what before seemed settled.

It is comparatively easy, when collecting in a small field, to separate the specimens into fixed and definite groups; but as one's observations become extended, the varieties multiply, and increased knowledge of both facts and records causes embarrassment. The necessary changes, however, even of familiar names, must not be too deeply regretted, for they indicate a real advance in our conception of the great plan of Nature.

The kind reception given to my "West Coast Shells," and my other efforts to popularize the study of mollusks, led to the publication, late in 1904, of a larger volume, entitled "West American Shells." The great conflagration in San Francisco, following the earthquake of April, 1906, destroyed practically all of the unsold copies of that last edition, though most of the cuts had been previously removed to a place of safety. The unsettled conditions and the increased duties following the earthquake prevented my rewriting the book until last summer. It is now to be published under the old name, as that seems more appropriate.

While it cannot be hoped that it is free from mistakes, it is certain that some of the errors of the last edition have been corrected, and an honest attempt has been made to provide a handbook both readable and reliable.

It is not so complete and full as some teachers desire, and no one feels more deeply than the author our need of a manual, in which the shells of this region shall be fully described in scientific language. We have assurances that such a volume or series of volumes will be published at Washington in due time, and that much material has already been collected for that purpose. The work is a great one, however, and years may elapse before the volumes are issued. Therefore it has not been thought wise to delay the publication of this handbook, which was never designed to take the place of an official manual.

Though much difficulty has sometimes been experienced in deciding between the claims of rival synonyms, the name usually selected has been the latest one adopted by standard authors, particularly those connected with the National Museum. In case of real doubt a conservative course has been followed.

The chapter on Fresh Water Mollusks was written by Mr. Harold Hannibal, who is an earnest student in that interesting field of research; and his conclusions, while somewhat opposed to past usage, have been adopted by him after much investigation.

Especial acknowledgments are due to the authorities of the United States National Museum for permission to copy figures found in their bulletins. This permission has been freely used, as the large number of illustrations marked with an asterisk (*) will testify. Thanks are also due to Dr. William H. Dall for helpful suggestions, to Mr. and Mrs. T. S. Oldroyd for assistance in various ways, to Professor William J. Raymond of the University of California for help in the study of the Chitons, and to the many friends who have encouraged the writer to put forth a substitute for the burned book. Thanks are due also to the publishers, the Whitaker & Ray-Wiggin Company, for their patience, for their assistance in preparing suitable colored illustrations, and for putting the work into so presentable a form.

In conclusion, I would express my growing appreciation of the magnitude of the field which I have attempted to cover, and my hope that this work may be accepted by students as a helpful assistance towards obtaining a complete knowledge of West Coast Shells.

JOSIAH KEEP.

*Mills College, California,
November 15, 1910.*

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SUGGESTIONS FOR BEGINNERS

Whenever you collect shells it is well either to make a record or write a label stating where and when they were found. These labels become increasingly valuable as the years go by. There are a number of things which you will wish to learn about your specimens, three of which are as follows: their names, their structure, and the habits of the animals which constructed them. This book is designed to enable you to obtain the names, so that you may be able to speak of your shells intelligently, and to suggest a proper mode of classification. It also gives hints concerning the structure and markings of the shells, and tells you some things about the mollusks to which they originally belonged.

Very much, however, will depend upon your spirit of investigation. Never be satisfied to simply know the name of a shell, but go on to learn all that you can about the life of its former inhabitant. The more familiar you become with this book the easier you will find the work of naming shells. Note carefully the general plan and the order of the chapters. Study the pictures carefully, and you will soon learn the probable place to turn for the description of an unknown shell. Consult the Biographical Index, and get acquainted with the men who gave names to the shells. Study the Glossary, and learn the meaning of all the terms used in the descriptions. The general Index will help you in the pronunciation of the Latin names, as the vowel of the syllable to be accented is designated by a mark. Keep a record-book for drawings and additional descriptions of your specimens. Love your work and it will bring you many hours of real profit and pure pleasure.

WEST COAST SHELLS

CHAPTER I

LAMP-SHELLS AND THEIR ALLIES

Almost everybody knows something about sea-shells. They are found in nearly every home and are used for many different purposes. Some handsome ones are perched in parlors as choice ornaments, while round and smooth kinds are given to babies for playthings. The very common varieties, like oyster-shells, are pounded up for the chickens to eat, and by them are converted into the material for egg-shells, so necessary for the safe handling of an important article of food. Besides the many forms from the sea there are others that are frequently found in lakes, rivers and smaller streams, while snail-shells are occasionally picked up under old boards or in the woods, or possibly a live snail is found "with his house on his back." The creatures that produce shells are called Mollusks, which really means soft animals. This name of course refers to their bodies, which never have any bones, for the shells which protect them are often as hard as stones.

Some mollusks, however, never have shells at all, but crawl around naked and trust to good luck for protection. It saves them a lot of work, both in building shells and carrying them around, and so they have quite an advantage in some ways over their better protected neighbors. We commonly call

these naked mollusks slugs, and most people have very little love for them, for they have greedy appetites and can destroy young pansies or lettuce plants in a single night. During the daytime they commonly keep out of sight, getting into cracks in the ground or under old boards, where they may be found and destroyed. The chief kinds that live in this region will be described on a later page. There are some naked slugs in the sea too, but most of the marine mollusks are provided with strong shells, and it is the purpose of this book to describe them.

We understand that the first object of these shells is the protection of the creatures that carry them around, and it is exceedingly interesting to see how well they are adapted to this purpose. But as we wear clothes that are supposed to be somewhat ornamental as well as useful, and as we paint and decorate our houses, so many mollusks build very gorgeous coverings for their bodies, though it is true that much of the beauty does not appear until after the death of the humble builder. Of course we know very little about the motives which impel these creatures to construct their shells, and we can only fall back on that old word "instinct," which has received so many different explanations. Perhaps we cannot do better than to call it the guiding influence of the great Creative Power that controls all nature.

The material of which shells are made is carbonate of lime, the basis of all limestone, chalk and marble. This substance is very widely distributed, though in some soils and some rivers it is far more abundant than in others. For this reason land and river shells

are more common and more heavy in limestone regions than in those provinces where lime is deficient in quantity. Most rivers are constantly carrying dissolved limestone to the sea, where it is used not only by mollusks for the making of their shells, but also in vast quantities by coral animals, crabs, worms, and many other creatures, as well as by certain forms of plants. By geological changes the coral reefs and shell banks may be lifted out of water and transformed again into beds of limestone.

Naturalists do not wholly agree as to the limits which divide the great class of mollusks from other animals. Some of the lowest of these creatures have affinities with the worms and the sea-bottles, but these matters may be studied more fully by those who are specially interested in the subject. For the present we may assume the usual division to be correct, and will describe the shells to be found on the seacoast under four heads, namely, the lamp-shells, the bivalves, the sea-snails and the cuttles, of which the second and third divisions include the vast majority of specimens. In fresh water lakes and rivers there are bivalves and pond-snails, but no lamp-shells or cuttles, while on the land are found only air-breathing snails and slugs. Thus we see that the first and last of the four great divisions are confined to the ocean, the second to water either salt or fresh, while the snails, also called univalves, are the most widely distributed of all, living alike in air, fresh water, and also in the sea.

To be sure the same animal cannot endure a change from one medium to another, and a trained

shell-man, or conchologist, as he is often called, can quickly tell even from a dead shell the probable surroundings of its dwelling-place. A novice may make mistakes, even in collecting, for often land shells get washed into rivers and even into the ocean, and may be found where they did not grow; but all this is to be expected and guarded against in the study of shells. The real test is to find the animals that make the shells living at home and in natural conditions, and then you are sure that they are where they ought to be. And so if you find banks of oyster-shells attached to rocks on some hillside you may rightly infer that that part of the country was once under the sea, and not that in olden times oysters went off on picnics to the mountains.

Sometimes dead shells are found washed up on a beach a long way from the place where they lived, having been brought in a ship's ballast and cast overboard or else scattered from some collection. I once had a shell brought to me for identification which the finder declared he picked up on the California coast, though I am certain that its home was in the Atlantic Ocean. Doubtless he was truthful in his statement, but as the shell was dead the probability was great that some one had accidentally or willfully dropped a foreign shell in the water far from its original home and that the waves had washed it up along with many native shells. If it had been alive the case would have been different. In a much greater degree it is unsafe to buy shells in stores along the seaside with the thought that therefore they are certainly natives of that coast.

Most shells that are sold in stores come from the warm waters of the tropics where they grow more abundantly than along cooler coasts, and as a rule they are of a more attractive appearance and have brighter colors than their neighbors which are exposed to a more wintry climate. And so it happens that though certain species of native shells may be on sale, it is always best to consult some one who knows before deciding upon the native locality of any shell. In far Alaska I once bought a shell as a native rarity, and afterwards found out that it was really a Mexican species that had been carried to that land, to sell to tourists. A little familiarity with the shells of a coast will often give one a pretty sure sense of what he ought to expect to find there and will put him upon his guard against imported novelties. And now, having given these warnings against possible deceptions, let us turn to the description of the chief species of shells which are known to be true inhabitants of the territory under consideration.

There are on our northern Pacific coast only a few species of Lamp-shells, or Brachiopods, as they are called in the books. Figure 1 represents the Snake's-head Lamp-shell, *Terebratulina caput-serpentis*, Linn. You note that the fraction $\frac{4}{3}$ is placed under the figure; this implies that its length and breadth are one-third too great. Sometimes a

Fig. 1, $\times \frac{4}{3}$ (*)

* By permission, from Proceedings of United States National Museum.

figure is too small instead of too large, but the proper fraction will inform you of that fact. If there is no fraction you will take it for granted that the figure is the same size as an ordinary shell of that particular species. You notice that after the name of the shell there is given the authority, as it is called. In this case the abbreviation "Linn." stands for Linné, or Linnæus, according to the Latin form of his name. He was the man who gave the name, "caput-serpentis," to this species, and published a description of the same. And so all through the book you will find the authority after each name. If you wish to know something about the men who named the shells you will find short accounts of their lives in the latter part of this book. After reading these short accounts you may wish to consult larger books of reference and learn more about them. You will also find other helpful lists and tables in the latter part of this volume.

The Snake's-head is not a common shell, but is chiefly obtained by dredging, sometimes from the depth of half a mile. This species is found in northern waters, both of the Atlantic and the Pacific, and it also occurs as a fossil in the rocks of Europe. Externally the shell is ash colored.

Figure 2 represents the Kii Lamp-shell, *Terebratulina kiiensis*, Dall and Pilsbry. It is so called because it was named from specimens gathered on the coast of the province of Kii, in Japan. It is a large shell, the picture being about the natural size of a mature specimen. The lower figure gives an end view, showing its plumpness. This species as well

as the last lives in the sea where the water is cold and deep. It has a very wide range, extending from off Santa Cruz, Cal., up past Alaska and down to the Philippine Islands. The color is waxen white, with stains of brown.

Platidea anominoidea, Sacchi, the Little Lamp-shell, is not much larger than the head of a good sized pin. It is quite flat, without distinct sculpturing, circular in outline,

Fig. 2 (*)

Fig. 3 (*)

and light brown in color, but it has a distinctive hole in one valve. My specimens came from San Pedro Bay, and lived under 600 feet of seawater. This species is also found in the Mediterranean

Sea and other parts of the ocean.

We have in Figures 3 and 4 two views of another brachiopod, *Terebratalia occidentalis*, Dall, the Western Lamp-shell. The figures are of the natural size, as is indicated by

Fig. 4 (*)

the omission of a fraction. This shell is not a common one, but is reported as occurring from Monterey southward. The groundwork of the shell is white, and there are ribs of carmine.

Fig. 5, $\times \frac{3}{4}$ (*)

The appearance of *Terebratalia transversa*, Sby., the Red Lamp-shell, is well shown in Figures 5 and 6. It is by far the most common species of the brachiopods to be found on our coasts. It

attains its highest development in the cool waters of Puget Sound, where it sometimes grows to a size much larger than that of the picture. On the east side of Vancouver Island it is reported to be found in thousands, attached to the rocks. From that point it extends both northward and southward, having been found from the frozen Aleutian Islands of the Arctic to the sub-tropical Catalina Island of California. It can sometimes be collected about San Pedro at very low tide. Note that the central scallop on the edge dips downward in this shell, while in the last species it bends upward. The general color is red, though in some specimens a considerable part of the shell is white. It makes a very pretty specimen for the cabinet.

Fig. 6, $\times \frac{3}{4}$ (*)

Laqueus californicus, Koch, the California Lamp-shell, Figure 7, is entirely different from the last species, the shell being very thin, smooth, and free from wrinkles of any kind. If you turn the figure

on its side you can readily see why these shells have been compared to the ancient lamps, such as are dug out of the ruins of Pompeii and other Roman cities. The large valve of the shell answers to the bowl of the lamp, and at the end is a small hole as if for the wick. Through this hole really runs a strong stem, by which the animal is firmly attached to the rock or some other anchorage.

Fig. 7

The hole in this shell, however, is very small when compared with that shown in the last figure. The color is reddish, at least in large specimens, though some of the little ones are brown. Rich markings of a deeper color sometimes seem to show through the shell. Most of the specimens are obtained by dredging or from fishermen's nets, and sometimes a whole cluster is pulled up, all of them attached to some old shell, and looking like a bunch of plums. They are mostly collected in the vicinity of the Santa Barbara Channel, though they extend northward at least to Monterey Bay.

Laqueus jeffreysi, Dall, Jeffrey's Lamp-shell, resembles the last species, but lacks the rich, warm, reddish tints. The shell is heavier, browner, and the foramen, or opening, is larger. It is found farther to the north, and was once called the Vancouver variety of the last species. They exist side by side, however, off the coast of California.

Fricleia halli, Dall, the Parrot Lamp-shell, is a

Fig. 8, $\times \frac{3}{2}$ (*)

small brachiopod, which has been dredged from deep water at various stations along the coast. Figure 8 shows several views of this little shell, which is thin, translucent, and of a yellowish-gray color.

It is hard for us, who live in the air and the bright sunshine, to imagine the conditions at the bottom of the ocean, where these creatures have their home. In the first place, it is very cold down there, the temperature of the water being but little above the freezing point. This has been proved by sinking self-registering thermometers and pulling them up again. It is very dark, too, for how can much light struggle down through thousands of feet of water, even if it is remarkably clear. There is but little motion, for the swell of the waves is all far above, and the slow drift of ocean currents makes but little impression on the oozy bed of the sea. Dark, cold, still, without morning or noon, only a gloomy night; how dismal it seems to us who live on the merry surface of the earth. And yet, countless generations of these quiet creatures have apparently lived in comfort down in the depths of the sea. Verily, the study of any kind of life ought to broaden and deepen our ideas of the actual and the possible, and to show us that our mode of living, splendid though

it may be, is not the only opportunity for healthful existence.

The last member of the brachiopod family to be described is closely related to some of the shells which are found in the oldest of the fossiliferous rocks. Perhaps, therefore, it has a pedigree reaching back farther than that of any other shell in the world. Its name is *Glottidea albida*, Hinds, the White Tongue-shell, and it is shown in Figure 9. It has been collected at Monterey, and it extends to the shores of Lower California. I once gathered a few specimens from the mud flats of San Pedro, which were left bare by a low tide. A friend instructed me to dig where I saw little narrow slits in the surface of the mud. I obeyed, and found that the little creatures were buried in holes, the tips of the shells being just beneath the surface. A fleshy stem, longer than the shell, reached down into the mud, and served as an anchor. In the picture you can see the remnant of the stem, curled and dry. When the tide returned, I dare say the creatures rose a little and began gathering minute particles of food from the water. The shells are smooth, thin, and when freshly gathered are more brown than white. Exposed shells, however, soon bleach. Unfortunately for shell-gatherers, the old collecting grounds at San Pedro have been largely spoiled by the dredging operations by which the shallow bay is being made into a good harbor for ships.

Fig. 9

In olden times the lamp-shells were more abun-

dant than they are at present. In some parts of our country great masses of rock may be found which are made up almost entirely of these fossil shells. But now it is different, and so we turn to another class of animals, which seem to be in their full glory at the present time. Where we had only half a dozen species of lamp-shells to describe, we shall find more than a hundred of the bivalves to claim our attention.

We call them bivalves because each animal is protected by two valves, or half shells, which are hinged together at the top and which open somewhat at the bottom. Clams, oysters, scallops, and cockles all belong to this division of the mollusks. Their real name is Pelecypods, which means hatchet-footed creatures, since many of them have a burrowing organ, or foot, as it used to be called, shaped somewhat like the blade of a hatchet. To be sure some use this foot to jump with, and others modify it into a kind of finger, and still others have no foot at all to speak of, and yet, in their organism they all show many signs of resemblance and all have the two shells, a right and a left valve. None of them are blessed with a head, a lack of which organ any of us would find very embarrassing; but not so our happy clam, for never having possessed a head he feels no use for one.

So he digs a burrow with his hatchet-shaped foot and pulls himself down into it and feels reasonably safe. To be sure he needs food and some kind of breath, but he is so wonderfully made that he has little trouble in obtaining either, for in fact they

come together. He has two tubes, or siphons, as they are called, which he pushes up through the burrow to the surface of the sand or mud, and then opens them out in the clear water above. Then he starts his pump, which is a double-action affair, and the work begins. Water is sucked down one pipe and forced up the other, and with the water come organic particles for food and dissolved air for breath. His wonderful gills absorb the latter and gather up the former, which they pass on to the mouth that is waiting to receive the nourishment.

When the tide goes out and the sand is left bare, our happy clam has just to wait, that is all. But if you walk along over his hole he may become startled by your footstep and suddenly pull down his siphons into his shell. As they are full of water, the result will be a little fountain which you will see spouting up for an instant and then disappearing. If you have a hoe or a shovel you may now dig the poor fellow out of his revealed burrow, and his fancied security will prove vain; but if he is a large clam his burrow may be too deep to be easily explored, and if he is lively he may dig too.

If you pick up a dead shell and look inside one of the valves you may see that it is marked somewhat like Figure 57, on a later page, except the letters will not be there to guide you. The line p. l. is called the pallial line, because the pallium, or mantle, or skin of the animal is attached to the shell along this line. If the creature lives deep in the mud and has long siphons there will be quite a notch at p. s., which stands for pallial sinus. A sinus is

a gulf, or bay. If the creature simply lives on the surface of the mud, or is only partly buried in the sandy bottom, he will have no need for long pipes, and the pallial sinus will be omitted.

The two big scars marked *a* and *a'* show where the adductor muscles are grown to the shell. These muscles are strong affairs, and enable the creature to close his doors with a snap and to hold them closed against most intruders. Sometimes there is but one adductor, as in the oyster, and then it is situated near the center of the shell. But when the clam or the oyster shuts his shell he is obliged to stretch a thick, heavy spring, which, when it is wet, resembles rubber; though it gets brittle when it is dry. This spring is marked "*l*" in the picture, which stands for ligament. In some species the ligament is internal instead of external, and in such cases it is compressed instead of lengthened, when the clam closes his shells. In either case the elastic ligament opens the valves as soon as the muscles become relaxed, either by the will of the clam or by his death, for dead shells are nearly always open.

The ligament also serves to keep the two valves from falling apart, and beside it there are more or less hinge-teeth for the same purpose. The lateral tooth is marked "*l. t.*" in the picture, while the three cardinal teeth are situated just below the umbo, which is marked "*u.*" One more mark, namely, "*lu*," signifies lunule. This is a heart-shaped depression on the outside of the shell, half in each valve, and is seen best when you look at the end of the shell, as in Figure 54.

It is interesting to capture a healthy clam and put him in a jar of sea-water with a thick bed of sand at the bottom, and see him adjust himself to the changed conditions. He digs with his foot, and he pumps water through his siphons. His pumps, however, are invisible, for in reality they consist of innumerable little lashing hairs, or cilia, covering the surface of the gills. A bit of gill may be snipped off from a freshly-opened oyster or clam and placed in a drop of sea-water under a microscope, and the movement can be plainly observed.

Although the clam has no head, the part which goes down into the burrow first is called the front end, and the siphons always follow. In the dead shell the pallial sinus is therefore always at the posterior end. When a shell is in position for describing, as in the figure, the ligament is at the top. It is easy to see that Figure 57 represents a left-hand valve, for the position of the sinus is plain.

In describing the shells of the pelecypods we shall have occasion to call attention to all of these features, also to the epidermis, or periostracum, which is a kind of horny covering on the outside of the shell that is found in some species. It is secreted by the mantle, somewhat as the shell is formed, but is composed of a horny material and contains very little lime, while the shell proper contains a great deal. With these simple explanations we will pass on to a description of the species, leaving a fuller account of the anatomy of the animal to the numerous excellent books on zoology.

The first shell of this great class that we are to

Fig. 10, $\times \frac{1}{3}$ (*)

consider is one that very few of us will ever collect, for it lives in the ocean where the water is very deep, from one to two miles being recorded by the steamship "Albatross" at some of the stations where it was dredged. A slightly diminished view is shown in Figure 10. Its name is *Solemya johnsoni*, Dall, which may be translated into English as Johnson's Solemya. It is a singular shell, with fingers of epidermis reaching out nearly an inch beyond the edge of the firm portion, as is shown in the figure. The whole shell is about four and a half inches

long. It has been dredged from deep water off various parts of the coast as far north as Puget Sound.

The next shell on our list is named *Nucula castrensis*, Hinds, the Camp Nut-shell. It is well named, for the shell resembles a three-cornered, dark brown nut, while its sides have sculptured markings, reminding one of many steep-walled tents. Internally it is beautifully pearly, and it has about seven little hinge-teeth on each side. The whole shell is wedge-shaped, and is about as large as a good sized

pea, though it sometimes grows a little larger. This species is seldom found on the shore, but a large number were dredged off the southern coast of California a few years ago. The shells are sometimes thickly coated with fine mud. It has also been found in Puget Sound, and even farther to the northward.

Nucula suprastrata, Cpr., the Fine-lined Nut-shell, has a much smaller shell, and the sculptured lines are concentric, instead of forming angles. It probably lives within about the same limits as the last species. The abbreviation "Cpr.," printed after the name of the shell, shows that its name was given by that great naturalist, Dr. Philip P. Carpenter, who lived a generation ago. Let me remind you again that near the close of this book you will find a brief biographical list of the principal men whose names or initials are appended to the Latin names of the species. It is a goodly list, and is worthy of being read by every young person who wishes to honor those who have done so much to make our present knowledge possible. It makes our shells seem more alive and interesting if we know who studied them and gave them their names.

Nucula tenuis, var. *lurida*, Gould, the Thin Nut-shell, is the common species found in moderate depths about Alaska, and in deeper waters farther south. It has also been known as *N. expansa*, Rve.

Nucula carlottensis, Dall, the Charlotte Nut-shell, is a small species only six mm. long, and was dredged from deep water off Queen Charlotte's Islands by the U. S. Steamer "Albatross." It has been con-

founded with *N. exigua*, Sby., which is a Panama shell, smaller, more inflated, and with less conspicuous sculpture. There are a few other species of *Nucula* to which names have been given, but they are uncommon and difficult to determine, and it does not seem wise to give them here. The purpose of this book is to describe all of the species which the ordinary collector will be likely to find, as well as most of the conspicuous rare shells. In due time it is hoped that an official book will be published by the National Museum, giving a complete list of all the species that have ever been collected on this coast, with the limits of their locations. The difficulties of making a complete book of this kind are very great, however, especially since so many species have received different names at various times, and only the best informed naturalists are competent to decide which should be retained as the true ones.

Fig. 11, x $\frac{1}{3}$ (*)

Figure 11 represents *Leda hamata*, Cpr., the Hooked Leda, though the picture is nearly three times as long as the real shell, as is indicated by the fraction. The shell is compressed and is of a dark chestnut-brown color. The specimen was obtained by dredging near Catalina Island, in about 300 feet of water.

Another species, considerably larger than the last, but not quite so long as the figure, is *Leda taphria*, Dall, the Grooved Leda. The name is taken from the Greek, and indicates that the shell is full of ditches or furrows. The shell is as round as a fat bean, and there are more grooves on the sides than

in Figure 11, as might be expected by the name, but the narrow end of the shell is much shorter. The specimens in my cabinet were obtained from San Pedro Bay.

At this point it may be well to explain just what is meant by the locations designated as "north" and "south," also the adjectives "northern" and "southern."

Beginning at the southwestern corner of the United States, the Pacific Ocean forms the western boundary of California, Oregon, Washington, British Columbia, and Alaska. At San Diego and San Pedro, which lie on the coast of the southern part of California, the water is nearly as warm as it is off the coast of northern Mexico. Near Point Conception there is a decided change in the temperature, and many species of mollusks which are freely found farther south are seldom seen north of that angle in the coast line.

The remaining part of the coast of California, together with that of Oregon and southern Washington, forms a "central" region; while Puget Sound and the adjoining waters may be spoken of as the northern region, or simply as the north. The Alaskan waters are still colder, and have their own inhabitants. By the "south," or "southern" California, we refer to the coast south of Point Conception, and not to any specific section of the State. The "north" refers to the cooler waters along the coast of northern Washington and Vancouver Island, while still more northern coasts are designated as "Alaskan,"

The genus *Yoldia* resembles *Leda* in many respects, but the shells are generally larger and the posterior end is not so prolonged or distinctly marked. The hinge-teeth are V-shaped and numerous, sometimes numbering 20 or more on a side. There are a good many species found along our coast, but most of them live at a considerable depth, or in the cold waters of the north.

Fig. 12, x $\frac{2}{3}$

The largest species is named *Yoldia cooperi*, Gabb, Cooper's *Yoldia*, and sometimes it grows to a length of two or three inches. The general shape is shown in Figure 12.

The shell is thin and compressed, while the hinge-teeth are very numerous, there being about 12 in front and 40 or 50 behind. The surface has distinct concentric ridges. It is found as a fossil at San Pedro, and alive off the coast of central California.

Yoldia montereyensis, Dall, the Monterey *Yoldia*, has a length of 32 mm. It was dredged in Monterey Bay, from mud where the water was nearly half a mile deep. The hinge-teeth are about 20 in number on each side, and the epidermis is green.

The genus *Malletia* resembles *Yoldia*, but the ligament is external, elongated, and prominent, while in *Yoldia* it is slight. *Malletia faba*, Dall, the Bean Malletia, has an elegant little shell, nearly an inch long. It is smooth, ovate, inflated, with a

polished epidermis. It has been dredged from deep water off the coast in various places from British Columbia to San Diego.

The *Arcidae*, though very abundant in some parts of the world, are but poorly represented on this coast. In general they prefer warmer waters, being especially common on the coast of Florida. The Arks, as they are called, have a great number of small hinge-teeth which are alike in shape, and taken together they resemble a comb. The shells are generally strong and well developed.

Arca reticulata, Gmel., the Cross-lined Ark, is very small, and has been found from San Pedro southward. *Arca mutabilis*, Sby., and *Arca multcostata*, Sby., are occasionally found at San Pedro and vicinity, though really belonging to the fauna of Mexico.

Glycymeris intermedia, Brod., the Medium Ark-shell, is round, like a button, and is about half an inch across. The shell is solid and white, though tinged with brown, and is marked with many small, transverse hinge-teeth. It was formerly called *Axi-neia intermedia*.

Figures 13 and 14 represent the outside and inside of a remarkable shell from northern Alaska. As it was dredged from pretty deep water, it is probable that very few of my readers will ever see a specimen; but it is well to know about some of the rare forms that live in the sea, even if we never have the privilege of seeing them. The brown epidermis is densely hairy and the margin of the shell is curiously bent,

making a deep pit behind the hinge. The name is *Limopsis vaginata*, Dall, and we will call it the Bearded Ark-shell.

A remarkable new shell was obtained a few years ago by some fishermen who were pursuing their calling

Fig. 13, x $\frac{3}{4}$ (*)

Fig. 14, x $\frac{3}{4}$ (*)

on the waters of San Pedro Bay. From a depth of 25 fathoms they hauled up a living specimen of a large shell, such as had not been seen there before, or at least had never been described. It was sent by two enthusiastic

conchologists to Washington, where it was named by Dr. Dall *Atrina oldroydii*, Oldroyd's Pinna. There are two large, dark valves, some nine inches long, broad above and pointed at one end. Externally it is almost black, but the inside is a dark olive-gray, with some iridescence. It is the first Pinna ever found in this part of the ocean, though in some other parts of the world these large, thin "feather-shells" are common enough. One or two other speci-

mens have been reported recently, and if we could go down into the depths we might find them quite common in favored spots.

From a very large shell we turn to a very small one, only one-eighth of an inch in length. It is white, oval, and shaped like a minute Pinna. It is named *Philobrya setosa*, Cpr., the Moss-lover. It occurs from Santa Barbara southward.

CHAPTER II

MUSSELS AND PECTENS

The great family of the Mussels have elongated, dark-colored shells, and most of them spin a byssus of strong threads by which they anchor themselves to a place of safety. Where the waves dash over the rocks and the white foam curls like flowing milk, there the mussels love to make their home. Moored by their strong cables they enjoy the rush of air and water and fear no danger.

The principal species on our coast is named

Fig. 15, $\times \frac{1}{2}$

Mytilus californianus, Conr., the California Mussel. A very good picture of an empty shell is given in Figure 15. This species can be easily distinguished from other mussels by its conspicuous ribs, which are never wholly absent, particularly on the newest parts of the shell. The beaks of old specimens are apt to be much eroded, but the growing edge is protected by a glossy epidermis. The general color of the shell is purple, though the thicker parts of it are white, and sometimes there are streaks of brown, which har-

monize remarkably well with the purple. Occasionally a very large and perfect specimen is polished on a lapidary's wheel, and the result is remarkably pretty. But far more often we see Nature's method of bringing out the colors. If you find a little beach near a mussel ledge you will notice that the sand contains unnumbered bits of blue and white and brown, all bright and polished, and forming the most lovely bed of gaily colored gravel imaginable. If you examine the pieces you will find that most of them are nothing but broken mussel-shell, and you will admire the bright colors that blend so perfectly. And while we are speaking of colors, let me ask you to observe the combinations all along the rim of the ocean. What soft tints of olive green in the seaweeds, enlivened by the brilliant red of a starfish or the bright emerald of a frill of *Ulva*. How beautifully they harmonize with the gray of the rocks and the blue of the sea and the sky. What fertile suggestions for an artist who is seeking new patterns for a fabric or a carpet.

But to return to our mussel, the flesh of which is bright orange-colored. Its shell was one of the first from our coast that received attention in Europe. In 1789 Captain George Dixon published an account of his voyage around the world, and he speaks of finding this species on the northwest coast of America in these words:

"We saw, also, on this coast a kind of mussel, in color and shape much like the common edible mussel of Europe, but differed in being circularly wrinkled and a great deal larger. One valve I saw at Queen Charlotte's Islands measured above nine

inches and a half in length. With pieces of these mussels, sharpened to an exquisite edge and point, the Indians head their harpoons and other instruments for fishing; they fasten them on with a kind of resinous substance."

Mytilus edulis, Linn., the Edible Mussel, is the same species that is found on both shores of the Atlantic. The shell is smooth and regular, and is covered with a dark, glossy epidermis. The shell of this species is smaller than that of the last, and it is more often found living in quiet water. In San Francisco Bay a variety, *glomeratus*, Gld., is found clinging in large groups to posts and wharves. Its length is seldom more than two inches. It is one of the few mollusks commonly found for sale in the San Francisco markets.

There is another mussel, found chiefly in the south, concerning which there has been much discussion. In a former volume it was called *Mytilus bifurcatus*, Conr., but it seems to have been confounded with another shell of the same name. In 1898 it was renamed *Mytilus stearnsi*, Pils. & Raym., Stearns' Mussel, in honor of the late veteran conchologist of this coast, Dr. Robert E. C. Stearns, and by this name we trust that it will continue to be known. Externally it greatly resembles Figure 16, though it is usually considerably smaller. Internally it may be distinguished from a *Septifer* by the absence of a deck across the point of the umbo.

Fig. 16

Figure 16 is a good picture of the little shell which resembles the one referred to above. Its name is *Septifer bifurcatus*, Rve, the Branch-ribbed *Septifer*. Its gen-

eric name signifies that it is a partition-bearer, and it was given on account of the fact that a little shelly deck is stretched across a small part of the interior of each valve, near the umbo. The shell itself is strong, has a thick, dark epidermis, and is very pearly within, where the color varies from white to dark purple. Outside, the ribs increase in number towards the edge of the shell, sometimes seeming to actually fork into two. Sometimes the outside is exceedingly eroded, and almost all signs of ribs disappear, or the surface may become incrustated with foreign substances. The *Septifer* spins a strong byssus and attaches itself to stones, where it may dwell in safety. Occasionally a specimen is found which is nearly twice as long as the picture. On the whole, this is a very interesting shell, and it should be sought for, especially in the south.

Closely allied to the common mussels is another group of shells which for some reason are popularly known as "Horse-mussels." The true name is *Modiolus*, which means a little measure, or drinking cup. They are usually more solitary in their habits than the true mussels, and they often spin a kind of covering, filled with bits of broken shells. Some of them live in the mud, with only a small part of the shell above the surface. In all of these shells the umbo is not the extreme point, as in the mussels, but a part of the shell projects by the hinge, forming a rounded lobe.

Of the species found on this coast there is first *Modiolus modiolus*, Linn., the Great Horse-mussel, most abundant in northern waters. In Puget Sound

there have been found specimens nine inches long and four inches in diameter, standing perpendicularly in the mud. The epidermis is roughly bearded near the edge of the shell, while the buried parts are strongly eroded. The Horse-mussels usually grow rapidly.

Modiolus capax, Conr., is a similar species from the south, though I have grave doubts whether it is really distinct from the last species. I have gathered them abundantly about San Pedro. When the epidermis peels off from the outside of the shell the latter often appears of a brick-red color.

Fig. 17

Modiolus rectus, Conr., the Straight Horse-mussel, is shown in Figure 17. The shell is long and narrow, thin and delicate. The epidermis near the hinge end is dark brown and glossy; in front it is light brown, with numerous chaffy hairs; internally the shell is white. The common length is three or four inches, but a variety, *flabellus*, Gld., found on the shores of British Columbia and in deep water off the coast of California, grows to a much larger size.

Modiolus fornicatus, Gld., the Arched Horse-mussel, has a very short and full shell, somewhat wedge-shaped, having a breadth more than half of its length. The naked shell is white, though somewhat tinted, and it is normally

covered with a light brown epidermis, especially near the edges. This shell is sometimes found solitary, but at other times in large masses, grouped around the base of a seaweed, or in some similarly protected situation. The common length is about an inch.

Modiolus plicatulus, Lam., the Plaited Horse-mussel, is really an Atlantic species, being extremely abundant in sheltered bays around the city of Boston. It doubtless came to California with seed oysters, which were planted in San Francisco Bay, where it may now be found in considerable numbers, and where it may ultimately become as abundant as it once was in the celebrated "Back Bay" of Boston, a place now converted into solid ground and covered with fine streets and elegant buildings. It has a rather pretty shell, about two inches long, covered with a glossy epidermis. It is marked with a great number of small but very distinct plaits or ribs, radiating forward from the umbo. The ligament is long and strong, and the interior of the shell is tinted with purple.

It is extremely interesting to note the

Fig. 18

different habits which members of the same family now possess, and which they may have acquired long ago and passed down to posterity. The long, singular shell shown in Figure 18 is evidently a kind of mussel, but its owner prefers a safe, sheltered retreat to a mere anchoring place on the side of a wave-swept cliff. The name of this species is *Adula falcata*, Gld.,

the Pea-pod Shell. Among the difficult things to explain is the fact that a mollusk with a thin and flexible shell can bore a deep hole into hard rock. But this creature does it, for I found the rocks of Duxbury Reef at Bolinas almost alive with this and other borers. It spins a byssus, too, like other mussels, and attaches itself to the sides of its burrow, though this would seem to be an unnecessary bit of precaution, inherited from the time when its ancestors lived in more exposed situations. The figure represents a rather large specimen. The inside of the shell is white and pearly, while the outside is covered with a dark chestnut epidermis, which has numerous transverse wrinkles.

Adula stylina, Cpr., the Short Adula, is smaller, shorter, and has very angular shells, with a brown epidermis destitute of distinct wrinkles.

Lithophagus plumula, Hanl., the Rock-eating Mussel, has a small, cylindrical shell, rounded in front and tapering behind. It constructs a burrow sometimes in rocks and sometimes in old shells. It has a light brown epidermis, and is an inch or two in length.

Modiolaria taylori, Dall, Taylor's Modiolaria, is a little creature hardly a quarter of an inch long, but shaped like a true Modiolus. It was found in tide-pools, at Victoria, B. C., by Rev. G. W. Taylor.

Modiolaria vernicosa, Midd., the Varnished Modiolaria, has an oval shell, with beaks near one end. It is smooth, reddish-brown, and has a brilliantly polished epidermis. Its length is 15 mm. It is found in Alaska, where there are other species of the same genus, which we will not now describe,

Crenella decussata, Montagu, the Netted Crenella, is a little affair, about 3 mm. long, which is circum-boreal in its range. The valves are rounded and marked by numerous radiating ribs. The edge of the shell is crenulated behind the ligament area. While it is sometimes found in San Pedro Bay its true home is in the north, where several allied species are also found.

The Pectens, or Scallop-shells, are among the most pleasing mollusks to be found in the ocean. Of regular shape, brightly colored and finely sculptured, it is no wonder that their shells have been imitated in all sorts of carved work. And

Fig. 19

if one is fortunate enough to become acquainted with a live specimen, he will be abundantly rewarded by watching its interesting habits. We have a good many species on this coast, some of which are not too distinct from one another.

The first in importance is *Pecten circularis*, var. *aequisulcatus*, Cpr., the Speckled Pecten, a good view of which is given in Figure 19. This species abounds in the south, where it may be dredged in large

quantities, though good specimens are often found at low tide. This creature can swim freely by flapping its broad shells, though it sometimes moors itself to a piece of seaweed by spinning a byssus with the aid of a singular little organ shaped like a finger. You will notice in the picture a little notch in the back shell, just under the left "ear," through which the little creature thrusts out this finger when spinning the threads. In a good specimen you will find that this opening is set with little projections, like the teeth of a comb.

Pecten caurinus, Gld., the Weather-vane Shell, is a species found in the north, which has very broad, thin and flat shells, each marked by about twenty ribs. The edges are thin, the ears small, and the color is white within and light brown without. Its diameter is sometimes as much as five or six inches.

Pecten diegensis, Dall, the San Diego Pecten, sometimes grows nearly as large as the last species, though it is totally distinct. Its two valves are dissimilar, the one being nearly flat, while the other is moderately arched. Both have very large and distinct ribs, twenty or more in number, with deep channels between them. The shells vary in color from dark red on the flat side to yellow on the curved. It is found living at least as far north as Monterey, though as its name indicates, its home is in the south.

Figure 20 represents an exquisitely beautiful species which is essentially a northern, deep-water inhabitant, though it is occasionally found quite far down the coast. The shell is thin, the ears are very

unequal, and the edges of the principal ribs are cut into many short and slender teeth. The valves differ from each other in sculpturing and color, the under one having more ribs and being nearly white, while the upper one is richly marked with concentric bands of pink. Its name is *Pecten hericeus*, Gld., the Pink Pecten.

Fig. 20

It has sometimes been mistaken for *Pecten hastatus*, Sby., the Spear Pecten. That name is now applied to a similar species, closely allied, found in deep water off Southern California, the adult shells of which are about one and a half inches across. The ten very prominent ribs on the back have long-toothed combs, while the colors are very vivid, ranging through various tints of red, yellow and purple.

Pecten rubidus, Hinds, the Red Pecten, is from the north, and closely resembles the shell shown in Figure 20, but the ribs are more smooth and even, and are without the serrations so prominently seen in that species.

Pecten latiauritus, Conrad, the Broad-eared Pecten, is a southern species, about an inch across, having thin valves, with twelve to fifteen squarish,

distinct ribs. The ears of the shell, by which we mean the flattened parts on each side of the umbo, are broad and pointed. The color is white and brown.

Fig. 21

A variety of this species, known as var. *monotimeris*, Contr., is shown in Figure 21. It is sometimes described as a distinct species. The shell is very thin and delicate, the ribs rounded and rather faint, and the ears are smaller than in the last form. The colors incline to yellow and brown, variously mottled with zigzag lines of white. I have found this variety living at San Pedro, and at times it is abundant as far north as Carmelo Bay, near Monterey. There are also several other varieties of this species.

Pecten davidsoni, Dall, Davidson's Pecten, is represented in Figure 22, the form and sculpture of both valves being plainly

Fig. 22, x $\frac{1}{3}$ (*)

shown. The left valve has twenty-one rounded ribs, while the right is nearly smooth. The color is waxen white. It was dredged from deep water off Alaska, and in Bering Sea. Very few of us, probably, will ever have a specimen in our cabinets, but how interesting it is to know what creatures are living at this moment on the bottom of that cold ocean far towards the North Pole.

Pecten randolphi, Dall, Randolph's Pecten, was obtained by the U. S. Fish Commission from deep

water at various stations extending from Bering Sea to Mexico. The shell is thin, glossy, and unsculptured, translucent white in color, and measures about an inch in diameter.

Pecten vancouverensis, Whiteaves, the Vancouver Pecten, is perhaps the smallest member of the genus to be found on our coast. The little shells are only 5 mm. across, and are very fragile. Form nearly circular, ribs fine and numerous, color very light brown. It has been collected on the coast of British Columbia, also in San Pedro Bay at a depth of two hundred fathoms.

Pecten ventricosus, Sby., the Bulged Pecten, is found fossil at San Pedro, and is said to be living from Santa Barbara southward. "*P. aequisulcatus* resembles this species very closely, but is thinner and flatter and has narrower ribs." (Arnold). Diameter, about two inches.

We now come to a notable species which differs from the typical Pectens in that the valves become unsymmetrical when they become old. It is called *Pecten giganteus*, Gray, the Purple-hinged Pecten. It belongs to the division of the Pecten genus sometimes known as *Hinnites*. In its early life it is a true little fan-shell, with thin, fine-ribbed, unequally eared left

Fig. 23, x 3

valves, some white, some yellow, and some red, while the right valves have about twelve serrated ribs and are apt to be mottled in color. When the shell is about an inch long a reddish purple spot begins to show along the hinge area, inside the valves. The spot increases with age, and never fades, though the shell may be sadly worn and broken. Fragments of shell on the beach show the color distinctly. At the same time the little creature quits its free life and settles down in some quiet nook, like the inside of an old abalone-shell. There it turns over on its left side and begins to grow, fastening itself firmly to the nook that it has chosen.

And now, as it is confined, it loses its perfect symmetry and grows in whatever direction it has room, sending out short spines and thorns for defense. Sometimes it becomes a giant indeed, with thick shells four or five inches long; but more often it is considerably smaller. The ligament is internal, lodged in a deep, narrow pit; the central muscle-scar is smooth and very large. Live specimens are not common, but dead shells are thrown up all along our coast. Figure 23 shows the appearance of a long and narrow specimen.

At this point we will quote, for our younger readers, a part of "The Story of the Pecten" from the author's "Shells and Sea-Life."

THE STORY OF THE PECTEN

"One bright morning in springtime I found myself swimming with a number of my brothers and sisters in a little pool which had been left among the rocks

when the tide went down. Of course I did not then understand that there was such a thing as a tide; the only thing that I did know was that I felt happy, and that I could snap my two shells together and make myself dart off through the water at a great rate.

"After doing this a little while, I felt tired; so I just stopped swimming, and found that I slowly settled down upon some sand which lay at the bottom of the pool. Then I opened my shells and looked out of the little eyes which are in the margin of my mantle. I could not see far, but everything about me looked so fresh and cool that I concluded to go to sleep for a little while and then wake up and swim races with my brothers.

"I do not know how long I slept, but after a hazy dream about nothing, I was awakened by hearing a rush of water over my head, or over what you, perhaps, would call my head; for to tell the truth, I never had a head and never expect to have one. But a head is not necessary if one has eyes and ears in other parts of his body, as I have.

"At any rate, I heard a great rushing sound above me, and I started up in considerable alarm and began to snap my shells vigorously. I was so light and agile that my pair of shells served me as well in the water as a pair of wings serve a bird in the air; so away I flew towards the surface of the water, which I soon found was in a state of great commotion.

"The little cove in which I went to sleep was now all covered, and the waves were whirling and tossing as if they intended to mix the air and water together

into a kind of soda-water fizz. I have since learned that that was just what they were doing, and that 'air-fizz' is just what a great many creatures in the sea are particularly fond of, and that they make their homes where they will be pretty sure to get it fresh at least twice a day.

"But I soon saw that this place where the waves were churning air was no place for me; so with a few bold snaps I shot off for deeper water. I was none too quick, for just as I had made up my mind to move I caught sight of a big-mouthed fish coming straight towards me. He doubtless knew that the incoming tide would startle a great many helpless creatures like myself, and he had come, ready to swallow us as we were trying to make our escape.

"Luckily for me his attention was turned at that instant to a fat worm which seemed to be swimming just in front of me. His mouth closed on the worm, and in an instant more he was shooting upward as if he had been pulled by a string, and I never saw him again. Perhaps some of you may know why he disappeared so suddenly, and can guess what became of him.

"I was dreadfully scared, for there were other fishes all about, and I am sure that some of my poor brothers did not escape, but I did, and in a few moments I was down in the deep water where everything is quiet and still.

"That night, before I went to sleep, I spun some strong, silky thread with my one finger, and fastened myself to the stem of a great seaweed, so that I would be safe even if a great storm should arise.

You can see the little notch in one of my shells where I put out my finger and made fast my threads. It is just under one of the 'ears' of the shell, and you can find it in Figure 21.

"Well, I lived down in the water for a good many months and I saw many things that you would like to see. There was a whole bed of my brothers and sisters around me, and all sorts of funny things used to come and visit us. Sometimes a big jelly-fish would swim by, looking for all the world like a glass umbrella. We seldom spoke to the jellies, for they seemed rather vain of their long trains, and we did not care to encourage them.

"Sometimes our visitors would coax us to reach out our little fingers and untie our cords and take a swim. We were often willing to do this in fine weather, and many a famous journey we have taken, sometimes visiting other species of Pectens that have their home far out from the shore.

"I grew rapidly, getting my food from little plants and animals that abound in sea-water, and as I kept enlarging my pretty shells, they never failed to cover me when I wished to be alone. I have heard that our shells have been used for many purposes by men and women, and of course the children always love to find them, and use them for spoons and dishes. The funniest thing of all was told me by an oyster, who said his grandfather had heard a fisherman say that sometimes the meats of oysters are mixed with cracker-crumbs and butter, and baked in large scollop-shells, and so when they are brought to the table they are called *escaloped* oysters. You

know some people call us scallops, though we prefer to be known by our true name, *Pectens*. And he said, too, that lately the cooks leave out the shells (for which I am very thankful), but keep the name, though somewhat shortened, and so they are called 'scalloped oysters,' even if they are baked in an earthen dish.

"I feel that I am growing old, and that in a little time nothing but my shells will be left; so I have been asking carefully about my ancestors and my kindred, for I want to know who have gone before me and who will be likely to follow me.

"I find that my family is a very old one, and that we have colonies all over the world. Our flesh has always been esteemed a delicacy, and our shells have been much admired by men. But, better than that, I find that we and a very few of our near relatives are the only bivalves in the ocean that have the power to swim freely wherever they choose.

"Some of my relatives have shells that are fully six inches across, while others are tiny little things no larger than a dime. But our oddest relative is the rock-oyster, or winter shell, as some people call him. Figure 23 shows you how he looks, and he may be found all along the coast of California.

"When his children are young they look like little yellow-shelled *pectens*, and they swim about and moor themselves as we do. But after a while they grow weary of a wandering life, and then they settle down in an old abalone-shell or a hollow place in some rock, and cement one of their shells to the new support.

"As time goes by, they enlarge their shells on whatever side there is the most room, and so when they get to be old, some are long and narrow, some flat and round, while others are cramped or half doubled up.

"As soon as they settle down they close up the finger-hole, for they have no more need to spin anchor threads; but you can always see on the shell the place that used to be open. You can tell their shells, even if they are old and broken, for they always color the part next to the hinge with a rich purple that never fades or washes out.

"But good-bye, now, for I must go, or the tide will leave me high and dry. When I am dead you may find my shells washed up on the beach. If you do find them, please put them in your cabinet with a proper label; and whenever you look at them, think of me, and of my little story about the pectens."

Lima dehiscens, Conr., the File-shell, is shown in Figure 24. It resembles a pecten, but the ears are small. The animal can swim freely. The shell is pure white, delicate, oblique, the valves gaping on one side. The sculpturing is fine and straight, like the teeth of a file. It is sometimes thrown up by storms, and is also found attached to seaweed. Some specimens grow to a much larger size than is indicated by the figure. It occurs from Monterey southward.

Fig. 24

CHAPTER III

OYSTERS AND SMALL CLAMS

Did you ever wake up very early some fine summer morning and suddenly remember that you went to sleep full of a determination to rise with the sun and go out shell-hunting? And did the tempter say to you, "It's really too much work; for is not an hour of dreaming worth more than a whole bushel of shells?" But of course you knew better, and told him so; for it was not shells alone that you were seeking, but far more valuable things, such as exercise, health, a good appetite, a cheerful disposition, and best of all, the inspiration which comes with an early walk by the seaside.

I do not know where you were sleeping or where you intended to take your walk. Such things do not matter so much, provided you go to the shore instead of going to sleep again. It may be that you live at the mouth of the Columbia, or at Bolinas, or at San Pedro, or at any of a hundred places between; if you really hear the call of the sea and obey the summons, you are pretty sure to be rewarded.

My call came while I was sleeping in Pacific Grove, and it led me along the old "Lighthouse Road"; it took me past rows of houses where the lazy smoke was just beginning to curl from kitchen chimneys, along through the silent pines with their gray, mossy beards, across the railroad, through

the turnstile into the lighthouse grounds, past the tower where the lamp had been burning all night, down through the sandy pasture and on towards the point of rocks, where the mournful note of the whistling buoy told of active waves and restless tides. There had been some fog and the trees were dripping, but now the sun was just breaking through the clouds in the far east, and the whole morning was glorious.

A few other early risers were out on the point before me; some on the beach, some searching for pretty seaweeds, while others were exploring the moss-covered rocks for star-fishes, sea-urchins and other sea-creatures.

The tide was low, and one could easily cross the sand to the first island, then work his way down and get to the second without much risk of taking an involuntary bath. The second island is rather craggy, and though one could see treasures on the slippery rocks beyond, still it was not wise to venture much farther, for the green water was surging in and out among the rocks and warning you that all things beyond were strictly "taboo." All right; there is enough left any way; and up we clamber to the highest point of the little island and look off seaward. What a wonderful view! The ocean is on three sides of you, blue and white and green; deliberately active, vigorously quiet; in short, a mighty old giant, who knows his strength and who wishes you to know and admire it also.

Out on the distant rocks are flocks of sea-birds, mingling their morning cries with the sigh of the

surf; nearer, a line of these black-feathered creatures darts noiselessly by, just over the surface of the water, reminding one of the motions of the fabled sea-serpent. On this side are transparent tide-pools with their living inhabitants; crabs, sea-stars, little fishes, gay sea-urchins, and a host of minor creatures, all intent on getting their breakfasts and then settling down for the day's work. Over there are rocks, covered with olive-green seaweeds, which for all the world are almost the same that we find preserved in sandstones, a million years old.

But from all this assemblage of beauty, made more enjoyable by the soft murmur of the waves and the sweet breath of the morning air, we turn back to the little beaches that have been left bare by the retreating tide, and gleefully search for treasures that may have been left by the truant waters. Treasures indeed are all about us, though choice shells may be wholly absent. The white sand is here, inexpressibly sweet and clean, and multitudes of fragments are mingled with it, fragments of bright shells, white, red, purple and blue.

There are grains of pearl, broken but beautiful; pieces of limpet-shells, turban-shells, mussel-shells and bright abalones; white crystals of feldspar from the granite rocks, bits of green glass, worn smooth from broken bottles; clear quartz sand-grains and many other things, all ground up together in the great mill of the sea. Every handful of the sand contains something of interest, and every quart is liable to reveal some rare shell, beautifully cleaned and ready for the cabinet.

I lingered till the rising tide told me in no uncertain tones to leave the island immediately if I did not wish to be marooned there all day. And then I tramped back, carrying a few good specimens, a pocketful of pretty fragments, and a heart as light as ocean foam. I had seen the morning vision, and it had shown me life and light and beauty, and the vision had become a part of my being. And you may see the vision too, though you look from far different standpoints. There may be sight without vision, indeed, but happily the vision is waiting for those who wish to see it.

But leaving visions and all those immaterial things, let me remark that on this walk I found a good many broken shells, which, when perfect, resemble Figure 25. This shell is found along the whole coast, and its name is *Monia macroschisma*, Desh., the Pearly Monia. It belongs very

Fig. 25

closely to the oyster family, but it has decided differences. You will notice that one of the valves is much smaller than the other, and that it also has a large hole in the middle, through which you can see an oval muscle-scar with lines radiating from the center. The small valve is seldom found in the sands, as it usually adheres to the rock to which the whole shell is attached, even after the death of the animal, while the upper valve is torn off by the

waves and washed ashore. The outside of this upper valve is rough, and marked by irregular, radiating ridges; but the inside is sometimes beautifully pearly, the green and purple tints being most common. There are two muscle-scars, the lower one of which is not shown in the cut, but it is smaller and smoother than the other. The shell is normally circular, though it assumes various shapes. The picture represents a rather small specimen. When the structure and color of the interior are once known, even a small fragment of this shell can be readily recognized.

Anomia lampe, Gray, the Lawless Shell. This is a southern species, similar to the last, but smaller, the animal having a very thin and delicate shell. It also lies upon its right valve, which is concave and perforated. Through the opening runs a strong byssal plug, firmly attaching the whole to the support on which it rests. In color it is yellow and shining, and the upper valve is marked with four muscle impressions instead of two, as in the last species. It gets its name from its irregular habits of growth. Some call this shell *Anomia peruviana*.

A great many years ago there were plenty of large oysters living off the coast of a land that was in time to become the State of California. Some of them were very large indeed, so big that a ten-year-old boy would not want to carry one of them far without resting. These shells would be almost as long as one of his arms and a good deal thicker than his two fists, and what a time he would have in trying to open one of them.

But all that kind of oysters have been dead for thousands of years; possibly they were all dead before there was a man upon the earth. Yet we now find their shells in the rocks, high up on the Coast Range of mountains, in the western part of Fresno County and in other localities. The name given to these huge creatures is *Ostrea titan*.

Long, long ago the ocean waves must have rolled over these places, for the land was much lower then than at present. Apparently the big oysters must have had a comfortable life; but there came a change, and the ocean beach was slowly lifted up and gradually converted into a range of mountains, while the sea swept away to the westward.

Well, after this age of change and disturbance there came one of comparative quiet, and the oysters of this new age were far smaller than those of the old one. In fact, they were very little fellows, with thin shells about as large as the petals of a big rose. The meats were good eating, however,—Dr. LeConte says that they were probably much better flavored than the huge Tertiary oysters,—but so small that a man needed about a hundred to make a good meal. These “native oysters” now live all along the coast, but those about Puget Sound are especially good. In some parts of San Francisco Bay their shells wash up on the shore and are gathered in large quantities. They are sold for making walks and for feeding to chickens. This native species is named *Ostrea lurida*, Cpr., the Lurid Oyster. There are two fairly distinct varieties,

expansa, Cpr., which is nearly circular, and is attached by the whole surface of the lower valve, and *rufoides*, Cpr., whose shells are reddish in color, and often quite oblong in shape.

As soon as the railroad from California to the East had been built over the mountains and across the plains there was a chance to bring live oysters from the Atlantic coast and plant them in the shallow parts of San Francisco bay. Young oysters can be conveniently packed in barrels, and if they are kept moist and cool, they will live for a week or more, and that was long enough to bring them on the cars from one ocean to the other. When they arrived at Oakland they were at once put upon rafts and taken to places that had been well fenced in to keep out the big fishes, which the boys call "sting-arees," that like oysters as well as we do. Then a man on the raft would take them up in shovelfuls and sow them into the water as a man sows wheat in his field. In this manner large spaces were planted with eastern oysters, mostly *Ostrea virginiana*, Lister. After living three or four years in the bay the little oysters have grown from the size of a dime or a silver quarter to a length of some four inches. They are now gathered by tongs, shaped like two rakes fastened together, and piled upon rafts. The larger ones are sent to market, while the smaller ones are returned to new beds and allowed another year of peaceful repose.

Among the enemies of the oyster may be mentioned the Ray fish, already alluded to, the starfish, which has a bad habit of insinuating its everted

stomach between the two shells of its victim and digesting him alive; various "drills," or small sea-snails, which bore their way through the shell and attack a vital spot; also mud, which may be washed in in time of freshet and then bury the helpless creatures; also frost, which may occur during cold mornings in the winter when the tide is low and the beds of oysters are left exposed to the full influence of the weather. This last enemy is not much feared in California, but is liable to cause extensive damage farther to the north.

The native oysters reproduce rapidly, but experiments with the imported species have not been altogether satisfactory. It is certain, however, that some of their young do survive and grow, and the subject needs further investigation. Large oysters always command a high price upon the Pacific coast, and this fact has led to a great trade in canned oysters, put up on the other side of the continent. Some attempts have been made to introduce living Japanese oysters upon the northern coasts of California. The whole subject is one of great interest, and in a financial way, is perhaps the most important problem connected with our study of western mollusks.

We now come to a very different family of mollusks, and they are far more regular in shape than those that we have just been considering. Figure 26 gives a good idea of the Little Heart-shell, *Cardita subquadrata*, Cpr. The name is very much longer than the shell, and even the little picture is too large for ordinary specimens. It is a firm, hard little shell, however,

Fig. 26

and can easily be identified by the strong ribs which seem to radiate from one corner. The color is brownish-white, the inside being sometimes stained with purple. It may occasionally be found alive, attached to stones, while dead specimens are often washed up with the gravel on the beach.

Fig. 27 (*)

In Figure 27 we have a picture of the inside of the right valve of *Calypptogena pacifica*, Dall, the Pacific Calypto. The outside of the shell is nearly smooth, being marked only by lines

of growth, though the white exterior may be covered with a thick, greenish epidermis. It was dredged off Dixon Entrance, Alaska, in 322 fathoms of water. You will notice in this shell, as in all belonging to this great family, that the pallial line is entire, showing that the creatures do not burrow deeply in the mud at the bottom of the sea.

Figure 28 gives a good external view of *Venericardia alaskana*, Dall, the Alaskan Venus-heart. It was collected at Nunivak Island, in Bering Sea. Notice the strong ribs, the lines of growth, and the artistic outline of the whole shell.

Fig. 28 (*)

Figure 29 shows both an inside and an outside view of *Venericardia ventricosa*, Gould, the Ventricose Venus-heart. The figures were made from a specimen found in Puget Sound. This species also lives from the Aleutian Islands in the north to Catalina Island in the south, where it has been dredged in thirty fathoms of water.

Fig. 29, $\times \frac{1}{2}$ (*)

Venericardia barbarens, Stearns, the Santa Barbara Venus-heart, shown in Figure 30, resembles the last species, but is more circular, has more ribs and a less prominent beak.

Dredged off Santa Barbara Islands in green mud, at 276 fathoms depth.

Fig. 30, $\times \frac{1}{2}$ (*)

Fig. 31 (*)

Figure 31 gives an inside view of *Venericardia crassidens*, Brod. & Sby., the Heavy-

toothed Venus-heart. The figure is of the natural size, and the specimen from which it was made was obtained in the vicinity of Icy Cape. Notice the very heavy hinge-teeth, from which the species received its name.

The last member of this family of the *Carditidae* to be noticed is named *Milneria minima*, Dall, the Least Milner-shell. It was discovered by Dr. Wm. H. Dall in 1866, at Monterey, where it was found nestling on the back of abalones. It is a curious little bivalve, about as large as a grain of wheat, light brown in color, very strongly angled, and marked by numerous lines of growth. It is worth looking for.

Fig. 32 (*)

The members of the genus *Astarte* have thick shells, covered with dark, heavy epidermis. *Astarte*, by the way, was the Syrian Venus, so we have another mythical name added to the many which have gone before. As Venus was supposed to represent beauty, so the beautiful shells are appropriately given her various names. Figure 32 represents *Astarte alaskensis*, Dall, the Alaskan *Astarte*. The figure is about natural size, and very plainly shows the peculiarities of the shell. The epidermis, or periostracum, is very dark, and becomes black in old shells, while the solid portion beneath it is white. This species lives in Bering Sea, and has been found as far south as Puget Sound.

Astarte polaris, Dall, the Polar Astarte, is shown, somewhat enlarged, in Figure 33. This shell is more delicate than the last, with finer and more numerous ridges; it has a polished, light brown epidermis. It comes from Alaska, near the Shumagin Islands, also from Baffin's Bay on the Greenland coast.

Fig. 33, x $\frac{1}{3}$ (*) Fig. 34, x $\frac{1}{3}$ (*)

Figure 34 shows the appearance of the Esquimalt Astarte, *Astarte esquimalti*, Baird, which may be easily recognized by its irregular sculpturing, so clearly shown in the picture. This species ranges from the Aleutian Islands to Puget Sound.

Astarte vernicosa, Dall, the Varnished Astarte, Figure 35, is a small species, its shell being covered with a yellow-brown periostracum and brilliantly polished. It is found in Bering Sea. There are several other species of this genus, living in northern waters, which will not be described in this book.

Fig. 35, x $\frac{1}{3}$ (*)

Crassatella marginata, Cpr., the Margined Crassatella, is a minute, southern shell, about the size of a

large pin-head. Somewhat triangular, yellowish, marked with brown chevrons.

Chlamydoconcha orcutti, Dall, Orcutt's Cloak-shell, is a singular mollusk, which was discovered by Charles R. Orcutt, in False Bay near San Diego. It lives under stones. It is a bivalve mollusk, but the shells, singularly enough, are internal, and very minute when compared with the size of the body, which is about an inch long. The animal is shaped somewhat like a cowry, and the flesh is translucent and jelly-like.

Fig. 36, x $\frac{1}{2}$ (*)

Under the Leptonidæ we have quite a number of shells, most of them of small size. Figure 36 gives an enlarged view of *Erycina compressa*, Dall, the Compressed Erycina, which has a delicate, white, compressed shell, covered with a thin, wrinkled periostracum. It occurs in Bering Sea and southward as far as Sitka. Erycina is still another name for Venus.

In Figure 37 we have a singular combination. The greater part of the picture is a ventral view of the Mud Prawn, *Gebia pugetensis*, Dana, which lives in the waters of Puget Sound, and is very expert in burrowing in the soft sediment. But attached to its abdomen is a little mollusk, represented of natural size, which the prawn carries along wherever it goes, whether willingly or not I do not know. This little mollusk is named *Erycina rugifera*, Cpr., the Rough Erycina. It was formerly called *Lepton*

rude, Whiteaves. It also lives on the "Sea Mouse."

We now come to two little shells, very smooth and pretty, the first of which is named *Kellia laperousii*, Desh., after the French explorer, La Perouse. We will call it the Smooth Kelly-shell. When living it is covered with a shining, light brown epidermis. The ligament is small and internal. This little nestler lives in sheltered places, such as holes in the rocks; often in the deserted homes of the piddocks, or rock-borers. I once found a whole colony of them of different ages, all living happily together within the valves of a dead clam. The shell is somewhat oval in shape, and is about half an inch in length.

Fig. 37 (*):

Kellia suborbicularis, Montagu, the Globose Kelly-shell, is a thin, delicate little bivalve, about one-third of an inch in length. The little creature can spin a byssus with its foot and attach itself at will to any projecting object. It is often found among the twisted holdfasts of seaweeds. It is an interesting fact that this species lives not only on this coast, but is found in European waters as well,

thus connecting the fauna of the Atlantic and the Pacific oceans.

Fig. 38, x $\frac{1}{2}$ (*)

The members of the genus *Myrella* are very small creatures, with thin, sometimes transparent shells. Figure 38 represents the inside of a valve of *Myrella aleutica*, Dall, the Aleutian *Myrella*.

Its shell is solid, smooth, and white, and it is covered with a polished, straw-colored epidermis. Its length is only 4.3 mm.

A closely related shell is the little *Lasea rubra*, Montagu, the Red Lasea. As the name indicates, it is reddish-brown in color. This shell is found living on the coast of England, as well as on this coast. It loves to hide in the root-like holdfasts of seaweeds and in cracks of the rocks. Jeffreys says that it is viviparous, and that it lives as much out of the sea as in it.

Another little creature that lives on the shores of the Atlantic and the Pacific is *Turtonia minuta*, Fabr., which the naturalist, Rev. J. G. Wood, calls the Little Mullet-shell, because it is often found in the stomachs of mullets. He advises all zoologists to examine the stomachs of such fishes as they can secure, since they often contain objects of much interest. "This little shell," says he, "is about the size of a capital O, is exceedingly thin, purple-brown in hue, dark at the beak. It may be found by looking among the roots of corallines and other Algæ." On our side of the world it lives on the coast of northern Alaska.

Turtonia occidentalis, Dall, the Western Mullet-shell, also lives in Bering Strait and northward. It is said to be larger, stouter, and shorter than the last species.

We now come to the great sub-order *Lucinacea*, named from the word *Lucina*, one of the titles of the goddess Juno, in heathen mythology. The shells internally are marked with one very long and narrow muscle-scar, while the other is nearly round. The pallial line which joins them has no sinus. Figure 39 gives two

views of *Thyasira bisecta*, Conrad, the Cleft Thyasira, which was found in the deep water of Puget Sound by Prof. O. B. Johnson. It has also been found

Fig. 39, $\times \frac{1}{2}$ (*)

in the far north. It is the largest species of the genus, sometimes measuring two or even three inches across. The figure plainly shows its peculiarities.

Thyasira barbarensis, Dall, the Barbara Thyasira, resembles the last, but the beaks are more nearly in the center. It was formerly known as *Cryptodon* or *Axinus*. It ranges along the coast from Washington to Mexico. The shell is white and chalky externally, and measures 17 mm. in length.

Thyasira excavata, Dall, the Sculptured Thyasira, has a thin, white shell, with a yellowish epidermis.

The side of the shell is deeply infolded, making a sharp excavation. Its length is only 20 mm., less than an inch. It has been dredged from cold water off the coast of Oregon, and also in the Gulf of California.

Fig. 40, $\times \frac{1}{2}$ (*)

Axinopsis viridis, Dall, the Green Axinopsis, is shown in Figure 40. The polished, pale green periostracum gives the shell its specific name. It is only a quarter of an inch across, and so the figure really looks sixteen times too large.

This little mollusk lives in muddy or sandy bottoms along the coasts from Japan and Bering Straits down to Catalina Island. How full of life are the waters of the ocean.

Axinopsis sericatus, Cpr., the Silky Axinopsis, is very similar to the last, but the outline is less circular. It comes from Puget Sound, but also from the coasts of Alaska and California. The silky epidermis suggested its name.

Diplodonta aleutica, Dall, the Arctic Diplodonta, ranges from the Pribilof Islands to the Aleutian chain, and eastward to the Shumagin Islands. The picture, Figure 41, represents a young specimen, having a silky, olivaceous epidermis. Other species grow to the length of an inch or more, and are coarse and chalky.

Fig. 41, $\times \frac{1}{2}$ (*)

Diplodonta orbella, Gould, the Round Diplodonta, is a not uncommon California shell. It is a

pretty species, smooth and white, and the valves are so much inflated that small specimens resemble white marbles. The animal has a habit of forming a protecting nest of sand, cemented by mucus. This nest has long, tubular openings for the siphons, so that the inmate is wholly concealed.

In Figure 42 a nearly natural sized view is given of both the outside and the inside of *Phacoides æquizonatus*, Stearns, the Banded Lucine, a rare species, specimens of which were dredged from deep water in the Santa Barbara Channel. Most of the shells of the genus *Phacoides*, which means lentil-like, were formerly called *Lucina*, the goddess of light, a name applied to one or more of the mythical beings of the olden time.

Fig. 42 (*)

Fig. 43

Figure 43 represents one of the most common bivalve shells to be found along the coast of central California. Its name is *Phacoides californicus*, Conr., the California Lucine. It is pure white in color, circular in outline, and varies in its size from that of a dime to that of a half-dollar. The cardinal hinge-teeth are small, while the lateral ones are strong. The ligament is external, and the

lunule, in this species, belongs wholly to the right valve, instead of being divided nearly equally between the two, which is the more common fashion. As in other species of this genus the forward muscle-scar is long and narrow, and the pallial line is entire.

I have gathered a few living specimens from the gravel among rocks at Pacific Grove, when the tide was very low, and have collected many empty, but really good shells that have been cast up by the waves. It is one of the shells that you will be sure to find on the little beaches beyond the lighthouse at Point Pinos, near which, from the island cliffs, there is one of the finest sea views to be had anywhere along the coast.

Phacoides nuttallii, Conr., Nuttall's Lucine, is similar in shape to the last species, but is much more highly sculptured. The sharp, fine lines of growth are crossed by many delicate rays, making its surface look like fine basket-work. It is somewhat flattened and is ridged along the hinge-line. Color white, length an inch or less, southern.

Fig. 44 (*)

In Figure 44 we see a drawing of the inside of a valve of *Phacoides annulatus*, Reeve, the Ringed Lucine. It is a large shell, and it ranges from Sitka to San Pedro, living in moderately deep water. This is the

species formerly known on this coast as *Lucina borealis*, and sometimes as *Lucina filosa*, Stimp., which, however, is an Atlantic species. It has also been called *Lucina acutilineata*, Conr. The shell is large and full, and its outside is marked with sharp, concentric ridges.

Phacoides tenuisculptus, Cpr., the Fine-lined Lucine, occurs mostly in the cold waters of the north, ranging from Puget Sound to Bering Sea, though it occasionally occurs as far south as Catalina Island. Alaska dredgings from muddy bottoms yield it abundantly. The shell is chalky and it is usually somewhat abraded.

Fig. 45, x $\frac{3}{1}$ (*)

Still another illustration of a member of this genus is given in Figure 45, which shows both the inside and outside of *Phacoides richthofeni*, Gabb, the Heavy Lucine. It is occasionally found at Catalina Island, Long Beach, and southward, though it is never plentiful. It is a small, heavy shell, the picture being drawn from a young specimen, very clearly marked.

CHAPTER IV

CHAMA, CARDIUM AND VENUS

Fig. 46

We pass now to some entirely different shells; very irregular, very rough, and very firmly fixed in their places. A picture of one of these shells is shown in Figure 46. This species is named *Chama pellucida*, Sby., the Agate Chama.

You notice by the figure that the inside of the shell is smooth enough, and that there is a big, oblique hinge-tooth near the upper right-hand corner. The outside, however, is very rough, being covered by many close frills, which are translucent, like agate or chalcedony. Sometimes they are white or almost colorless, and sometimes they are dashed with rosy red. The inside of the shell is lined with a white, opaque layer, which is beautifully crenulated at the edge. The living shell is always attached to some firm support, like a rock or a post. So strong is the adhesion that you must break off a part of the rock or you will sacrifice a part of the shell. It is very easy to overlook them, as they appear like ragged knobs on the rock, but when you have collected a good specimen you will greatly admire its peculiar beauty. Upper

valves are often torn off by the waves and washed ashore. They are easily identified, though a novice often confounds them with limpet-shells. I have some exceedingly beautiful specimens that were taken from piles that had been pulled up from a disused wharf at San Pedro.

Chama exogyra, Conr., the Reversed Chama, has a coarser, more opaque shell, with but little beauty of form or color, and is usually of a dirty white color. The chief difference, however, is determined by the curve of the umbones. If you stand a specimen of this species on its edge, with the beaks uppermost and curving towards you, the side which was attached to the rock will be towards your left hand. But if you place a specimen of *pellucida* in the same position, the rocky side will be towards your right hand. I have gathered the two species growing side by side, and I have never known this rule to fail. Both of these species live at Monterey.

Chama spinosa, Sby., the Spiny Chama, is a southern species, living mostly along the Mexican coast, but perhaps reaching as far north as San Diego. It resembles the first species, but its ridges are broken into close, short spines.

We now come to the interesting family of the Heart-shells, or Cockles, as they are called in many places. There are over two hundred species of them known in different parts of the world, and they vary exceedingly in size and appearance. They are all very decidedly heart-shaped, whether you look at them from the front or the back of the shell. Most of them have prominent ribs running from the umbo

to the edge of the shell. Internally, there is a central hinge-tooth, and also strong lateral ones, somewhat removed to the right and left. The pallial line is simple, for these creatures do not burrow. They have a long and strong foot, however, by means of which they can move rather freely, or even anchor themselves, if such an operation is necessary.

Fig. 47

Figure 47 gives a good end view of *Cardium corbis*, Martyn, the Basket Cockle. This is the most common species on the west coast, occurring as far south as San Diego. But the true home of this species is in the cold water of the north. At Fort Wrangel in Alaska, I once collected very fine specimens, one morning

when the tide was low, some of which were as much as four inches across. I shall never forget that strange scene. The little village by the seaside, the dark forests in the background, the rocks laid bare by the retreating waters, the olive-green seaweeds with here and there the big white cockles lying upon them. On shore was a mixture of the new and the old; modern houses and ancient totem poles, white men and native Indians, and all lighted up by the early sun on that first day of June.

The shell of this cockle, and in fact of most cockles, is rather brittle, being of an earthen tex-

ture, and specimens are easily broken. Like most creatures of the sea, the cockles make an excellent article of food. The Basket Cockle lives as far north as Bering Sea, and follows down the other coast to Japan. It includes *Cardium nuttalli*, Conr.

Cardium californiense, Desh., the California Cockle, has a similar range as the last species, but is reported as far south as Monterey. The ribs on this species are close and flat, and the margin is regular. A variety, *comoxense*, Dall, is reported from the boulder clay of Vancouver Island, that has the ribs so flattened that they are defined only by the interstitial lines. *C. pseudofossile*, Rve., and *C. blandum* are included in *C. californiense*.

Cardium fucanum, Dall, the Straits Cockle, was formerly supposed to be a young form of *C. californiense*. It was given a specific name in 1907. The shell is small, plump, compact and solid with about fifty small, low ribs. Most of the specimens come from the Straits of Fuca, though it has been dredged at Monterey. It is not a common shell.

Cardium ciliatum, O. Fabr., the Bearded Cockle, ranges through the boreal seas and descends to Cape Cod on the eastern, and to Puget Sound on the western coast. The shells are small and bearded. There are many varieties, which have received separate names.

Cardium biangulatum, Sby., the Angled Cockle, is a southern species, being found from the Santa Barbara Islands to Panama. It has a heavy shell, 40 mm. high, with strong ribs. The interior is reddish in color.

Cardium elatum, Sby., the Giant Cockle, is the largest species of the genus, some specimens being fully six inches high. Its range is about the same as that of the last species. It is yellowish externally, but white inside, and the smooth ribs are very slightly elevated.

Fig. 48, x $\frac{3}{2}$

Cardium substriatum, Conr., the Egg-shell Cockle, is another southerner, very much smaller than the last, for Figure 48 represents an unusually large specimen. Obscure ribs are generally visible, and the shell is mottled, especially inside, with reddish-brown splashes, like a sparrow's egg.

Cardium quadrigenarium, Conr., the Forty-ribbed Cockle, is another southern species, and it grows in deep water to a remarkable size. In spite of its name the ribs are usually rather more than forty in number. While the shell is young the ribs are comparatively smooth, but when it is older the newer parts are set with yellow teeth, or short horns, giving the shell a very peculiar appearance. The strong crenulations on the edges of the valves are also yellow, especially in adult specimens.

Serripes gronlandicus, Gmel., the Greenland Heart-shell, is an arctic species coming down to Cape Cod and Puget Sound, like *Cardium ciliatum*. Its hinge-teeth are small and almost obsolete, and the surface is smooth or only slightly radiately striate.

Protocardia centiflosa, Cpr., the Hundred-Lined Cockle, has a small, thin shell, whose surface is sculptured with very many exceedingly fine lines. The umbones are prominent, the outline circular, with a diameter of nearly an inch. It ranges from British Columbia to San Diego. A variety, *richardsonii*, Whiteaves, reaches from the north to the coast of Oregon. It is very small, and is rarely found.

We now come to the *Veneracea*, a sub-order including many of the most interesting shells to be found along our coast. The typical genus of this order is named *Venus*, after the goddess of beauty, but the old genus has been divided among many names. The first shell to be described is *Dosinia ponderosa*, Gray, the Heavy Dosinia. Its real home is near the equator, but it is found from Peru to San Pedro Bay. The shell is nearly circular, about four inches in diameter, pure white internally, but creamy brown on the outside. It is very smooth, save for concentric lines of growth, and the deep lunule is heart-shaped. The shells are thin at the edges, but very thick and heavy in the older parts. The pallial sinus is V-shaped, and the ligament is external.

Transennella tantilla, Gld., the Little Transennella, has a shell ranging from $\frac{1}{8}$ to $\frac{1}{3}$ of an inch in length. It is somewhat triangular, its surface is very smooth and bright, its external color is white, or perhaps marked with brown, while internally it is white with a purple stripe at the posterior end. It was formerly called *Psephis tantilla*, and it has also received various other names. It ranges from Sitka to Mexico.

Figure 49 represents a very large, heavy shell, probably the largest of all the Venus shells. It is now known as *Tivela stultorum*, Mawe, the Great Tivela. Of course that is not a correct translation

Fig. 49

of the Latin; that you may make for yourselves, avoiding the joke. It used to be called *Pachydesma crassatelloides*, and it has also had a good many other names, all of which have been duly considered at the Smithsonian Institution, and the one most entitled to permanence has been selected to remain. The name *Tivela crassatelloides*, Conrad, is, however, now considered to be the correct one.

The specimen figured above was over five inches in length, and weighed over a pound, without the animal. The valves are very thick and heavy, even to their edges, which are smooth and finely rounded. The hinge-teeth are strong, the heavy ligament ex-

ternal, and the pallial sinus is small. Externally the shell is smooth, yellowish white, sometimes marked with conspicuous purple rays, and is partly covered with a glossy epidermis. The inside is white, with purple muscle-scars. The Tivelas live from Santa Cruz southward, and they burrow but slightly. Sometimes at low tide the farmers come down with a plow and run furrows in the sand, turning out the mollusks like potatoes. They are highly esteemed by lovers of a good clam chowder, and occasionally they get into the city markets, where they are called Pismo clams.

Amiantis callosa, Conr., the White Amiantis, is shown in Figure 50. This is a beautiful, pure white, southern shell, three or four inches in length. The

valves are thin at the edges and thick near the umbones. Externally there are no ribs whatever, but many concentric, rounded ridges, some of which divide into two.

Pitaria newcombiana, Gabb, Newcomb's Pita-

Fig. 50

Fig. 51, $\times \frac{5}{8}$ (*)

Fig. 52 (*)

ria, Figure 51, has been found in moderately deep water from Monterey southward. It is thin and delicate, with zigzag, brown markings, and a papery epidermis.

Figure 52 gives a bold picture of *Cytherea fordii*, Yates, Ford's *Cytherea*, which is found from the Santa Barbara Islands to Panama. It is very thick and heavy and has a very deep lunule. It sometimes reaches a length of two and a half inches. This is the shell that passed for years as *Venus toreuma*, Gld., but that is found to be a distinct Polynesian species.

Fig. 53

The Saxidomes of this coast have recently been revised by Dr. Dall, and the numerous names reduced to two. The first is *Saxidomus nuttallii*, Conr., Nuttall's Saxidome, a good likeness of which is shown in Figure 53. It includes the old *S. aratus*, Gld. The shells are usually marked by rough, concentric ridges, as shown in the figure. When young, there are brownish markings near the beaks, with a trace of purple internally, on the upper, posterior margin. The hinge-teeth are strong, and the sinus deep. This shell sometimes reaches a length of nearly five inches. It is found from central California to San Diego.

Saxidomus giganteus, Desh., the Giant Saxidome, is the other species. It ranges from the Aleutian Islands to the Bay of Monterey. It is solid, broad and heavy, but the concentric structure is much less pronounced than in the last species. While the young are yellowish white, and the exterior of older specimens is sometimes fulvous, the interior is always white. The adult shell is said to sometimes reach a length of five inches. I gathered numerous specimens at Sitka, averaging about 3 inches in length and nearly that in height. They were pure white inside, and almost glossy, while externally they were comparatively smooth and quite chalky. This shell has been confounded with *Saxidomus squalidus*, but that species is found on the coast of South America. The Giant Saxidomes are sometimes sold in the markets of Portland, Ore., being brought up from the coast.

There are three species of *Chione* upon the coast,

Fig. 54

but they have received, however, several times three names. Figure 54 gives an end view of *Chione succincta*, Val., the Banded Chione. The cordate lunule is a prominent mark, while on the other side of the beaks is the long and deep escutcheon. Numerous ribs radiate out from the umbo, but those in the middle generally become flattened towards the edge of the shell. The concentric ridges, as shown in the picture, run around the shell somewhat like hoops around a barrel. The interior of the shell is white, while the outside is a dingy yellow.

Chione undatella, Sby., the Wavy Chione, is a species which varies considerably, but it can usually be told readily by the great number of concentric lamellæ, which are closer together as they come near the edge of the shell, almost completely concealing the ribs. The valves are inflated, thick and heavy. Sometimes the interior is purple around the pallial sinus. These shells, which are seldom over two inches long, are found abundantly in southern California.

Chione fluctifraga, Sby., the Smooth Chione, is about the same size as the others. There is no distinct lunule, as in the other kinds, and the rib structure in the middle of the disk becomes fainter with age, till it sometimes almost disappears near the edge of the shell. Internally the valves are more or less purple. All three of these species have strong, heavy

shells, which are marked by fine internal teeth around the edges. Farther to the south there are many other species.

Venus Kennicottii, Dall, Kennicott's Venus, is a very rare shell which has been found at Neah Bay, Washington, and off the coast of central California. It is finely and closely lamellose over the whole surface. It somewhat resembles the common *Venus mercenaria* of the Atlantic coast. Its length is two and a half inches.

Fig. 55 (*)

Figure 55 represents a fine, large shell, taken alive at Sitka. A worn valve was found many years ago at Carmel Bay, near Monterey. Its name is *Marcia kennerleyi*, Rve., Kennerley's Marcia. It is nearly three inches in length, and is grayish white in color.

Marcia subdiaphana, Cpr., the Translucent Marcia, lives in Alaskan waters, and also, in tolerably deep water, as far south as the Santa Barbara Channel. The shell is thin, white, with an olive-gray epidermis, and reaches a length of over two inches. It was described by Carpenter under the name *Clementia*.

Fig. 56

Figure 56 represents one of the commonest shells to be found on the western coast. It has received quite a variety of names, but it is now classed as *Paphia staminea*, Conr., the Ribbed Carpet-shell. It is one

of the few mollusks sold freely in the San Francisco markets, where it is known as the Hard-shelled Clam. In color it varies from pure white to deep chocolate, and some of the varieties are prettily marked with chestnut chevrons. While it occurs all along the coast, it is most abundant to the north of San Francisco. The name *Paphia* relates to the city of Paphos, one of the haunts of the goddess Venus, for whom so many shells are named. Among the numerous varieties of this shell, we mention var. *petiti*, Desh., the large, unmarked kind found north of the Columbia river; var. *laciniata*, Cpr., a southern form with beautiful network covering, and many small prickles; var. *runderata*, Desh., which has distinct, concentric ridges, sometimes larger than the ribs; var. *orbella*, Cpr., which includes swollen and irregular specimens, living in holes in the rocks, where they are confined and cramped, while most members of the species live in coarse gravel and grow to regular shapes.

Paphia tenerrima, Cpr., the Finest Carpet-shell, is a rather rare species, very distinct, and very pleasing in appearance. An inside view of a left-hand valve

Fig. 57, $\times \frac{3}{4}$

is given in Figure 57, to which reference has already been made on page 21. The outside of the shell is marked with many low, concentric ridges, and innumerable, minute ribs. The valves are thin and the color is brownish gray.

Fig. 58, $\times \frac{3}{4}$ (*)

Figure 58 represents *Liocyma scammoni*, Dall, Scammon's *Liocyma*, which is found off the coast of British Columbia. The shell is dark, solid, with strong hinge and ligament.

The pallial sinus is small.

Liocyma viridis, Dall, the Green *Liocyma*, is a far northerner, being found in the neighborhood of Bering Strait.

Fig. 59 (*)

The shell is oval, and when fresh it is of a fine olive-green color, which bleaches to cream. In each valve there are three cardinal hinge-teeth, the middle one being cleft. The form of the shell is shown in Figure 59.

Fig. 60

Venerupis lamellifera, Conr., the Rock-Venus, is shown in Figure 60. The shell is white, very irregular, and is marked with many thin, concentric laminae, which sometimes are very prominent. There may also be a trace of obsolete ribs. In habit it is a nestler among rocks. Very young specimens are often purple tinted. Some specimens are considerably larger than the figure.

Figure 61 gives two good views of *Psephidia lordi*, Baird, Lord's Pebble-shell, a plump little bivalve which lives off the shore, below the tide line, from Alaska to southern California. In color it is white or pale tinted. The figures are much enlarged.

Fig. 61, $\times \frac{7}{8}$ (*)

Psephidea ovalis, Dall, the Oval Pebble-shell, is larger, more oval, and more compressed. The shell is white and polished. Its range is about the same as that of the last species. Viviparous.

Gemma gemma, Totten, the Gem-shell, is a very small bivalve recently introduced into San Francisco bay, with seed oysters from the Atlantic. The shells are nearly round and are marked with delicate, concentric ridges. The color is white, or they may be tinged with purple. Many specimens are not

larger than a big pin head. The inflated, trigonal variety is known as var. *purpurea*, H. C. Lea.

Petricola carditoides, Conr., the Rock-dweller, is a very variable creature, and often seems to be the victim of circumstances. Normally the shell is oval, with radiating ribs; but the creature has the habit of boring into soft rock, or getting into a hole that was there before, and then growing to fit the premises. For this reason it happens that specimens differ much in external appearance. Sometimes one is long and narrow, while its neighbor is shaped like a fat bean. The ligament is external, the hinge-teeth strong, though sometimes they are nearly obsolete, while the shell becomes thick and rough. The color is dingy white, and the length is an inch and sometimes even two inches.

CHAPTER V

OTHER BIVALVE MOLLUSKS

Fig. 62

While returning one morning from a ramble over the rocks of Pacific Grove that had been left bare by the retreating tide, I was much sur-

prised to see what seemed to be two white worms moving about in a little hollow between the mossy rocks, which was filled with sand and sea-water. They were long and round, and about the size of a lead pencil. As soon as I disturbed them a little, they disappeared beneath the surface of the wet sand. Suspecting what these singular creatures might belong to, I at once began to dig, and soon came upon a fine clam, with a shell like that which is shown in Figure 62.

I was exceedingly glad to make the acquaintance of a real, live *Psammobia californica*, Conr., the California Sunset-shell, for so I learned to call him. As I wanted to see more of him and become better

acquainted, I took him home in a large glass jar, filled with sea-water and sand, and had the pleasure of seeing him dig a burrow and throw out his beautiful siphons. I kept him thus for several days, but he could not live comfortably in my very limited "ocean," and when he had ceased to live at all I prepared his shells for my cabinet, where they remain to this day.

Within, they are the purest white, resembling fine porcelain. The pallial sinus is large, the hinge-teeth small, and behind them is a thickened portion of shell about half an inch long, which terminates quite abruptly, exposing part of the ligament. Externally it is white, with red rays running from the umbones, while the newer parts are covered with a brown epidermis. My specimen was the same size as the figure, but sometimes, and especially in the north they grow considerably larger.

Psammobia edentula, Gabb, the Great Sunset-shell, is a fine large species resembling the last, but having the beaks only one third of its length from the front end of the shell. The posterior portion are full and broad. The external ligament is very conspicuous, and the hinge-teeth are present, in spite of its name, two on the right valve and one on the left. The specimen before me was dredged in San Pedro Bay, and measures five inches in length.

Figure 63 is a rather poor picture of *Donax levigata*, Desh., the Smooth Wedge-shell. This species is found abundantly in southern California, living just under the surface of the sand. It is short

Fig. 63

and stumpy, cut nearly short off at one end, and tapering to a rounded point at the other. The edges are finely crenulated. In color the shells vary from white to purple, and are often beautifully striped. This species is sometimes used for food, in spite of its small size.

Donax californica, Conr., the California Wedge-shell, is quite distinct from the last species, and is easily distinguished by the fact that the shells are much thinner and lighter. The posterior end is much more prolonged, bringing the beaks much nearer the middle of the shell. It is less highly colored than the last. There has been considerable confusion about the names of these species, but the present arrangement is believed to be correct. This species included Hanley's *Donax navicula*.

Heterodonax bimaculatus, d'Orb., the Spotted Heterodonax, differs greatly from the true Wedge-shell. It is oval in shape, rather flat, thin, and marked with fine, concentric lines. Its colors are very diverse, white and purple being the prevailing tints. This southern shell is usually less than an inch in length.

Fig. 64

In Figure 64 we have a good representation of *Tagelus californianus*, Conr., the Short Razor-clam. These creatures live in sandy mud in a perpendicular burrow. They have thin, gray shells, partly covered with a dull epidermis. It is a southern species, and the com-

mon length of the shell is two or three inches. I once gathered quite a quantity of them in San Pedro harbor. It is said that the wild ducks are particularly fond of this species, and in one instance, at least, the quacking of a flock of ducks revealed to a shell hunter the place to dig for the shells. The variety *subteres*, Conr., is small, compact, with violet rays and a very dark epidermis. It occurs with the common form.

Sanguinolaria nuttallii, Conr., Nuttall's Sanguinolaria, is a southern species, having a thin, oval shell, partly covered with a dark brown epidermis. The colors of the shell are white and lilac, the latter being sometimes beautifully rayed. One valve is much more bulging than the other, and the external ligament, just behind the beaks, is very prominent. The shell is two or three inches long.

We now come to the Tellens, whose name is derived from a Greek word meaning a certain kind of mussel; but when we use the term we think of a flat, thin bivalve shell with very small hinge-teeth and a deep pallial sinus. Many of the tropical Tellens are bright and beautiful, while those that live in our cooler waters are far less ornate. The first species that we will consider is named *Tellina bodegensis*, Hinds, the Bodega Tellen. Figure 65 shows the inside appearance of a right valve. Externally the shell is creamy

Fig. 65

white in color, smooth, with a polished surface, and marked with fine, concentric lines. Old specimens show a marked tendency to thicken the shell from the inside. This species is found more abundantly in the north.

Fig. 66, $\times \frac{3}{2}$ (*)

Figure 66 gives two views of *Tellina buttoni*, Dall,

Button's Tellen, which was formerly known as *Angulus obtusus*, Cpr. It may be found from Alaska to the Gulf of California. In the left-hand figure an internal, strengthening rib is seen just in front of the sinus. The shell is thin, white, and polished, but sometimes it has a greenish periostracum.

Tellina carpenteri, Dall, Carpenter's Tellen, formerly known as *Angulus variegatus*, Cpr., resembles Figure 67, but is smaller. Its range is nearly as great as that of the last species. It is pink and white, glossy, flat and narrow, hardly half an inch long.

Fig. 67

Fig. 68 (*)

Tellina idae, Dall, Ida's Tellen, is well shown in Figure 68. This rare and beautiful shell was named in 1891 in honor of Mrs. Ida Shepard Oldroyd. It has

since been collected sparingly at Long Beach, San Pedro and Catalina Island. The color is white. The excellent figure represents an unusually large specimen.

Tellina meropsis, Dall, the Pure Tellen, is shown in Figure 69, which is much magnified. The shell is white, sometimes yellowish within, thin and delicate, somewhat angled and bent behind as shown in the cut. It is about half an inch long, and is found from San Pedro southward.

Fig. 69, x $\frac{1}{2}$ (*)

Tellina lutea, Gray, the Muddy Tellen, comes from the very far north, being found in the neighborhood of Bering Strait. It is a fine large shell, and its general appearance is well shown in the two parts of Figure 70.

Fig. 70, x $\frac{5}{8}$ (*)

Tellina modesta, Cpr., the Modest Tellen, is shown in Figure 67, on a previous page, which is of the natural size. It is found in Puget Sound. The shell is

thin, white and glossy, with a very deep pallial sinus, and an internal ridge near the forward muscle-scar.

Tellina salmonea, Cpr., the Salmon-colored Tellen, is a very distinct little species, variable in color, but constant in form. The typical shell is quite thick, about half an inch long, nearly rectangular in form, the beaks being at one corner and the external ligament at one end. The surface is very smooth and glossy, but shows distinct lines of growth. It is nearly white on the outside, but within it is beautifully salmon-tinted. It is quite often found among the smaller beach shells at Pacific Grove.

Fig. 71, $\times \frac{1}{8}$ (*)

Tellina santarosae, Dall, the Santa Rosa (Island) Tellen, is shown in Figure 71. It considerably resembles *Tellina bodegensis*, but is thinner, flatter, and has different details of sculpturing. It is found near the Santa Barbara Islands.

At various points around San Francisco Bay there are great heaps of rubbish, which mark the site of old Indian camping grounds. They are always situated close to some spring or brook, the presence of which is now indicated by a growth of willows. The mounds are of various shapes and sizes, and often cover as much ground as would suffice for a good-sized garden. These mounds are largely made up of old shells, ashes and charcoal dust. This shows that the Indians had their fires there, and that they threw away the rubbish which was left from

their meals, and then repeated the operation on the slowly rising pile. It has been found that some of the old shell heaps are now partly under water, indicating that formerly the shore was a little higher than it is at the present time. Large quantities of the old shells have been removed from time to time for various purposes, particularly for the use of hens and chickens in poultry yards. It is quite remarkable that the refuse of the old Indian feasts should become the basis for modern enterprise in the way of producing food. The old clam shells are made to re-appear in the form of fresh egg shells.

It is interesting to examine these old "kitchen middens," and determine what species of shell-fish formerly abounded in the adjacent mud flats. I have found various kinds of shells,

Fig. 72

but by far the most abundant ones are those of the species named *Macoma nasuta*, Conr., the Bent-Nosed Macoma, Figure 72. Although so abundant then, this species seems to be dying out, and its place is rapidly being taken by the Rhode Island clam, *Mya arenaria*, which we will presently consider, but not a specimen of that shell is found in the mounds. *Macoma nasuta* is a common species on the Coast, reaching from Kamchatka to Mexico. It inhabits muddy flats, burrowing quite deeply, and

reaching the water by its two small, red siphons. The shell is smooth, flat and thin, rounded in front, but narrowed and bent to one side behind. The hinge-teeth are small, and in one valve the pallial sinus reaches to the forward muscle-scar. The color of the shell is white, and its common length is two inches.

Macoma inquinata, Desh., the Polluted Macoma, is a variable mollusk, resembling a degraded form of the last species. It can be distinguished, however, because the pallial sinus does not touch the forward muscle-scar in either valve. The shell is white, and it measures about an inch and a half in length. This species ranges from the far north down to Monterey on this side of the ocean, and to Japan on the eastern border.

Fig. 73

Macoma balthica, Linn., var. *inconspicua*, Brod. & Sby., the Little Macoma, is well shown in Figure 73. The little shell is thin, flat, and either white or pink. The figure represents a good-sized specimen, though it sometimes grows to be still larger. It is a lover of cold water, and is found on both sides of the Pacific Ocean, and also in the Atlantic, particularly in the Baltic Sea. On the California coast it reaches as far south as Monterey.

Macoma inflatula, Dall, the Inflated Macoma, resembles a young *M. nasuta*, but it is thin, rather inflated, strongly bent, and has a pointed posterior and a greenish epidermis. It is a northern species, but is found in deep water farther to the south.

Fig. 74, $\times \frac{1}{2}$ (*)

Macoma sitkana, Dall, the Sitka Macoma, is shown in Figure 74. The shell is thin and white, while the other features are well brought out in the engravings. As its name indicates, its home is in Alaska, reaching northward from Sitka.

Fig. 75

Macoma secta, Conrad, the Giant Macoma, is shown in Figure 75. It is the largest and finest species of the whole genus. The general form of the shell is oval, but the posterior end is suddenly contracted. Thin and glossy, with some epidermis around the edges. Pallial sinus large, ligament strong and broad, making a conspicuous external

feature. This noble species reaches from British Columbia to Mexico.

Macoma indentata, Cpr., the Indented Macoma, is a southern shell resembling a small specimen of the last species, but the edge of the shell near the posterior end is indented and beaked.

A very pretty shell found far to the south is named *Metis alta*, Conr., the Yellow Metis, formerly known as *Lutricola alta*. The shell is round oval, wrinkled at the siphon end, and marked with fine but distinct concentric lines. The ligament area is depressed. Externally the color is whitish or brownish, while the inside is glossy white, suffused with a bright yellow flush in fresh specimens. Its length is about two inches.

While the last shell was very pretty, we now have one that far exceeds it in beauty, namely, *Semele decisa*, Conr., the Clipped Semele. The first name is that of the mythical mother of Bacchus, while the second refers to the short posterior end, which looks as if it had been cut off with a pair of scissors. The shell is nearly round, rather heavy, the ligament internal and lodged in an oblique pit, and the pallial sinus is high and oval. The outside of the shell is coarsely wrinkled, and is brownish in color. The interior, where the beauty resides, is finely polished, looking like bright porcelain, and is more or less tinged with purple, particularly around the edges. Grown specimens are two inches or more in diameter. This shell is found in southern waters, as might be expected.

Semele rupium, Sby., the Semele-of-the-Rocks, is

smaller, nearly circular, white, with a pink hinge area. I have found pretty specimens as far north as Monterey.

Semele pulchra, Sby., the Beautiful Semele, has a small, thin, oval shell, with crowded concentric sculpture and radiating lines at the sides. This is a southern species, but the variety *montereyi*, Anld., is found farther north, as its name indicates. It is less than an inch in length, oval, thin, ventricose, the beaks quite posterior to the middle of the shell; the pallial sinus is very large, being rounded and expanded interiorly.

Semele californica, Ads., the California Semele, is a southern species, very rarely found. The shell is about an inch in length. It is the same as the yellow *Semele flavescens*, of Gould.

Semele rubro-picta, Dall, the Rose-painted Semele, is thick, convex, white, with rose rays on the outside, and marked with heavy, interrupted concentric ridges and obsolete radial striation. The surface is not granular. This is a southern species, found near San Diego. It is very probable that there are other species of this difficult genus, that are not yet described.

Cumingia californica, Conr., the California Cuming-shell, is shown in Figure 76. It is somewhat triangular in outline, with the front end rounded and the rear end narrowed and slightly twisted. The lines of growth are very distinct, forming concentric ridges. The shape of the shell varies

Fig. 76

considerably in different specimens. Pallial sinus large, color white, length about an inch. It lives from Monterey southward.

Cooperella subdiaphana, Cpr., the White Cooper-shell. This species has a thin, white, glistening shell, which appears quite swollen. The hinge-teeth are central, and the short ligament is situated almost between the prominent beaks. The length of this southern shell is about half an inch.

Cooperella scintillaeformis, Cpr., the Thin Cooper-shell, is another southern species. The shell is very thin and brittle, about the same length as that of the last species, but less swollen.

Corbula luteola, Cpr., the Yellow Basket-shell, is a small species found freely in the vicinity of San Diego. The whole shell, which is shaped somewhat like a small *Donax*, is hardly a quarter of an inch in length, but it is quite strong and is well marked with lines of growth. The edges of a full-grown specimen turn inward like the rim of a paper box. The color is ashy yellow. The ligament is internal, lodged in a small pit, the pallial sinus is small, and the shells are angled at one corner.

Neara pectinata, Cpr., the Dipper-shell, is a very small affair, nearly globular, with about twelve prominent radiating ribs. The posterior end is drawn out into a small tube, so that each valve looks like a small dipper. Southern, 6 mm. long.

We now come to the *Myacidae*, a small family, but distinguished as containing one of the most important species on the whole list, if we think of the mollusks only as food for man. *Mya arenaria*, Linn.,

the Common Mya, or Soft-shelled Clam, was known in Europe and on the Atlantic Coast long ago, and was highly esteemed as an article of food, whether it was fried, steamed, or made the basis of a chowder. It was unknown in San Francisco Bay until the year 1874, when a few specimens were discovered near Oakland. They were supposed to be novelties and were named *Mya Hemphilli*, Newc., in honor of the veteran collector, Mr. Henry Hemphill. In a little while, however, its true nature became known and conchologists realized that the Atlantic Mya had crossed the continent, doubtless with seed oysters from Chesapeake Bay, and had settled down in the western waters. Unlike the aristocratic oyster, which propagates but slowly with us, the more plebeian clam began to fill the mud-flats on both sides of the bay with its burrows and in a few years its descendants were numbered by the millions. This species has been planted at Santa Cruz in the south, and in Shoalwater Bay in the north, where it is a great success; also in Coos Bay and elsewhere along the coast of Oregon and Washington.

Although not quite so delicious as the oyster, the Mya is an excellent food-mollusk, and great numbers of these clams are sold in San Francisco and Oakland. Its domains are not fenced in like the oyster fields, but it

Fig. 77

may be gathered by anyone who will take the trouble to dig. Figure 77 gives a view of the inside of a left valve, showing the spoon-like hinge-tooth, the muscle-scars, and the pallial sinus. The valves are rather thin and brittle, gaping at the ends, and the edges are covered with a gray epidermis. The common length of grown specimens is three inches.

Mya truncata, Linn., the Blunt *Mya* resembles the last, but the siphon end is truncated, as if it had been chopped off. This species also lives in the northern Atlantic and is reckoned as circumboreal, coming down on the west side of the continent as far as Puget Sound.

Cryptomya californica, Conr., the False *Mya*, is found at various places all along the coast. The shell is elliptical, slightly gaping, nearly smooth, though sometimes marked with faint lines. The sinus is small or obsolete, and the right valve is provided with a large, spoon-shaped hinge-tooth, on which is the ligament. The shell is rather thin,

whitish, with an ashy epidermis; its length is an inch or a little more.

Fig. 78

Figure 78 gives us a good idea of *Platyodon cancellatus*, Conr., the Flat-

toothed Clam. It closely resembles the *Mya*, but its broad hinge-tooth is not so large; moreover the valves are much thicker and firmer, and are greatly bulged. The shell is white or gray, and the length is two or

three inches. I found them abundant at Bolinas, and they reach as far south as San Diego.

The shell of the little *Saxicava arctica*, Linn., the Arctic Saxicave, is small, thin, wrinkled, and irregular. The beaks are near the front of the shell, which is abruptly terminated. Ligament small, external, behind the beaks. Color ashy white, length from 6 to 12 mm. It is found on the holdfasts of kelp and in similar situations. By some this form is considered to be but a variety of *S. pholadis*, Linn., a small species which has been dredged in San Pedro Bay. *Saxicava rugosa*, Linn., the Rough Saxicave, occurs

Fig. 79

in the far north, and also as far south as San Diego. I believe all three are but varieties of one species.

Panopæa generosa, Gld., the Giant Panopæa, is shown in Figure 79. This huge mollusk, which lives

in northern waters, is the king of all the burrowing clams. A pair of shells, kindly sent to me by friends in the vicinity of Puget Sound, measures seven and a half inches in length. The creature burrows to a depth of two feet or more. The valves are oblong, rather flat, and are marked with decided lines of growth. They gape widely where the siphons enter. The left valve has a sharp hinge-tooth, resembling a short horn. The shells are of a dull white color without, but are pearly and shining within. In the north this great creature is sometimes known by its Indian name, Goeduck.

Panomya ampla, Dall, the Ample Panomya, is an Alaskan shell, coarse, chalky white in color, with a black, tarry epidermis which falls off. The shell is nearly square, and is some three inches across. It gapes widely and does not fully cover the living animal.

The mollusks which are now to be considered belong to the *Solenidæ*. They include what are popularly known as the Razor-shells, because most of them are long and narrow and in shape somewhat resemble the handle of a razor. Most of them are covered with a glossy epidermis, making them look as if they had received a coat of varnish. Some of the Latin names that have been given to them refer to bean-pods, which the shells resemble even more than they resemble razors.

Siliqua patula, Dixon, the Flat Razor-shell, is shown in Figure 80. Beautiful examples of this shell are found on the Oregon coast and farther

north, though it is found to some extent much farther to the south, probably in deeper water. Broken shell used to be washed up on the Cliff House beach in San Francisco.

As this shell was first figured long ago I will quote its description from the words of the discoverer, Capt. George

Fig. 80, $\times \frac{1}{2}$

Dixon, who wrote an exceedingly interesting book entitled "A Voyage Round the World," which was published in London, A. D. 1789. This extract is said by Dr. P. P. Carpenter to be probably the "first description on record of mollusks from the Pacific shores of N. America by the original collector."

"At the mouth of Cook's River are many species of shell-fish, most of them, I presume, nondescript. For a repast our men preferred a large species of the Solen genus, which they got in quantity, and were easily discovered by their spouting up the water as the men walked over the sands where they inhabited: as I suppose it to be a new kind I have given a figure of it in the annexed plate. 'Tis a thin brittle shell, smooth within and without: one valve is furnished with two front and two lateral teeth; the other has one front and one side tooth, which slip in between the others in the opposite valve: from the teeth in each valve proceeds a strong rib, which extends to above half-way across the shell and gradually loses itself towards the edge, which is smooth and sharp. The color of the outside is white, circularly, but faintly zoned with violet, and is covered with a smooth yellowish-brown epidermis, which appears darkest where the zones are: the inside is white, slightly zoned, and tinted with

violet and pink. The animal, as in all species of this genus, protrudes beyond the ends of the shell very much, and is exceeding good food."

There are several varieties of this species, including var. *alta*, B. & S., which lives in the far north; it is short and broad, with a straight rib. Var. *nuttallii*, Conr., is found in Alaska and also in California as far south as Monterey; the shell is very straight, brilliantly polished, and has a very oblique rib.

Siliqua lucida, Conr., the Bright Razor-shell, lives from Monterey to San Diego. According to Dr. Dall it was confounded by Carpenter with the young of the last mentioned variety. The shell is small, fragile, and has a short, narrow, and nearly perpendicular rib, or callus.

Fig. 81

Solen sicarius, Gld., the Blunt Razor-shell, shown in Figure 81, is short, slightly curved, and truncated in

front as if it had been chopped square off. The white shell is covered with a glossy, yellowish epidermis. This species ranges from Vancouver Island to San Pedro, Cal.

Solen rosaceus, Cpr., the Rosy Razor-shell, lives only in the south. It is two inches long and less than half an inch wide, and resembles a small flattened tube. The shell is straight, rosy white in color, and is covered with a glossy, horn-colored epidermis.

Ensis californicus, Dall, the California Razor-shell, is a rare species, found from Monterey southward. It is delicate, narrow, slender and curved. Length, about two inches.

The members of the *Macridæ*, which we are now to consider, may be distinguished by the triangular pit for the cartilage, which is situated in the midst of the hinge-teeth. The shells are mostly quite thin, with sharp edges, and are often partly or wholly covered with a thin epidermis.

Macra nasuta, Gld., the Beaked Macra, resembles Figure 82, a figure which shows the general appearance of several species of this group. The shell is of moderate size, and is scattered widely along the coast.

Fig. 82

Macra californica, Conr., the California Macra, has a rather small shell, somewhat depressed behind the furrowed beaks, which are about midway between the ends of the shell. It is from an inch to an inch and a half in length.

Macra dolabrimis, Conr., the Mattock Macra, occurs from San Diego southward, and so scarcely comes into our list. The shell is compressed, and is of a polished white under a dull brown epidermis. In the hinge-area the ligament is separated from the cartilage pit by a shelly plate. This fine shell grows to a length of three and a half inches.

Spisula polymyma, var. *alaskana*, Dall, the Alaska Mactra, resembles *Mactra californica*, but is larger. It is found about Icy Cape, but it comes southward as far as Neah Bay.

Fig. 83, $\times \frac{1}{2}$

Spisula catilliformis, Conr., the Dish-shell, formerly known as *Standella Californica*, is shown in Figure 83. This is the fine large shell which is said to exist from Neah Bay to San Diego. I have collected large specimens at Long Beach, Cal. The shell itself is thin, whitish, and is covered with a gray, wrinkled epidermis. The cartilage pit is large and its shape is triangular. The pallial sinus reaches nearly to the middle of the shell. These great Dish-shells sometimes reach a length of over five inches, and can hardly be mistaken for any other species, except the next.

Spisula hemphillii, Dall, Hemphill's Mactra, is a rare species occurring in San Pedro Bay and at San Diego. It resembles the last species, but grows even

larger, a specimen before me measuring fully six inches in length. The white shell is covered with a brown periostracum, which in young shells is prettily lined and almost glossy, while at the posterior end it is decidedly ridged and wrinkled. The front end of this shell is narrower than that of the last species, and the pallial sinus is smaller.

Spisula falcata, Gld., the Falcate Mactra, has a shell of moderate size, resembling *Mactra californica*, but it has a narrower anterior end and a smaller sinus. The shell is glossy, thin, and rather flat. It is found in British Columbia, but it extends far southward.

Labiosa undulata, Gld., the Wavy Ræta, is a very distinct, though rather rare southern species. The hinge resembles that of the Mactras and shows the triangular pit plainly. The outline is not very different from that of Figure 83, but the shell is very thin, not merely at the edges but throughout its whole extent, and it is very decidedly marked with concentric ridges, which even appear on the inner surface. Most clams as they grow not only add to the edge of the shell but also thicken the older parts from the inside, but the Wavy Ræta does nothing of the kind, and it is no wonder that good specimens of so large and so thin a shell are quite rare. Near the beaks it is much inflated. Externally it is light brown or ashy, and when at all thickened the interior is white. Three or four inches is the common length of grown specimens.

The last member of this group has the largest shell of all, sometimes reaching a remarkable length,

while specimens of six inches are not uncommon. Its name is *Schizotharus nuttallii*, Conr., the Washington Clam. This huge mollusk burrows deeply in the mud, and is therefore rather hard to capture. It makes an excellent chowder, however, and a very few clams are sufficient for the wants of a large family.

The shell is more or less oblong, bulged, rather thin, and it gapes widely at the end where the long siphons pass out. The sinus, as might be supposed, is very broad and deep. The hinge-teeth are small, while the cartilage pit is large and deep. The white shell is covered with a thin epidermis. This species delights in muddy bays, and is found along the whole coast.

Passing now to a very different group of shells we come first to *Thracia curta*, Conr., the Short Thracia. In form and markings this shell resembles Figure 43, though it is somewhat oblong and also wrinkled at the rear end of the valves. Ligament external, hinge-teeth small, sinus shallow, length from an inch to two inches. *Thracia undulata*, Conr., the Wavy Thracia, also called *plicata*, is a rare species that is larger and thinner than the last.

Fig. 84

Figure 84 represents the inside of the left valve of *Periploma planiscula*, Sby., the Silver Lantern-shell.

This is a pretty species easily recognized by its peculiar spoon-like hinge-teeth, one of which is found in each valve. Oblong,

beaks near the posterior end, sinus small, right valve inflated, left valve flattened. The shell is beautifully white and smooth, with fine lines of growth, and the interior is shining and silvery. It is a southern species, and it grows to a length of two inches, though most specimens are shorter.

Periploma discus, Stearns, the Round Lantern-shell, is well shown in Figure 85. This fine species was discovered at Long Beach, Cal., not many years ago, and for a time specimens were very rare. Afterwards a considerable number were washed up on the beach, though it is by no means a common shell. The valves are white, exceedingly thin and fragile, almost circular in outline, though with one square corner. The diameter of a large specimen is nearly two inches.

Fig. 85 (*)

Fig. 86

A delicate little shell, of which Figure 86 represents a large specimen, found at various points along the coast and also in San Francisco Bay, is named *Lyonsia californica*, Conr., the California Lyonsia. The shell is bulged at one

end, while at the other it is narrow, thin and crooked. The outer coat shows many concentric striæ, but this is easily rubbed off, revealing the inner layer, which is quite pearly.

Fig. 87, $\times \frac{3}{2}$ (*)

Lionsiella alaskana, Dall, the Alaska Lyonsiella, is shown in Figure 87. The specimen here represented was dredged from deep water in the Gulf of Alaska. The figure is somewhat enlarged, but it shows the main external features of this thin and delicate shell.

As you walk among the rocks when the tide is out you can often find many strange forms of life. On the top of the rocks, so as to be exposed to the sunlight, are masses of seaweed, often harboring and concealing various living things. In the caves under the rocks grow quite different animals. Some of them can walk or crawl, and are comparatively easy to classify, while others form mats or cushions and seem to have little in common with ordinary animal forms. One of these thin mats, often brilliantly colored, is really a kind of sponge. Another and thicker one, yellowish in color, smooth and firm to the touch, is really a mass of low animal forms and is known as a compound Ascidian, or group of Sea-bottles. Imbedded in these strange groups of creatures may sometimes be found specimens of *Mytilimeria nuttallii*, Conr., the Sea-bottle Shell. In shape it resembles an inflated bladder with the spiral beaks at one end. The shell is very thin,

white, and covered with a brown epidermis. There is an oscicle, or little detached piece of shell, under the hinge. The greatest diameter of the shell is about one inch. This is a singular instance of a thin shell deriving protection from the bodies of the animals by which it is concealed.

Our next species is named *Entodesma saxicola*, Baird, the Rock Entodesma. It is a singular creature, living in holes of various shapes and taking whatever form seems most convenient. The shell is somewhat oblong or pear-shaped, bulging at the hinge end, gaping beneath, and prolonged around the siphons into an irregular process consisting chiefly of epidermis. Internally the shell is white, while externally it is very rough and unsightly, being partly covered with a brown periostracum. When dry it is usually more or less bent or broken, owing to the unequal shrinkage of the hard parts and the covering. A large oscicle covers the hinge internally. This is especially a northern species.

The southern shell, *Entodesma inflata*, Conr., the Puffed Entodesma, resembles the last, but is smaller, thinner, and more irregular, and is composed largely of epidermis. It is narrow in front, wider and thinner behind, and is about an inch or less in length.

Verticordia novemcostata, Ad. & Rve., the Nine-ribbed Verticordia, has a minute shell, only 4 or 5 mm. high. In outline it is nearly square, and from the beak near one corner run about nine prominent ribs. The shell is pearly within. It is found near San Pedro. Dr. Carpenter considers it identical with the Chinese shell, *V. ornata*, D'Orb.

Clidiophora punctata, Cpr., the Dotted Pandora, is a rare shell of very unusual shape, somewhat oblong and beaked. Instead of being inflated it is very flat and compressed. The valves are thin and silvery, while within they are marked with many little pits or dots. It is somewhat over an inch in length. From Victoria to San Diego.

The last family of the Pelecypods is that of the Boring-shells, of which there are two divisions. The first of these include the Piddocks, which force their way into clay, shell, or rock; while the second division, the Teredos, work chiefly in wood.

Pholas pacifica, Stearns, the Western Piddock, is the first species to be mentioned. The shell is thin and delicate, long and cylindrical, marked with wavy, concentric ridges and faint radiating lines. The sculpturing is not sharply divided into two sections as it is in some of the following species. Within each valve, beneath the hinge, is a slender spoon of shell, very narrow and delicate; its use is not fully known. On the outside, just above the ligament, is a long protecting plate with straight sides. This auxiliary valve, as it is called, is curved in front and straight behind. The valves gape widely at the ends. The length of the white shells of this species is about two and a half inches. The creature burrows in mud and clay. It was first found on the Alameda side of San Francisco Bay, but has since been reported from the southern part of California.

Pholadidea penita, Conr., the Common Piddock, is shown in Figure 88. While it is often much smaller than the picture, specimens are sometimes found

that are more than twice as long. Like the other Piddocks, the forward part of the shell is rounded and rasp-like, while the latter part is narrow and smooth.

A triangular plate covers the hinge-area, and the valves end in epidermal flaps or scales. It is commonly found in burrows which it constructs for itself in the softer rocks which occur here and there all along our coast. In young specimens the forward end gapes widely to allow the strong foot to press against the side of the burrow and thus assist in turning the shell, whose sharp points probably wear into the rock, though just the method by which it bores is not clearly known. As it grows older it seems to realize that it has gone far enough, and closes the front of the opening in the valves with a wall of shell, making them appear nearly round.

Pholadidea parva, Tryon, the Little Piddock, is a very small species, which some consider as a reduced variety of the last. It burrows into *Haliotis* shells.

Pholadidea ovoidea, Gld., the Oval Piddock, is a small, oval form, resembling in shape a small *Zirphæa crispata*, whose forward end is filled out with curved shell.

Pholadidea darwinii, Sby., Darwin's Piddock, is a little borer found in rocks. The front of the shell is open and circular, while the latter part is prolonged into a narrow, flattened tube, shaped like a duck's bill. The shell is marked with striæ, and is

Fig. 88

divided into two parts by a narrow constriction. The shell is whitish in color like that of all the piddocks, and it is only about half an inch long.

Fig. 89

Figure 89 gives a good idea of the shell of the Rough Piddock, *Zirphæa crispata*, Linn. This fine borer is able to force a tunnel into the hardest of blue clay,

doubtless by means of its sharp rasp. There is no accessory plate over the hinge-area in this species, but it is protected by a membrane, and in front of the umbones the valves are reflexed. The shell is thin, white, and very hard, and its length is from two to four inches. This species is widely distributed, being found in both great oceans.

It is said that all of the piddocks give out a phosphorescent light when they are alive, and that this light may be seen by carefully removing specimens from their homes in the rocks and placing them in a pan of sea water. Great care is necessary to prevent the creatures from receiving injury, as the shells are very delicate. Some of my younger readers may have an opportunity to experiment in this line and watch in the darkness for signs of light from the living animals. It is possible, also, that some one may even detect them in the act of boring their holes. The sea is very large, and there are opportunities for a bright boy or girl to observe much that is really valuable.

The great California Piddock, *Parapholas californica*, Conr., is represented in Figure 90, which well illustrates its main features. The upper end of the shell is composed mainly of large scales of epidermis. Near the line of union of the two valves there are accessory plates, long, straight, and smooth. The shells are white, rather delicate, and are three or more inches in length. The rocky dust which the animal obtains in the process of excavation he uses in building up a strong, conical chimney, which protects the siphons.

Fig. 90

Martesia intercallata, Cpr., the Shell-boring Piddock, is a very small borer, from the southern fauna, which is sometimes found in large shells like that of the *Haliotis*. Its presence sometimes greatly disturbs the occupant of the shell, especially if its burrow has been carried nearly through the pearly lining. In that case a knob is built up as a defense against the intruder, and these knobs, or "blisters," as they are often called, may be cut out and set as jewels. Occasionally, however, the borer goes clear through the shell, and then there is trouble for all concerned. The valves of the Shell-boring Piddock gape widely in front, and the outer entrance to its burrow is quite small.

There is a very singular and very destructive mollusk, which lives especially in San Francisco Bay,

that is known by the name of *Xylotria setacea*, Tryon, though it is commonly called the Teredo, or Ship-worm. Its great end in life seems to be to bore as long a hole as possible; not for the reason that it desires the wood for food, but simply for the fun of the boring.

The young of this mollusk, like those of many others, are free swimmers, quite unlike their adult parents. After a brief and sportive life in the water the little creature finds a post or a piece of floating wood and begins to bore. As he advances, he lines the hole with a tube of shell, and if he nears another hole he turns to one side and bores on through undisturbed wood. The openings on the outside of the wood, where the little creature entered, are so small that they are hardly noticed, and so it often happens that the timbers of a wharf may appear perfectly sound, when in fact they are completely honey-combed.

The valves of the shell are at the very front of the tube, and are nearly spherical in shape, though they gape widely at both ends. The front ends of the shells are very beautifully sculptured, though the markings are so fine that a microscope is needed in examining them. The creature also has two oar-shaped, shelly appendages, which close the external opening of the burrow, and perhaps perform other duties. The globular shell of the Teredo is about half an inch in diameter, and the pens or oars are some two inches in length.

To provide against the rapid destruction that is wrought by the Teredo, many precautions are taken

by builders. The bottoms of wooden ships are covered with copper, and the timbers used in building wharves are either soaked in poison before using or sheathed with metal. A still better plan is to build the piers entirely of concrete, or to cover the wooden piles with a thick coating of cement. Unless some such precautions are used the woodwork of a wharf may be ruined in the brief space of one or two years. Much good, on the other hand, is done by the borers, for they tend to break up the timbers of old wrecks, and to cause obstructing ledges of rock to crumble and disappear.

Xylotria stutchburryi, Jeff., the Little Teredo, has a very small shell, of which the valves are white and triangular, while the pens are minute and club-shaped.

This closes our description of the two-valved mollusks. Very much concerning the details has been left unwritten, and for every observer there remain plenty of interesting facts, which are only waiting for some patient discoverer.

CHAPTER VI

UNIVALVE MOLLUSKS

A few years ago I visited the pretty little town of Bolinas, situated on the first bay to the north of the Golden Gate. From the shore there runs out a ledge of rock far into the ocean, which is commonly known as Duxbury Reef. One morning when the tide was low I went far out on this reef and found that it furnishes an excellent home for many living creatures. Turning back the masses of olive-green seaweed I found a considerable number of mollusks with shells like the one shown in Figure 91. It is not a very common species for California, but is more abundant in the north.

The shell of a full grown specimen is an inch and a half long. It is spindle-shaped, that is, it is largest in the middle and tapers towards each end. Various parts of the shell have received names, and as this is the first species which we are to consider which belongs to the great class of the Gasteropods we will now notice these names. The Gasteropod shell is really a long tube, coiled in a spiral form. This fact may not seem so evident in this species as in certain others, but it is the plan of the shell nevertheless, and a knowledge of this fact will help to answer many troublesome questions.

The opening to this tube is called the aperture, and it is named *ap* in the figure. As you face the

shell you notice that this aperture is on the side next to your right hand. This is true of most shells, which are therefore called dextral; though a few, which turn the other way, as in Figure 102, are known as left-handed, or sinistral shells.

The upper part of the shell is known as the spire, marked *sp*, of which the very top, *a*, is the apex, while each turn of the spire is a whorl, the largest of which, *b. w.*, is the body whorl. The spiral groove between the whorls is the suture, marked *s*. The central post, *c*, is the columella, while the central opening, *u*, is the umbilicus. The little open tube

Fig. 91

marked *ca* is called the canal, and the outer edge of the aperture, *o. l.*, is the outer lip. The inner lip in this specimen is grown to the columella and does not appear, though in some shells, as shown in Figure 156, it is very evident. Many shells have no canal, and in most instances we judge that the animal which has such a shell is herbivorous, while those with canals are carnivorous.

Lines of growth run parallel to the edge of the outer lip, while spiral lines run around the shell and cut the lines of growth. Varices are enlarged portions of the shell, parallel to the lines of growth, while the operculum is a kind of door that the animal pulls up to the aperture, after he has withdrawn into his shell. With these few simple definitions,

we are ready to describe almost any of the numerous shells that we are to consider in the remaining part of the book.

The name of the species whose shell is shown in Figure 91 is *Chrysodomus dirus*, Rve., the Dark Chrysodome. The clean shell is of a dark liver color, though this is often obscured by an ashy powder, giving it a dingy appearance.

As we have considered this type of the uni-valve shells out of its natural order, we will now turn our attention to what is properly
Fig. 92 our first species of the great class of the Gastropoda, named *Actæon punctocalatus*, Cpr., the Barrel-shell, shown in Figure 92. It is a pretty little thing, which is sometimes found washed up on the beach, and at certain times of the year it may be found alive in the tide-pools where it has gone to lay its eggs. Its length is about half an inch. There is a small fold on the columella and numerous revolving ribs. The surface is pure white, with two series of narrow black bands. I have seen dead specimens of this shell at Pacific Grove, and have found it alive on the shores of Dead Man's Island, near San Pedro.

Actæon painei, Dall, Paine's Actæon. This is one of the new species secured by Lowe and Paine, while dredging near Avalon, Catalina Island. The length of the shell is 8 mm., and it may be distinguished from the last species by its short spire, stouter form, and the absence of color bands.

Tornatina culcitella, Gld., the Pillow Lathe-shell, is shown in Figure 93. It has a cylindrical body as

if it had been turned in a lathe, and it certainly is dainty enough for a fairy's bolster. The color is brownish, and fresh specimens are banded with numerous microscopic striæ. Large specimens are nearly an inch long.

Fig. 93

Tornatina harpa, Dall, the Harp Lathe-shell, is smaller, being about six millimeters in length. The color is white, and it is easily distinguished by the presence of longitudinal grooves and lines on the upper half of the last whorl.

Tornatina eximia, Baird, the Excellent Lathe-shell, resembles Figure 93, though it is smaller. It differs in having a more depressed spire, a longer and narrower aperture, and a smaller plait on the columella. It is found in Puget Sound, and also at San Diego.

Tornatina cerealis, Gld., the Grain Lathe-shell, has a minute white shell, less than a quarter of an inch in length. It is quite solid, and has a spire rounded at the apex.

Cylichna alba, Brown, the White Cup-shell, is another of these small species of shells which resemble little rolls of cloth. This species has a white shell, 10 mm. long, which is somewhat cylindrical and which tapers towards either end. It occurs on the coast of southern California and also on the Atlantic shores.

Volvula cylindrica, Cpr., the Roll-shell, resembles the last species, but is somewhat flattened in the middle and has an extended umbilical point, "Like a grain of rice, pointed at one end."—Cpr.

The fine shell shown in Figure 94 is named *Bulla*

Fig. 94

gouldiana, Gould's Bubble-shell. It is thin, polished and mottled, resembling a large bird's egg. The spire is depressed, or more properly speaking, the body-whorl is elevated above the original spire. This species lives in the south. I have gathered the shells abundantly at San Pedro, when the tide was low. The shell is so delicate that it is almost impossible to remove the animal without injuring the inner whorls. Fortunately, excellent specimens may be found, almost fresh, from which every trace of animal matter has been eaten by little crabs and similar animals. The shell is sometimes wholly brown in color, but in the finest specimens it is mottled with white and yellow clouds. It was named by Prof. Pilsbry.

Haminea vesicula, Gld., the White Bubble-shell, is shown in Figure 95. The shell is not strictly white however, unless it is bleached, but when fresh it is of a pale greenish yellow. It is very thin and fragile and can easily be crushed by the fingers. And yet its inhabitant is not a strict vegetarian, but he devours small mollusks and crabs that happen to come to his home, which he locates in a muddy place along the shore of the ocean near the mouth of some river. His alimentary canal is provided with a powerful gizzard armed with teeth to crush any hard morsels that he may have swallowed. The figure represents a rather

Fig. 95

large specimen of this shell. You will notice that the aperture is extremely large, the spire depressed, and the whole shell quite like a bubble.

Haminea virescens, Sby., the Green Bubble-shell, is smaller than the last, and has a very short body-whorl, while the outer lip is greatly extended. The animal that it is supposed to protect is much larger than the shell, however, and its delicate, greenish covering can give it but a scant defense. This species is found sparingly upon mossy rocks on the southern coast.

In 1863 three large specimens of *Aplysia californica*, Cooper, the California Sea-hare, were reported as found on San Pedro beach after a storm. One of these was fifteen inches long and five inches wide. Their stomachs were full of seaweed. The soft creatures have no visible shell.

Pleurobranchus californicus, Dall, the California Side-gill, also comes from San Pedro. The animal is oval and flattened and has a distinct head. The shell is a thin white scale, concealed in the mantle. The gill is single, feather-shaped, and is placed on the right side between the mantle and the foot. The animal is waxy white in color, about an inch long, while the little shell is half that length.

Somewhat similar in their anatomy to the last few species are the Sea-slugs, which form a great group of naked mollusks. While they have no shells they are far from being without interest. Their bodies are often very brilliantly colored, so that when they are alive and moving they are among the most beautiful objects of the sea. You will find them on sea-

weed at low water, looking like little lumps of soft tissue without form or beauty; but when put into a jar of sea-water they will extend their tentacles and expand their flower-like gills and display their fine colors in all their glory. Some are white with scarlet trimmings, others are yellow with brown rings, while still others have brilliant fringes of various hues.

They are mostly small, even when extended, and usually measure but an inch or two in length. As they cannot be preserved except in alcohol or some similar fluid by which their beauty is destroyed they can be satisfactorily studied only at the seaside. We give a brief description of a very few of the most common species, referring all who desire to study the subject farther to the excellent work of Professor MacFarland of Stanford University, entitled, "Opisthobranchiate Mollusca from Monterey Bay."

Archidoris montereyensis (Cooper), the Monterey Doris, has a rather large, slug-like body, sometimes reaching a length of three inches, though commonly much smaller. The color is pale yellowish, with scattered dark spots, and the surface is roughly tuberculate. The branchial plumes, or gills, form a crown-shaped expansion on the posterior third of the back of the animal. The tentacles are flattened and externally grooved. It may often be found at low tide, in little pools or among patches of seaweed. It is said to be especially abundant on the piles of the wharf at Monterey, where it is found in connection with the next species.

Anisodoris nobilis (MacFarland), the Noble Doris, resembles the last species, and was formerly

confounded with it. The Noble Doris, however, grows to a much greater size, being sometimes as much as six or eight inches in length. Its color is a brighter yellow, and its tentacles are finger-shaped. Internally, the differences are still more marked. Abundant at Monterey.

Triopha carpeni (Stearns), the Clown Sea-slug. This little creature, seldom more than two inches in length, is very common on brown kelp and in tide-pools. The body is soft, almost transparent, clearly showing the brown liver, and is of a white color. On it are borne numerous processes which are tinged with bright orange, and the mantle is also spotted with the same color. When the animal is extended the width is about a quarter of the length. It is interesting to see the creature move in water. Sometimes it comes to the surface and walks on the air, as it were, head down. With its bright dress and odd pranks it resembles a circus clown.

Triopha maculata, MacFarland, the Blue-spotted Sea-slug. This pretty sea-slug is about the size of the last and is found in similar positions, though it is not quite so common. Its color, however, is a deep yellowish-brown, thickly set with small, bluish-white, round or oval spots. It contrasts strongly with the last species, which has a white background and brightly colored spots. The foot of the Blue-spotted Sea-slug is orange-yellow in color, and touches of the same shade are seen on various organs of the body, especially the two club-shaped sense organs, known as rhinophores, which stand out like horns.

Hopkinsia rosacea, MacFarland, the Rosy Sea-slug, is a little oval creature, hardly an inch in length. Its rosy pink body is covered with slender, pointed projections of the same color. In fact, it is rosy throughout, and could not possibly be mistaken for any other member of this interesting class of sea animals. It was named in honor of Timothy Hopkins, the generous patron of the Seaside Laboratory at Pacific Grove.

Fig. 96

A strange little shell is that shown in Figure 96, and a fairy tale it could tell of the life of its tiny inhabitant. Shaped like the tusk of an elephant, pure white in color and open at both ends, it differs widely from all other kinds of shells. The name of this species is *Dentalium preciosum*, Nutt., the Precious Tusk-shell. It has also been called *Dentalium indianorum*, and with good reason, for in former years the Indians used to gather these shells from the little bays on the west coast of Vancouver Island and string them for wampum. The Tusk-shell lives partly buried in the sand, the small end down. An inch is perhaps an average length for shells of this species.

Dentalium neohectagonum, S. & P., the Hexagonal Tusk-shell is the common species of southern California. Sometimes the shells are two inches in length, and, as the name indicates, a cross section would be six-sided. The shell is thin, white, curved, and angled.

Dentalium semistriatum, var. *semipolatum*, Br. & Sby., the Ornamented Tusk-shell is a small species

that lives in the south. Its shell is thin, white, and ornamented with numerous fine ridges running from the apex two-thirds of the whole length. The aperture is circular.

Cadulus quadrifissus, Cpr., the Four-slit Tusk-shell. This very large name belongs to a very small shell, only half an inch long, which may be easily distinguished because the small end is cut by a little cross, composed of four slits. It has been dredged off San Pedro by Mr. H. N. Lowe, along with other rare species of shells.

Cadulus hepburni, Dall, Hepburn's Tusk-shell, is found near the city of Victoria, B. C. It is only 11 mm. in length, and is polished, white, and nearly straight. *Cadulus tolmiei*, Dall, Tolmie's Tusk-shell, is found with the last species, but it is more curved, and rapidly tapers. *Cadulus aberrans*, Whiteaves, the Wandering Tusk-shell, is the only other species of this genus found in the same locality as the last two; its shell is larger and more curved.

The Pteropods are mostly deep sea creatures, which live near the surface, and they have been well called Sea-Butterflies. The shells are very light and thin, and in modern times at least, they are quite small. A few have been found on our coast, notably, *Cavolinia tridentata*, Forsk., the Trident Sea-Butterfly. This little shell is thin, hollow, horn-colored, shaped like a small button with three small projections or points at one end, of which the middle one is the longest. It has come ashore in southern California, and perhaps elsewhere.

At this point we will describe a few odd mollusks

Fig. 97

that strictly belong with the air-breathers. The first one is named *Melampus olivaceus*, Cpr., the Olive Ear-shell. It has a comparatively strong shell, with a narrow, ear-shaped aperture, a short spire, and a pear-shaped outline. As is shown in Figure 97, there are two folds on the columella. Dark brown, with lighter stripes and bands; length, half an inch. This species occurs plentifully on salt mud-flats along the southern coast of California.

The next species is named *Phytia myosotis*, Drap., the Mouse-ear Alexia. The shell is brown and spindle-shaped, similar in form and size to a small grain of wheat. Probably it was imported from Europe, as it is found around Atlantic sea-ports, and also near San Francisco.

Carychium exiguum, var. *occidentale*, Pils., the Western Carychium. Shell minute, distinctly conical, whitish, with an evident spire of fine rounded whorls. Aperture nearly circular, columella with a distinct tooth. From Portland, Oregon. The shell is about one-sixteenth of an inch in length; it is found about wharves and on stones which are sometimes covered with tide-water.

Pedipes unisulcatus, J. G. Cooper, the Furrowed Pedipes. Spire short, body-whorl large and full, columella marked with very large and peculiar white folds. Surface light brown, length one-fourth of an inch. Southern.

Siphonaria peltoides, Cpr., the Shield-like Siphon-shell, has a limpet-shaped shell, small, thin, and low arched, with the apex a little to one side of the cen-

ter. The color is light brown with more or less darker rays, and its length is one-fourth of an inch or a little more. The interior muscle-scar is divided on one side by a siphonal groove, but this mark is not always very distinct. This little mollusk lives on rocks between tides, and is not found very often. When disturbed it gives out a milky fluid.

Gadinia reticulata, Sby., the Netted Button-shell. A rather small specimen of this pretty shell is shown in Figure 98. It is usually low arched, though it varies considerably in this respect. There is a nearly central apex, from which run radial lines to the edge of the shell. These rays are crossed by deep, circular lines of growth, giving the shell a netted or reticulated appearance. The color is pure white and the shell is quite solid. I have found a few specimens living on mussel-bearing ledges, near the low water line, but it is not often found alive, except occasionally in a tide grotto. Dead shells are frequently washed up from the sea by the waves. The peculiar markings make them easy to identify. Sometimes live shells are found, greenish white in color, quite conical, and nearly smooth.

Fig. 98

CHAPTER VII

MARINE UNIVALVES

Myurella simplex, Cpr., the Simple Auger-shell, shown in Figure 99, is a southern mollusk, having a pretty, slender, conical shell. The spire winds gracefully upwards and ends in a sharp point at the apex, while at the other end of the shell the aperture is small and ends in a short, recurved canal. Following the sutures is a spiral thread of beads, which adds much to the attractiveness of the shell. The length is an inch or more, the whorls are about twelve in number, and the color is whitish or brown. This shell is our representative of the genus *Terebra*, which has a large number of species of similar form, some of which are very strong and as long as your hand.

Fig. 99

Fig. 100

Figure 100 also shows our representative of a large genus of shells, most of which are found in tropical seas. Its name is *Conus californicus*, Hds., the California Cone. While large and beautiful specimens of the Cone-shells are found in the warm waters of the Pacific and Indian oceans, our little species is very humble, being about an inch in length, while its surface is of a sombre chestnut color, though one may be

found occasionally that has a brown, hairy epidermis. Specimens of this shell are most common on the coast of southern California.

Figure 101 represents the shell of the rare and beautiful *Bathytoma carpenteriana*, Gabb, Carpenter's Turret-shell, (*Surcula carpenteriana*). This shell is spindle-shaped, with a conical spire, sometimes more slender than is represented in the figure, which slopes with the utmost grace to the apex. The aperture is long and the outer lip sharp and thin. In perfect specimens the lip is recurved near the suture, making a small notch, but this feature is seen better in the next genus. The shell is marked with many fine lines of growth, each of which retains the peculiar curve of the notch. The color is brownish yellow, which

Fig. 101

is set off by numerous narrow, revolving stripes of reddish brown. The length of a good sized specimen is three inches. This species lives along the coast of California, particularly off the southern coast, and most of the specimens have been obtained by dredging. An allied species, *Bathytoma stearnsi*, Raymond, shorter, smoother, and relatively broader than *B. carpenteriana*, has been dredged off San Diego and in other places off the southern coast.

Bathytoma tryoniana, Gabb, Tryon's Turret-shell, resembles the last species, but the whorls are convex, angular, and ornamented by a row of nodes on the angle. It has been hauled up alive in the fishermen's nets at San Pedro.

There are several fossil forms in Oregon and California which greatly resemble the last three species, and which seem to indicate that they were all closely related through their ancient ancestors. Various names have been given to these old forms, such as *Bathytoma gabbiana*, Dall, to a fossil shell found near Coos Bay, and *Bathytoma keepi*, Arnold, to a form found near Coalinga, which may have been an ancestor to the recent *Bathytoma tryoniana*. The study of fossil shells has been an important means of increasing our knowledge concerning the original forms of living shells, and sometimes old and cherished names have had to be changed on account of this knowledge. This is often troublesome, no doubt, but we may be consoled by the thought that these changes, sometimes at least, mean that the science of Chonchology is alive and not dead.

Figure 102 gives us a magnified view of the shell of *Turris perversa*, the Perverse Turret-shell. It is called perverse because the whorls revolve from left to right, instead of in the usual way. It is called *Turris*, instead of *Pleurotoma*, meaning Notch-side, as it is called in the old edition, because it is found that *Turris* is the older name. In regard to this change of names Dr. Dall remarks, "It is always regrettable to part with an old and familiar name, but in the present case, if the rules of nomenclature

Fig. 102, $\times \frac{3}{2}$ (*) Fig. 104, $\times \frac{5}{8}$ (*)

be followed, there is absolutely no escape from the conclusion above indicated." Concerning another change he remarks, "It would have to come sooner or later, and it is probably best to have it over and done with. If we do not do so, the evil day is only postponed."

This species is dredged alive off southern California, and it is also found in a fossil condition.

Turris vinosa, Dall, the Topsy Turret-shell, is shown in Figure 103. This is a northern species, found around the Aleutian Islands and in that vicinity. It was described by Dr. Dall in 1874. It also has a sinistral shell, though it differs materially from the last species in other respects.

Fig. 103, $\times \frac{1}{3}$ (*)

Figure 104 introduces us to another northern shell, 80 mm. in length. Its home is in Bering Sea, and its name is *Turris circumdata*, Dall, the Girdled Turret-shell. As shown in the figure

each whorl is ornamented with a raised belt or girdle, from which fact it takes its name. The aperture is large, being half as long as the whole shell. Several other rare species of this genus are known to exist either in the cold waters of the north or in the deep water off the more southern coasts.

Fig. 105

Figure 105 represents a very graceful shell named *Turris ophioderma*, Dall, the Pencilled Drill-shell (*Drillia penicillata*). The spire consists of eight slender whorls, the aperture is long, and the surface is smooth, brownish, and marked with delicate cross-lines of color. Tryon maintained that this species is only a variety of *Drillia inermis*, Hinds. It is distinctively a southern species. *Turris penicillata*, Cpr., is a Mexican species, which was confused with *T. inermis*, a species already mentioned.

Drillia torosa, Cpr., the Knobbed Drill-shell, shown in Figure 106, is found somewhat farther to the north. It is rather less graceful than its southern relative, and it is smaller also. The surface is almost black, but each whorl is ornamented with a spiral row of lighter colored knobs.

The third species, *Drillia moesta*, Cpr., the Doleful Drill-shell, resembles the last species, but the whorls have cross-ribs instead of knobs. It is a southern shell and is found under stones between tides. Its color is brown or

Fig. 106

olive, and its length is one inch. A variety from San Pedro is smooth, with fine color lines.

Drillia empyrosia, Dall, the Burnt Drill-shell, is shown somewhat enlarged in Figure 107. It has yellowish whorls, with a burnt sienna brown tint on the later ones, though a paler band shows white patches where it crosses the ribs. It is not found near the shore, but is dredged from deep water off San Pedro.

Turris incisa, Cpr., the Incised Drill-shell (*Drillia incisa*), is an inhabitant of Puget Sound. Its shell is similar in shape to Figure 105, but it is smaller, being only a little over an inch in length. Its surface is ash-colored, with reddish revolving lines.

The genus *Bela* includes a large number of small shells, most of them from the north, and some of which are obtained by dredging. They are decidedly spindle-shaped, and many of them have the characteristic notch in the outer lip near the upper end of the aperture. On account of their small size or rare occurrence they will not be farther described in this book.

Figure 108 gives an enlarged view of the little *Mangilia merita*, Gld., the Ribbed Mangilia. It has six whorls and the surface is marked by high cross-ridges and fine spiral lines. It is a whitish shell, very delicate and pretty, and it is usually less than half an inch in length. Its home is on the west coast of Central America, but it reaches as far north as San Diego.

Fig. 107, $\times \frac{1}{3}$ (*)

Fig. 108

Fig. 109, $\times \frac{7}{8}$ (*)

Mangilia variegata, Cpr., the Variegated Mangilia, has a shell similar to the last, but rather more slender, and marked with more raised ridges. The shell is thin, yellowish in color, especially around the aperture, though the spire is apt to be darker. Large specimens reach a length of 10 mm. It is found on the coast of southern California.

In Figure 109 we have a bold picture of the rare and beautiful shell named *Cancell-*

laria cooperi, Gabb, Cooper's Cancellaria. Fine living specimens are occasionally hauled up in the nets of the fishermen or are gathered by the dredge, but good specimens are still very valuable, so much so that I never owned one. The few that have been found off the coast of California give us proof, however, that the depths of the sea hold many choice and beautiful treasures, and as we look over the blue waves we can in imagination

Fig. 110, $\times \frac{4}{3}$ (*)

call up these many and other fairy forms from their homes below.

Cancellaria crawfordiana, Dall, Crawford's Cancellaria, Figure 110, is another fine species which has been dredged alive in Drake's Bay and Monterey Bay. The surface of the shell is pale brown and rough, while the throat is pure white. Its length is about an inch and a half. It is to be hoped that many more specimens of this fine shell may be brought to the surface by careful dredging.

Another rare shell belonging to the same genus is shown in Figure 111. Its name is *Cancellaria middendorffiana*, Dall, Middendorff's Cancellaria. It comes from the far north, being found in Bering Sea and vicinity. Its white shell is only 17.5 mm. in length, and it is covered with a pale yellow epidermis.

One fine summer morning some years ago I rose very early, took my long rubber boots, an old hoe and a basket, put a few crackers in my pocket, and silently stole away from the little tent where the rest of my family were continuing their slumbers. I followed the long path which led along the cliffs, here coming down close to the shore and there cutting off a sharp headland of rocks, till I reached my destination. This was a strip of sandy beach from which the water had all receded, for it was at the very lowest ebb of the early tide. I sat down upon a rock, took a

Fig. 111, $\times \frac{1}{4}$ (*)

cracker from my pocket, and began to investigate both it and the prospect. In front of me was the strip of sand sloping down to the light waves; behind me was a high bank of earth, and the rocks were on either side; but no shell was to be found except a few well-worn specimens which had been tossed up by some departing wave.

But I was not expecting to find shells in plain sight, so I cheerfully pulled off my shoes and drew on those convenient appendages, the long rubber boots. (Were I to do it again I would go dressed in a bathing suit and snap my fingers at the waves.) Now I was ready for work, and taking up my hoe I began to dig in the sand. There was plenty of sand to dig in, in fact, too much of it, for it apparently took up all the room and left no place for the shells.

At length I struck upon a spot where a little stream of water was oozing out from a bank of sand. As I scraped away the surface I saw something which

Fig. 112

would have made me dance for joy, had I not been weighted down by the long boots. For there in very truth was a live Olive, with its graceful shell shaped like Figure 112. It had a beautiful pearl-colored body, which it quickly withdrew into the shell and closed the aperture with a very insignificant scale, which seemed to be an apology for an operculum.

I picked up the little creature and mused somewhat as follows: The name of this mollusk is *Olivella biplicata*, Sby., the Purple Olive-shell. It is about an inch in length, and the shell, while appar-

ently smooth and polished, is shown under the microscope to have fine and beautiful reticulations. The spire is short, the aperture long and narrow, the canal a mere notch, and the outer lip is thin-edged. Upon the inner wall of the aperture is a lump of white enamel, and at the base of the columella are two little folds, which are referred to in the name *biplicata*, meaning twice folded. The color of the shell varies much in different specimens; some are almost pure white, others are very dark, but most of them are dove-colored, with purple trimmings. They resemble the olives of our orchards in form and size, so their name has no mystery connected with it, but it was doubtless chosen by Mr. Swainson, in 1835, on account of the appearance of the shells. It is only fair to say, however, that back in 1789 the name *Oliva* was applied to the large group of smooth shells of which our little specimen is a humble representative. At the present time the genus *Oliva* includes the larger species, which have no operculum. The genus *Olivella*, meaning "little olive," includes the smaller species, among which the specimen that we are now considering is classed, and which proves its right to be there by the presence of an operculum, as we have already indicated. Concerning these shells Dr. Paul Fischer remarks in his *Manuel de Conchyliologie*, "Les coquilles sont de petite taille; l'une d'elles (*O. biplicata*, Sowerby) est recherchée par les indigènes de Californie, qui la polissent, la percent, l'emploient comme ornement ou monnaie sous le nom de *Colcol*. On en trouve d'assez grandes accumulations dans les tumuli." From these words I under-

stand that our Indians used to value these shells quite highly, that they used strings of them for ornament or for money, and that they have been frequently found in old mounds and graves. But it is not necessary for us to read French to learn all about this primitive money. Go to any good public library and ask for the Report of the National Museum for 1887 and turn to page 297. There you will find a delightful article on "Ethno-Conchology," written by our own Dr. Stearns, which begins as follows: "The study of Nature leads through enchanted fields, full of new surprises and fresh delights. Whichever path we pursue, vistas open on either side equally inviting, with every charm of life and form and color, ever changing but never old." * * * "Conchology, or the study of shells, in itself one of the most delightful studies, in its ethnical aspect is also full of interest." The article fills about forty pages and has a number of plates, showing both western and eastern shells that have been used by the aborigines for the making of beads and strings of money. There are many treasures hidden away in these old Government reports that ought to be looked up by our bright boys and girls, who will find them to be a perfect mine of information.

As I proceeded with my hoeing my joy increased, for I found the pretty shells by the hundred, and I had gathered about a thousand when the tide came in so far as to render further work impracticable. They seemed to lie in groups just under the surface of the sand, yet wholly concealed from sight. You must go at the very lowest morning tides, if you wish to

gather them, and search till you find the bed; for they seem to be active burrowers and to move rapidly from place to place.

I took some of them home and put them in a jar of beach-sand and sea-water. You will be pleased to do the same, if you ever have an opportunity, for their movements are very interesting. You will then see the plow-shaped foot which quickly digs a hole in the sand, and the long, breathing-siphon which curls up through the canal and reaches through the sand up to the clear water, like the trunk of a swimming elephant reaching up for air.

To clean the shells it is simply necessary to spread them in the sunshine for a few hours, when the animal will be found to be dead and loosened from the shell. The soft parts can then be easily removed with a pin. To clean most shells, however, it is necessary to throw them into boiling water. In a few minutes they can be taken out and the animal withdrawn by a little hook or piece of bent wire. Many marine mollusks may be killed readily by simply putting them into a dish of warm, fresh water and leaving them there for a little while. This can be done before boiling them, in any case.

If only a portion of the body of the animal can be extracted, the shell may be put into a solution of formaldehyde or some other disinfectant for a time, and when dry the aperture may be plugged with cotton, to which the operculum may be attached by a drop of glue. They will then appear as if they were living specimens. Much will depend upon one's time and taste for this part of the preparation, but the

thorough cleansing of the shell is indispensable, and should be attended to as soon as possible after the specimens are gathered.

Fig. 113

Olivella pedroana, Conr., the Pedro Olive-shell, has a more slender shell than that of the last species, though some specimens are a little more robust than is indicated by Figure 113. The lip is thin, the spire quite tapering, while the color is generally brownish or bluish. This shell, which used to be called *O. baetica*, is sparingly found all along the coast.

Olivella intorta, Cpr., the Twisted Olive-shell, has a small, oval shell, more compact than that of the last species. The spire is elevated, and the suture is very distinct. There is a large callus on the upper part of the inner lip, and there is but one distinct fold on the columella, instead of two. There are generally more or less yellow stripes on the surface of the shell, the greater portion of which is light-colored. The outer lip is more curved at the base than that of the last species.

A pure white little shell is often found washed up on sandy beaches, where it is found by the children and esteemed quite a prize. An enlarged picture is given in Figure 114. The little cross beside the picture indicates the true length and breadth of a large specimen. Its name is *Marginella jewettii*, Cpr., though we will call it the California Rice-shell. The spire is very short, and there are several folds or plaits on the columella. The true Rice-shell of the dealers, which is a little white *Olivella*, pointed at

Fig. 114

both ends, does not live on our coast, but is found in great abundance in the West Indies.

Marginella varia, Sby., the Colored Marginella, has a pretty little shell, about the size and shape of a fat grain of wheat. It has a very short, rounded spire, a long aperture, and a plaited columella. Its surface is very smooth and glossy, and varies in color from white to brown, the shades being often laid on in bands and stripes. It is a southern species, and is often found on rocks between tides. Several other species of *Marginella* exist on our coast, but they are very small.

Mitra idæ, Melville, Ida's Miter-shell, is shown in Figure 115. It is a dusky relative of the beautiful and brilliant Miter-shells which are found in the vicinity of Australia. Our species is by no means gaudy, either in color or ornamentation, but it has a plain, smooth shell, which is almost black, and is wholly devoid of the gay trimmings of its relatives. The columella is ridged with three strong, oblique folds, which are very conspicuous. The cut represents a small specimen, but dead shells are not infrequently found that are fully two inches in length, though they are almost always somewhat broken. Fresh specimens have a black epidermis, but worn shells are chestnut-brown in color, with a whitish interior. A large, perfect specimen was recently found at Monterey.

Fig. 115, x $\frac{3}{2}$

There has been much discussion as to the true name of this species. In most books it has been called *M. maura*, Swains. That name was appar-

ently given to a Peruvian shell in 1835, which the year before had been called *M. orientalis*, Gray. Another similar shell from the west coast of Mexico is named *M. fultoni*, and still another from San Pedro Bay is called *M. lowei*, Dall. They all have a general resemblance and perhaps a common ancestry. *M. ida* is named for Mrs. Ida S. Oldroyd of Long Beach, who has done so much for the science of shells.

Fig. 116, x $\frac{9}{1}$ (*)

Mitromorpha aspera, Cpr., the Rough Miter-form, Figure 116, is really only five millimeters in length, but the greatly enlarged picture brings out the details finely. It has a brownish surface, and is marked with a very distinct sieve-like network of fine lines.

Mitromorpha filosa, Cpr., the Threaded Miter-form, is shown in Figure 117. The little shell is about a quarter of an inch in length, and it is almost black in color. Very distinct spiral lines run around it, giving it a threaded appearance.

Fusinus kobelti, Dall, Kobelt's Spindle-shell, is beautifully shown in Figure 118. It is very graceful in form, and occasionally it grows to the size of the picture, though usually it is not over two inches in length. There are five or six whorls, with nine elevations on each

Fig. 117, x $\frac{9}{1}$ (*)

whorl, crossed by fine, dark spiral lines, though the main color of the shell is whitish. In former editions this shell was called *Fusus kobelti*.

Fusinus luteopictus, Dall, the Painted Spindle-shell, Figure 119, is really less than an inch long. The spire is ornamented with numerous ridges, extending up and down, and there are spiral paintings to be seen, especially inside the outer lip, the colors being light yellow and dark brown.

This shell is now believed to be identical with *F. cinereus*, Reeve, and should be so labeled.

Fig. 118, $\times \frac{1}{3}$ (*)

Fig. 119, $\times \frac{2}{1}$ (*)

Fig. 120, $\times \frac{2}{3}$ (*)

Figure 120 shows us another fusiform shell named *Fusinus harfordi*, Harford's Spindle-shell. It is a rare shell, a few specimens having been found off central California. In young shells there is a polished, ruddy brown epidermis, but in older ones there is a suspicion of shagginess. The interior of the aperture is white.

And now we will examine a few of the shells from far-off Alaska; that land of wonderful interest, with its hills clothed in evergreen, its mountains tipped with snow, its glaciers and icebergs, its mines and boundless forests, its numberless islands, bays and inlets. Whoever has sailed along the coast of Alaska never forgets its wonderful beauty. In those cold waters, where salmon jump and whales spout close to your steamer, and where the busy world seems far away,—in those polar waters live many mollusks, quite a number of which are classed under the family of the *Buccinidae*.

Fig. 121 (*)

Figure 121 represents two specimens of *Buccinum angulatum*, Gray, the Angled Whelk. The pictures are none too large, for the shells are strong and robust. Both of them represent females, for the shells of the males of the same species are materially smaller. This species lives on the shore of the polar sea, near Bering Strait, and in the Arctic Ocean. It represents a decidedly frigid type.

Fig. 122, $\times \frac{1}{3}$ (*)

Buccinum aleuticum, Dall, the Aleutian Whelk, Figure 122, has a thin, six-whorled shell, of a pinkish color with a white pillar. It is covered with a thin epidermis, somewhat bearded. The sculpture consists of fine, close-set grooves, with spaces between them. The figure is slightly magnified.

Buccinum percasum, Dall, the Thick-shelled Whelk, is shown in Figure 123. This solid little shell is found in the waters that bathe the shores of Bering Island, a name that makes us think of seal-skins and refrigerators. The operculum is remarkably distinct, and the shell is decidedly thick and solid.

Two specimens of *Buccinum castaneum*, Dall, the Chestnut Whelk, are shown in Figure 124. The left-hand figure represents the normal form of this large shell, while the other is the form with

Fig. 123 (*)

Fig. 124 (*)

three ridges, which is known as var. *tricarinatum*, Dall. Both shells have a translucent brown outer coat, and are marked with fine spiral lines of sculpture.

Fig. 125, x 82 (*)

Buccinum plectrum, Stimpson, the Lyre Whelk, is shown in Figure 125. This shell is distinguished by ridges, which suggest the second name, on account of their resemblance to the strings of a musical instrument. This species, which is not very common, is also found on the shores of Bering Sea.

Fig. 126 (*)

Buccinum viridum, Dall, the Green Whelk, shown in Figure 126, which represents it of its natural size, is not a northerner, but was dredged where the water was half a mile deep, off the Santa Barbara Islands. The shell is delicate and thin, which is apt to be the case with all shells which live at great depths, and it is covered

with a fine, greenish epidermis which easily falls off. The outer lip is thin and is but slightly reflected. The length is 46 millimeters.

Somewhat similar in shape to the last is *Chrysodomus amiantus*, Dall, the Unspotted Chrysodome, shown in Figure 127. This species has a large, thin, white shell, with a prominent nucleus at the top, while it is marked with numerous narrow revolving ridges. Several specimens of this fine shell were dredged near the Santa Barbara Islands.

Chrysodomus dirus, Rve., the Dark Chrysodome, Figure 91, was described and figured on a preceding page. It hardly seems to deserve its ill-omened name, as there is nothing direful in its appearance, though its color

Fig. 127, x $\frac{1}{2}$ (*)

is dark and mournful. An old name for this shell is *Euthria dira*.

Chrysodomus liratus, Mart., the Ridged Chrysodome, is a large Alaskan species, having a light brown shell some three inches long, swollen in the middle and pointed at both ends. The chief feature is the set of about ten strong ridges, or carinae, which circle around the shell in a spiral manner, leading back from the outer lip to the very apex. I once obtained a fine specimen of this shell on Wrangel Island.

Fig. 128, $\times \frac{3}{4}$ (*)

Figure 128 gives a good idea of a somewhat similar shell known as *Chrysodomus tabulatus*, Baird, the Tabled Chrysodome. It lives along the coast of Vancouver Island southward, inhabiting deeper and deeper water on the way. A beautiful specimen was recently dredged in Monterey Bay. The shell is usually of a yellowish white color, though sometimes darker, and it can be readily identified by the tabulated whorls, with their flat tops. It is also found as a fossil.

Chrysodomus kellettii, Forbes, Kellett's Chrysodome, is one of the largest of our mollusks. The shell is strong and heavy, and sometimes measures nearly six inches in length. It

has a regular, conical spire, three inches long, marked with numerous rounded knobs, which are often overgrown and partially concealed by a stony crust, which was once the home and protection of numerous little sea animals. The aperture is pear-shaped, and the outer lip has many small teeth and internal ridges, while the canal turns backward. The umbilicus is large and distinct, while the operculum is dark and conspicuous. This shell is found chiefly in southern waters.

Fig. 129 (*)

growth. It was dredged off British Columbia in 238 fathoms of water.

Chrysodomus magnus, Dall, the Great Chrysodome, Figure 130, grows to a length of three inches.

Fig. 130, x $\frac{1}{2}$ (*)

Figure 129 gives a view of *Chrysodomus phoeniceus*, Dall, the Purple Chrysodome. Its seven whorls are of a purplish brown color. The sculpturing is feeble, and the epidermis conforms to the lines of

The shell is rather thin, the whorls flattened, with a strong keel at the shoulder, and there is a thick, bearded epidermis. This fine shell was dredged in Bering Sea.

Figure 131 represents a magnificent shell from the waters around the Aleutian Islands and other cold currents in that vicinity. Its name is *Beringius crebricostatus*, Dall, the Ribbed Bering-shell. It grows to a

Fig. 131, $\times \frac{2}{3}$ (*)

Fig. 132, $\times \frac{7}{12}$ (*)

length of five inches. The color is white, with a darker flush in the throat, while the epidermis is of a bright yellowish tint. Like many of these northern shells it will be seen by comparatively few of our readers, and yet it is a good thing to know what kind of creatures have their home at the bottom of those apparently inhospitable seas. It shows us that abundance of life is by no

means confined to conditions that we ourselves should consider as congenial.

Beringius frielei, Dall, Figure 132, is another large shell of this genus, which bears the name of the great navigator. Vitus Bering was a Dane by birth, but he entered the Russian service and made many discoveries in the northern waters. He was wrecked on the island that bears his name in 1741, and there his life was ended. This specific name was given in honor of a Norwegian gentleman, Mr. Herman Friele, of Bergen. This shell is covered with a persistent, reddish-brown epidermis, and it is delicately sculptured. The aperture is snowy white within.

Another magnificent shell of this series is shown in Figure 133. Its name is *Beringius kennicottii*, Dall, Kennicott's Bering-shell. In spawning-time it comes into shallow water on the coast of Kadiak Island but afterwards it withdraws to greater depths. It has a light brown covering, under which the shell is white or purple,

Fig. 133. $\times \frac{2}{3}$ (*)

though at the aperture it is somewhat pinkish. It is fully five inches in length.

Three large shells now follow, all of which were dredged by the United States Steamer "Albatross" in cold, Alaskan waters. The first is named *Strombella fragilis*, Dall, the Fragile Strombella, and its general appearance is shown in Figure 134. The shell is thin and inflated. Its color is pinkish, and it is covered with a thin epidermis.

Fig. 134, $\times \frac{2}{3}$ (*)

Fig. 135, $\times \frac{3}{4}$ (*)

The outer lip, as may be seen in the cut, is widely deflected. The length of this large shell is about four inches.

Strombella midden-dorffi, Dall, Midden-dorff's Strombella, is shown in Figure 135.

This fine, large shell is marked with sharp, fine grooves which run around it spirally. The lip is reddish-yellow in color, or sometimes brown. It is a fine, shapely shell, and it reaches a length of 110 millimeters.

Figure 136 shows the largest shell of all, its length reaching the remarkable extent of 137 mm., while it is 75 mm. in breadth. This splendid shell is named *Strombella melonis*, Dall, the Melon Strombella. Although so large the shell is not very heavy, for it is quite thin, like most of the true Melon-shells. Its shape is well shown in the picture, and its color is pinkish, or yellow and white.

Fig. 136, x $\frac{3}{4}$ (*)

Tritonofusus rectirostris, Cpr., the Straight-beaked Spindle-shell is shown in Figure 137. The picture is considerably magnified, but it represents the features of the shell very closely. The shell itself is white, but it has a polished, olive-brown epidermis. It lives in the waters of Puget Sound and vicinity.

Fig. 137, $\times \frac{2}{1}$ (*)

Tritonofusus herndeeni, Dall, the Nine - whorled Spindle-shell, is shown in Figure 138. This species is an inhabitant of more northern waters, having been obtained at various places in the far north, and it grows to a length of nearly three inches. The shell has

Fig. 138, $\times \frac{2}{3}$ (*)

about nine whorls and is very symmetrically shaped. Its color is pinkish white with a yellowish tinge beneath, and over all is a pale olive periostracum. There are several other species of this genus, and they all prefer the cold waters of the north to the more temperate regions farther south.

In Figure 139 we have a natural-sized picture of the little *Macron lividus*, A. Ad., the Livid Macron. The shell is somewhat brownish in color, and when found living, it will be noticed that it is covered with a dark brown epidermis, which is laid on in little ridges, resembling a coating of fine, soft cloth. Near the top of the white columella is a sharp ridge. This species is seldom seen far north of San Diego, while another shell, *Macron Kellettii*, A. Ad., Kellett's Macron, is commonly found on

Fig. 139

the coast of Lower California. This species has a larger shell than that of the Livid Macron, and it is also of a darker color. The aperture is very large, the outer lip thin, and the canal a mere notch. Its length is rather more than an inch.

The large shell shown in Figure 140 comes from northern Alaska and it has received several names. It will be safe, however, to call it *Volutopsius kobelti*, Dall, Kobelt's *Volutopsius*. It is not a common shell, and the specimens that are usually collected are often beach-worn, but the picture represents the shell in perfection. Its full length is about four inches.

Fig. 140, x 3: (*)

Volutopsius castaneus, Morch, the Chestnut *Volutopsius*, is found more abundantly than the last species.

It lives in shallow water off the Aleutian Islands. It is of a brownish color and it has no epidermis. The aperture is large, the surface rough and destitute of any spiral sculpturing. It is about the same size as the last species.

Volutopsius attenuatus, Dall, the Slender *Volutopsius*, shown in Figure 141, comes from Bering Strait and the adjacent Arctic waters. The shell

is thin, white and delicately striated. The length is a little over two inches.

Fig. 141 (*)

Fig. 142, x $\frac{1}{2}$ (*)

Liomesus nux, Dall, the Arctic Nut-shell, shown in Figure 142, is well named, for it much resembles a round, well-filled nut. It also comes from far northern waters, the home of so many species of mollusks. The shell is dark-colored, with a creamy white layer above. In life there is a periostracum which resembles velvet.

Fig. 143 (*)

Liomesus canaliculatus, Dall, the Channelled Nut-shell, is shown in Figure 143. It is another northerner, and its white shell is covered with a velvety epidermis. Its length is 35 millimeters.

The next genus of shells that we are to consider has long borne the name of *Nassa*, a word which

means a net, or more properly, a basket that is used for taking fish. Most of the members of this genus are small, and the sides of their shells have a reticulated surface, somewhat like network or the sides of a basket. Much as we regret it, however, it now seems as if this good old Lamarckian name would have to give place to another in the near future. But for the present we will not anticipate any such change.

Our largest member of the genus is named *Nassa fossata*, Gld., the Channeled Nassa, Figure 144. The spire is conical and ends in a pointed apex. The surface of the whole shell is marked with spiral and transverse ridges, the former of which appear also within the outer lip. The thickness of this lip varies much with the age of the animal, as does the callus of enamel which is spread over the columella. This enamel, in mature specimens, is of a bright orange color, and contrasts finely with the light ash-color of the general surface of the shell. The canal is short and abruptly reflected, while just above it is a deep ditch, or *fossa*, showing at once from what fact the specific name is derived. The use of the canal seems to be to afford space and protection for a breathing-tube, which projects above the surface of the mud which the animal is exploring for his prey.

Fig. 144

The Nassas are active mollusks, and are cordially hated by the oystermen, because they are so prone to bore holes through the shells of young oysters,

eating the contents with as much relish as any other judges of good living. They bore into various clams, too, and it is even hinted that they sometimes attack their own kind. But they are scavengers also, and consume the flesh of dead crabs and like animals, which are so liable to be found near the shore. In turn they are themselves eaten, for I have some beautiful specimens of this species which were taken from the stomach of a large fish—showing that the enemy of other animals is liable to be swallowed whole when the avenging and hungry fish comes around.

Nassa tegula, Reeve, the Covered-lip Nassa, Figure 145, is a southern species, having a strong shell, a small aperture, and a reflexed canal. The inner lip is covered with a large callus of smooth, white enamel.

Fig. 145

The color is dark gray, and the length is three-fourths of an inch.

Fig. 146, x $\frac{3}{4}$ (*)

Figure 146 gives us an excellent, though greatly magnified picture of *Nassa insculpta*, Cpr., the Sculptured Nassa. This is a rare shell, being found in the south, and collected chiefly by dredging. It is thick and solid, the outer lip is strongly reflected, and there is no transverse sculpturing

except on the first few whorls. The color is light brown, but the aperture is white. My largest specimen measures 23 mm. in length.

Nassa perpinguis, Gld., the Fat Nassa, Figure 147, has the prettiest shell of all of our species of *Nassa*. The cut does scant justice to a good specimen, though it shows that the shell is finely checked, being cut into a multitude of little squares. The whorls are plump and fat, the shell rather thin, the color whitish or light brown, with sometimes a dash of orange inside, and a spiral stripe of chestnut running around the middle of each whorl. The outer lip is sharp and thin. Most specimens are rather smaller than the figure.

Fig. 147

Fig. 148

Nassa mendica, Gld., the Lean Nassa, Figure 148, is a variable species, having a more slender shell than the last. The surface is marked with numerous fine, spiral lines, crossed by ridgy varices. The color is light brown, with a white peristome. It occurs all along the coast from Puget Sound to San Diego. There is a variety, named var. *cooperi*, Fbs., which has for sculpturing a few strong transverse ribs and small spiral lines. Figure 148 resembles this variety.

Nassa californiana, Conr., the California Nassa, is a rare species, sometimes found alive on the coast of the southern half of California, particularly about San Pedro. It is as large as *Nassa fossata*, and it has the general form and sculpturing of *Nassa perpin-*

guis. It is found fossil in various localities in the State. Some consider *N. fossata* and *N. perguinis* as varieties of this species.

Ilyanassa obsoleta, Say, the Worn-out Nassa, is a very recent comer to this coast. It is extremely abundant on the Atlantic coast to the south of Cape Cod, being found especially on mud-flats, when the tide is low. In those regions the shell always has a dilapidated appearance, being partly covered with a dismal, mossy growth, and seldom reaching the length of an inch. It came to California, however, probably with young oysters, and settled in San Francisco Bay, on the Alameda side. As frequently happens with immigrants it began to spruce up quite wonderfully. Some specimens were sent me by a lady in Alameda in 1909, who asked for their name. They were so clean and bright and large that I hesitated long before I was fully convinced that they were the real "Worn-outs," but such they are now regarded by collectors. They are about the size and shape of Figure 147, but the shell is much thicker and heavier than those of our *N. perpinguis*. The exterior is dark, with a greenish tinge, while the peristome is brown and glossy, with two white, internal stripes. It would not be strange if they should increase rapidly and become a very common shell.

CHAPTER VIII

THE SMALLER SEA-SHELLS

When the tide is high the waves often wash up a great number of little shells into sheltered coves, and leave them there to be gathered when the water has ebbed away. It is very pleasant to lie down upon the warm sand on a summer afternoon, and while the waves are making gentle music at your feet to look for these beautiful bits of organic structure. Whenever you find a pretty one you put it away in a little bag, or what is more likely, you lay it in the bowl of some large shell that you have picked up for that purpose.

Among the most abundant of the shells to be thus found on our coast is the little Common Dove-shell, *Columbella gausapata*, Gould, shown somewhat magnified in Figure 149. The shell is really about the size of a grain of wheat. The spire is conical, the lip thickened, and in the variety *carinata*, Hinds, there is a distinct keel just below the suture. The coloring of the shell is chestnut brown and its surface is polished and glistening, and it is often mottled with dots and stripes. This little mollusk lives in great numbers at the roots of the eel-grass, and dead shells are washed up abundantly upon the shore. It may also be found alive when the tide is low.

Fig. 149. x 7

Fig. 150, x $\frac{5}{4}$ (*)

Columbella aurantiaca, Dall, the Golden Dove-shell, a greatly magnified view of which is shown in Figure 150, was found at Monterey many years ago by Dr. Dall, who gave it the above name. It is really a tiny shell, only 5 mm. in length, and it varies in the color of its translucent shell from orange to brown.

It sometimes has zigzag brown markings. It should be sought for among the rocks at low water.

Columbella tuberosa, Cpr., the Tuberculated Dove-shell, is another similar species. The shell, however, has a very slender spire, and the body-whorl is angulated. The inside of the outer lip bears a row of little tubercles. The color is brown, and the length is about a quarter of an inch. It is said to exist sparingly all along the coast.

Columbella chrysalloidea, Cpr., is the Chrysalis Dove-shell. This is a southern species, having a somewhat cylindrical shell like the chrysalis of an insect. There are six whorls, very slightly convex, while the surface is marked with delicate spiral ridges and furrows. The spiral ornamentation is prominent on the lower part of the columella. The length is eight millimeters.

Columbella permodesta, Dall, the Modest Dove-shell, is shown in a magnified form in Figure 151. The shell of this species is thin and polished, of a bluish white color, and it is covered with a pale, yel-

Fig. 151, x $\frac{3}{4}$ (*)

lowish epidermis. Its real length is 14 mm. It was dredged from deep water off the Santa Barbara Islands.

Amphissa versicolor, Dall, the Joseph-coat Amphissa, Figure 152, is a very common shell along the coast of California.

The drawing gives a very correct idea of the appearance of the shell, though it is considerably enlarged, the common length being eight or ten millimeters. The color varies exceedingly, as the name indicates. Some shells are reddish, others yellow, while still others are various shades of gray, and even almost black. A collection of these shells furnishes a very pretty assortment of tints. Living specimens are not so often found as dead shells, but at low water they may often be discovered, clinging to the rocks.

Fig. 152, x $\frac{3}{2}$

Amphissa corrugata, Rve., the Wrinkled Amphissa, is the name of the species which lives chiefly in northern waters. It was formerly supposed to include the last species, but it is now believed to be quite distinct. Its shell is much larger in the first place, the average length being three-fourths of an inch. It has a less ventricose body-whorl and relatively finer sculpturing. It is usually of a light yellowish-brown color.

Amphissa undata, Cpr., the Wavy Amphissa, is shown greatly magnified in Figure 153. This shell also has been confounded with *A. versicolor*, but it is really another species, though it is of about the same size. In the enlarged figure the sculpturing is distinctly brought out, though the color pattern is

Fig. 153, $\times \frac{1}{2}$ (*)

ignored. It has been found plentifully in mud off Catalina Island, in 16 fathoms of water.

The Two-tinted Amphissa, *Amphissa bicolor*, is shown in Figure 154.

The shell is 14 mm. in length, and is of a pale straw color, with a brownish base and a brown band.

Specimens were

dredged in various places off the coast of southern California, in quite deep water.

Fig. 154, $\times \frac{3}{4}$ (*)

We now come to the great family of the *Muricidae*. In the warm waters of the tropical ocean the members of the *Murex* family take on very bright colors and assume very fanciful forms. With us, however, their representatives are more modest, though many of them are full of interest to the collector, while some have considerable beauty.

As has been already explained in the Preface the names of some of the members of this family are still in a process of adjustment. To prevent confusion, where a new name has been definitely announced by the authorities at Washington it will be accepted, but the old name will also be given in parentheses. In most cases it is only the first, or generic, name

that is changed; and while we naturally call the recently announced name as a "new" one, still, in most cases it is really an older name than the one that has been in common use for nearly a century. We may doubt the wisdom of restoring these nearly forgotten names, but wiser men than we are have thought differently, and so we bow loyally to their decision. For those who are learning the names for the first time the difference will not be appreciated. While acting conservatively in this matter, it is proper to remark that other names may be changed, which for the present we have thought it best to retain.

We begin our descriptions with a rare species, *Murex carpenteri*, Dall, Carpenter's Murex, shown in Figure 155. The picture is of about the natural size of a large specimen, and it clearly shows the main features of the shell. The aperture is small, oval, and has an elevated rim without denticulations. The color varies from reddish brown to a light gray. There are three wing-like varices on each whorl, and between them the shell is nearly smooth. This fine species has been found at Monterey, and has also been dredged in various places southward from the Farallone Islands.

Fig. 155 (*)

The much befrizzled shell shown in Figure 156

Fig. 156 (*)

is another of the three-winged California forms, and is named *Murex petri*, Dall., St. Peter's Murex. It was obtained by Mr. and Mrs. Oldroyd from rather deep water at San Pedro, so it doubtless takes its name from that of the locality where it was obtained, Pedro's, or Peter's, Bay. The color of the shell is yellow-brown, mottled with lighter spots. Its length is 65 millimeters.

This shell is rough all over, while the last one is smooth between the varices.

Murex trialatus, Sby., the Three-winged Murex, has a much smaller shell, with dark brown and white color bands. The shoulder of the whorls is excavated, the three varices thick and rounded, and the frills sometimes beautifully recurved. A fine specimen was dredged by Mr. H. N. Lowe, off San Pedro, in ten fathoms of water.

Murex circumtextus, Stearns, the Circled Murex, Figure 157 (*Ocenebra circumtexta*), has a rather heavy shell, many low varices, and many very deep and distinct spiral grooves which give the outer lip a scalloped appearance. It is of a reddish color within, but externally it is whitish, with brown spots arranged in a spiral

Fig. 157

line. In a fully grown specimen there are four or five white teeth inside the outer lip.

Murex festivus, Hds., the Festive Murex, is shown in Figure 158. I gathered fine specimens of this grand species at San Pedro, by going among the piles of the wharves when the tide was low, and examining the upper part of the logs, to which these and other species of mollusks were clinging. Many of them were somewhat concealed by growths of seaweed and hanging drift, but they readily yielded to a careful search.

Fig. 158

The shell is festively ornamented with three reflexed frills on each whorl, alternating with rounded knobs. In perfect specimens there are numerous fine spiral lines of sculpturing, which are often covered with foreign substances. The canal is completely closed, forming a tube, which is bent back near its extremity. The color is white or gray, though the outside is often very dingy. The picture represents a good sized specimen, though it sometimes grows considerably larger. This species loves warm water too well to migrate far to the north.

Murex incisus, Brod., the Incised Murex, belongs to southern waters and is not very common. The shell has strong, rounded, transverse ridges which give the spire the appearance of being chopped full of holes. The color is white with cross stripes of brown, and its length is an inch and a quarter.

Figure 159 introduces us to another southern

shell, *Purpura nuttallii*, Conr. (*Murex nuttallii* and *Cerostoma nuttallii*), Nuttall's Hornmouth. If you

Fig. 159

examine a full grown shell of this species you will find a sharp tooth, or horn, near the base of the outer lip. Some young specimens have no horn, and they may also have an open canal instead of a closed one, which the adult has. Allowance must be made for the age and development of the specimen in determining its name. The shell of an adult of this species is about two inches long, and it is of a dingy white color, somewhat

marked with brown. On each whorl are three distinct varices, with rounded knobs between them. This species seems to be quite closely related to the next one, so much so that some have considered one but a variety of the other.

Purpura foliata, Martyn (*Murex foliatus*), the Leafy Hornmouth, is a more northern species and has a larger shell, which is very conspicuously marked with its three broad, wing-like varices. They appear to be made up of overlapping plates, like shingles on the roof of a house. The canal is conspicuously curved backward, and at each period of definite advance in the growth of the shell the old canal is left behind and becomes a distinct feature of the specimen. Strong spiral ridges appear on the back of the shell, spreading out in a fan-shaped manner upon the varices. A very large specimen dredged near Monterey measured 87 mm. in length and 63

mm. in breadth. The color of all of these shells is a dull white, somewhat obscured by external stains. The present name of this shell goes back to 1784, and has been recently restored by Dr. Dall. The shells commonly known as Purple-shells will no longer bear the name *Purpura*, as will be seen by reference to a later page. The purple dye of the ancients was obtained from one or more species of *Murex*.

Figure 160 gives an excellent idea of a rare shell named *Trophon triangulatus*, Cpr., the Three-cornered Trophon. The shell is quite large, but it is of light weight, owing to the extreme thinness of the varices. Externally it is reddish brown in color,

Fig. 160

though nearly white internally. When examined closely it seems to be almost wholly made up of wings, and one wonders where the animal found internal space enough to enable it to carry on business. The original young specimen from which the species was named was dredged from the vicinity of Catalina Island at a depth of sixty fathoms. It was less than half an inch long, but adult specimens

of the size of the cut have been dredged recently, and sometimes the shell reaches a length of about four inches. It has been obtained from fishermen who work in the vicinity of San Pedro in considerable numbers, and a few specimens have even been found on the shore.

Fig. 161, $\times \frac{1}{2}$ (*)

Boreotrophon scitulus, Dall, the Elegant Trophon, Figure 161, is a type of a large number of species which live mostly in northern waters, and which have been assigned to this genus. It is a little shell, two-thirds of an inch in length, but it is supplied with an abundance of frills, as is shown in the picture. It was first found in Bering Sea, but like many others of the cold water shells it probably exists in deep water as far south as the Santa Barbara Islands.

Boreotrophon stuarti, E. A. Smith, Stuart's Trophon (*Trophon orpheus*). This fine shell has from seven to twelve varices, with the interspaces crossed by four or five rounded spiral coils. It sometimes reaches a length of two inches. The sharp, white varices make a crown at the suture. It ranges from Alaska to Santa Cruz, seeking deeper water as it comes southward, doubtless because the deep water is colder and more like its Arctic home.

Boreotrophon gracilis, Perry (*Trophon multicostratus*), the Graceful Trophon. This northern

species has a pear-shaped shell, with several sharp, frill-like varices. The sutures are deep, and the few whorls of the spire are very distinct. The color in small specimens is generally white, though often the interior is somewhat brown. This shell reaches a length of one inch. There are many other species of this genus, most of them small, which will not be described in this book. Anyone who wishes to investigate the matter will find them properly described in Volume XXIV of the "Proceedings of the United States National Museum." That book should be found in all large public libraries. Interesting articles on shells are to be found in very many of the volumes of the same series.

We now come to a somewhat puzzling genus of shells, the *Ocinebras*. Most of them have small, fairly strong shells, with moderate apertures and distinct canals, though the latter are sometimes closed. By that term we mean that they are tube-like; they are never closed at the lower end of the shell.

Ocinebra interfossa, Cpr., the Sculptured *Ocinebra*, shown in Figure 162, has a small, spindle-shaped shell, marked with spiral grooves, sharp varices, and deep sutures. It varies in color through shades of yellow, gray, and brown. The picture gives an excellent idea of the shell, both as to size and shape. The color is white within and dull gray without. The shell is quite rough and rasp-like, owing to the distinct sculpturing. This species is liable to be found all along the coast, where there are rocks or cliffs.

Fig. 162

Fig. 163

Figure 163 gives a fairly good idea of the most common species of this genus, namely, *Ocinebra lurida*, Midd., the Lurid Ocinebra. This pretty little shell is common at Monterey and at other parts of the coast. It is spindle-shaped in outline, quite strong and thick for so small a shell, and is distinctly marked with fine spiral grooves. The aperture is oval, the canal sometimes open and sometimes tubiform. While the spiral lines are prominent, the transverse sculpturing is faint. The color is reddish-yellow, though sometimes it is nearly white. At low tide I have found living specimens, the size of the figure clinging to stones.

The southern form of this species, known as variety *munda*,

Fig. 165, x $\frac{1}{2}$ Fig. 164, x $\frac{3}{4}$ (*)

Cpr., shown in Figure 164, which is much enlarged, has low, rounded, transverse ribs, not varying from suture to suture. It is also marked with regular spiral lines. Its length is 16 mm.

Ocinebra michaeli, Ford, Michael's *Ocinebra*, two good views of which are shown in Figures 165 and 166, occurs at Cayucos, San Luis Obispo Co., California. The color of the shell is light gray, with a narrow median band of brown. The figures give excellent details of the shell, though it must be remembered that they are much enlarged, the real length being only 16 mm. The shell was named for Mr. G. W. Michael, who collected the first specimens.

Fig. 166, x 1

Ocinebra poulsoni, Nutt., which somewhat resembles Figure 158, has a strong, spindle-shaped shell, from one to two inches in length. The shell is rather more slender than the figure, and it has a distinct trace of an umbilicus.

Its surface is strongly marked with knobby varices, which are crossed by slight spiral ridges and fine, dark spiral lines. The walls of the aperture in mature specimens are pure white, and within the outer lips are five or six little round tubercles, or teeth. The canal is open and somewhat curved, and the operculum is a thin, brown scale. The exterior of the shell is gray, while the inside is white. This fine species lives in southern waters, and I have collected beautiful specimens at San Pedro.

Urosalpinx cinereus, Say, the Oyster Drill, is an

eastern species found in San Francisco Bay, especially around the oyster beds. It was probably introduced with young oysters from the Atlantic coast as were so many of the foreign creatures found in that bay, and it has now become quite common. In size and appearance it considerably resembles *Murex circumtextus*, Figure 157, but the shell is thinner and the spire longer and more pointed.

In fact, my first knowledge of its existence in San Francisco Bay was brought by a bright boy who told me that among the shells he had gathered on the Alameda beach were specimens of *Ocenebra circumtexta*. I knew that that species loved the breakers of the sea too well to flourish in the calm waters of a quiet bay, and I assured him that he must be mistaken; but he brought specimens to prove that he really had found the shells, and then it became evident that an unexpected species had appeared.

As the name indicates, the shell is ash-colored, though it is reddish internally. Specimens may readily be captured at low tide, and often the little egg-vases may be observed, attached to stones or posts. This species is not a welcome addition to our western fauna, for the "Drill" is a determined enemy of the oyster, boring holes into the young ones and quickly destroying them. It is thoroughly detested by the oystermen, who would be glad to exterminate the whole species.

Our next species is named *Trophon belcheri*, Hds., Belcher's Trophon, (*Chorus belcheri*). This large mollusk, whose shell is so well shown in Figure 167 is found chiefly on the coast of southern California.

It is one of our largest shells, the picture being much smaller than the real shell, and specimens have been found which are fully six inches in length. Its color is dull white, somewhat tinged with brown. Specimens may sometimes be picked up on the mud-flats, at the time of low tide. And right here let me remind you what a boon to collectors the ocean tides are. A large strip of land is frequently laid bare, enabling the seeker after shells and other sea-treasures to walk safely where a few hours before the waves had been tumbling over one another.

Fig. 167

The shell of this species is pear-shaped, and it ends in a long canal, to the left of which is a deep, funnel-shaped umbilicus. The spire is beautifully crowned with circles of sharp horns, and about the middle of the outer lip there is a large, pointed tooth.

We now come to the Purples, which received this name not because the shells are of a purple color themselves, but because in olden time a purple dye was prepared from the bodies of similar mollusks. This was especially true of a small *Murex*, *M. trunculus*, that lived in the Mediterranean Sea, and the inhabitants of ancient Tyre were peculiarly skilful in preparing the rich "Tyrian Dye."

How beautifully the different sciences are joined together. The study of conchology calls up pictures of the long ago, and cities of the Mediterranean come trooping past us, their inhabitants clothed in strange garments, which reflect bright colors in the light of the summer sunshine. Ancient ships again sail our seas, the shrill cries of the sailors and oarsmen mingling with the whistling of the winds through the cordage, and the splashing of the salt spray against the prows of the triremes. Again with Saint Paul we listen to the roar of the tempest from the deck of a stranded vessel that is fast going to pieces, and with him and all on board we escape to the shore of the island and enjoy the hospitable care of its rude but kindly inhabitants. History, geography, even religion itself come bringing their treasures as we blow a blast on a sea-god's trumpet, and voices from all around the world, both modern and ancient, tell us their stories as we hold an empty sea-shell to our listening ear.

Happy is the child, happy is the man, who sees in the shells of the seashore far more than lumps of limestone, far more even than lists of Latin names, but to whom they also speak of Nature's beauty and of the struggles of humanity. We cannot all be great scholars, we cannot all be familiar with foreign languages or the history of distant nations; but to each one of us the shells of the shore may speak of beauty and truth, of hopeful trust and providential care, of duty and loving obedience; and we may go back to our humdrum work with fresh courage, and take up our daily duties with a firmer faith that they all

are needed links in the great chain that binds earth to heaven.

As already explained the name *Purpura* is now applied to certain members of the *Murex* family. The familiar shells that formerly bore that name are now called *Thais*, a name given by Bolten in 1798. While this will be the Latin name, there is no objection to calling them Purple-shells as before.

Most of our Purples prefer to live where they will get frequent changes, for we find them selecting as a home those rocks that are alternately left bare and then covered again by the tide. They are carnivorous creatures, and like the Oyster Drill they can bore through the thin shells of bivalve mollusks, and then devour the poor inhabitants. We have but few species on this coast, but some of those furnish very numerous specimens. The first and most common kind is named *Thais saxicola*, Val., the Rock Purple, (*Purpura saxicola*), Figure 168. Though the cut is larger than the average shell, specimens are sometimes found that fully equal it in size. The shells differ much in details, even in specimens living near each other, and it is no wonder that many different names have been given to the varieties. In general the spire is short, the columella flattened, the outer lip thin, the aperture large, and the interior of the shell of a chestnut color. Sometimes the outside is smooth and almost black, sometimes the shell is light colored and coronated, but often it is of a dingy

Fig. 168, x $\frac{3}{4}$

white, decorated with double spiral bands of dark brown, accompanied with spiral grooves. The Atlantic Purple, *T. lapillus*, exhibits similar variations.

Fig. 169

Thais lima, Mart., the Grooved Purple, (*Purpura lima*), Figure 169, is more rarely met with than the last species, probably on account of its living in deeper water. The shell is commonly larger than that of the last species, while in appearance it is more smooth and symmetrical. The spire consists of four whorls, separated by distinct sutures. The distinguishing feature, however, and the one which gives the name to the shell is the presence of about fifteen spiral grooves on the whorls, giving its surface somewhat of the appearance of a coarse file. The operculum, as in all of the Purples, is thin, horny, and somewhat oval in shape. This is a very distinct species, and may be easily recognized by its rounded and channelled whorls. In northern waters the specimens are somewhat more similar to the last species, but a little care will easily separate them.

Another Purple, which lives in San Francisco Bay, but is more highly developed a few hundred miles to the northward, is named *Thais lamellosa*, Gmelin, the Wrinkled Purple, (*Purpura crispata*). A rather poor figure of a small specimen is shown in Figure 170. Specimens from Puget

Fig. 170, x 3

Sound are beautifully frilled and richly painted with brown bands. The shells are strong and heavy, and they have an average length of an inch and a half to two inches. Some are nearly smooth, while others are extremely wrinkled. Though the smooth, white varieties are very plain in their appearance, some of the northern beauties, all frilled and banded as if to attract attention, are worthy of a place in any choice collection of handsome shells.

Closely related to the Purples are the Unicorn-shells, a small group of mollusks which are almost exclusively confined to the west coast of America. Their former name referred to the fact that a little horn is developed on the edge of the outer lip, near the canal, as is well shown in Figure 171, of *Monoceros engonatum*, Conr., the Angled Unicorn, now called *Acanthina engonata*. These animals are usually found clinging to rocks under a heavy growth of seaweed. The shells themselves are almost the same color as the stones to which they are attached. The second name of this species was suggested by the fact that the whorls are sharply angled, quite in contrast to those of the next species.

Fig. 171

Fig. 172

Acanthina lapilloides, Conr., the Pebbly Unicorn, (*Monoceros lapilloides*), Figure 172, has a very pretty little shell, about an inch in length, with a spire of four whorls, a rather small aperture within which are several knobs or teeth. It is well named,

for it distinctly resembles a rolled pebble of granite, and the word "lapilloides" means "like a little stone." It might properly be added that this species is so closely related to the last that it is sometimes difficult to certainly separate them, in which case doubtful specimens should properly be referred to *A. engonata*. An orange-colored variety found on the rocks at San Pedro is called var. *aurantia*, Dall. Both of the foregoing species are now considered as varieties of *Acanthina spirata*, Blain.

Acanthina lugubris, Sby., the Sad Unicorn, (*Monoceros lugubre*), is found in the extreme limit of our territory, though its true home is on the west coast of Mexico. It has a thick, heavy shell, about an inch long. The wall of the aperture is of a brown color, and it is marked with several rows of white tubercles. The little horn near the canal is very distinct.

It is now our pleasant task to consider a few species of pure white shells, regularly marked with frequent varices. All of them are quite rare, but if you search along the shore you will probably have the good fortune to find one or more of them.

Fig. 173

The first one is shown in Figure 173, and is named *Epitonium (Opalia) borealis*, Gld., the Northern Opal-shell. It consists almost wholly of a long spire, composed of about eight whorls, each of which is crossed by eight blunt ridges, or varices. The aperture is entire, and the rounded lips are sometimes stained

by the rich purple juices of the animal. The operculum is a brown scale, nearly circular, and showing lines of growth. The color of the shell is white, and its common length is about an inch.

In Figure 174 is shown the beautiful shell of *Epitonium hindsii*, Cpr., (*Scala hindsii*), the White Wentletrap. It is pure white in color, very delicate, and is generally less than an inch in length. The whorls are very distinct, finely rounded, and each one is crossed by about twelve thin, sharp ridges. These shells are so highly prized that they have been worn as the drops of ear-rings. There is a large Chinese wentletrap, as all of these white shells are called, that is so rare and beautiful that it has actually been sold for a hundred dollars, or even more. And it is even said that the astute Chinaman,—who from the days of Bret Harte has been called “peculiar,”—it is said that he used to artificially construct a wentletrap from a preparation of rice, which was so natural that many purchasers were deceived and thought that they had secured a valuable treasure. The White Wentletrap is found on the southern shores of California.

Fig. 174

Epitonium indianorum, Cpr., (*Scala indianorum*), the Indians' Wentletrap, is a species found more commonly in the north, especially about Puget Sound. It has a thicker shell than the last species, more whorls, more varices, and less prominent sutures. The name Wentletrap is derived from a Dan-

ish word meaning "a spiral staircase." It has long been in use in literature, and it very properly takes the place of the old name, Ladder-shell, which itself was derived from the names *Scala* and *Scalaria*, both of which have now been laid aside.

Epitonium bellastriatum, Cpr., (*Scala bellastrata*), the Striped Wentletrap, is easily identified from the fact that between the varices fine spiral ridges may be seen, winding upward toward the apex. The spire is short, the last whorl quite large, the varices very numerous, and the sutures so deep that they almost entirely separate the round whorls. The length of a grown specimen is 15 mm. My shells came from San Pedro, but it is also reported from Monterey.

Epitonium crebricostatum, Cpr., (*Scala crebricostata*), the Close-ribbed Wentletrap, has a white, polished shell, with about fifteen sharp, thin, reflexed varices to a whorl, which form a kind of crown at the shoulder. It is about the same size as the last species, and it is found from Monterey to San Diego.

Epitonium (Arctoscala) greenlandicum, Perry, the Arctic Wentletrap, has a larger and more solid shell. A specimen from Wrangel, Alaska, measures over an inch in length, and is nearly half an inch in diameter at the base. The shell is dull gray in color, strongly marked with spiral ridges, while the low, solid reflexed varices number about nine to the whorl, and the whorls are as numerous as the varices.

Out on the wide ocean lives the Violet Snail, *Janthina exigua*, Lam. It is kept at the surface by a singular raft which it secretes, and it feeds upon

small jelly-fishes. The shell is small, and is shaped much like that of a land snail. It is thin and delicate, and has a deep notch in the outer lip, The color is deep violet, quite unlike that of any other shell. Though it usually lives far out at sea, some shells get washed to the shore; but they are comparatively rare on our coast. Specimens of another species of *Janthina*, *J. globosa*, Swains, has been found on our southern shores. They should be carefully looked for by all collectors.

Eulima micans, Cpr., the Shining Eulima, comes next on our list. This species has a beautifully polished and delicately tapering shell. The apex is very sharp, and the oval aperture is somewhat elongated. Large specimens grow to the size indicated by the cross in Figure 175. The color is nearly all white, though the shell is somewhat dark near the apex. It could hardly be mistaken for any other species. It is found from British Columbia to San Diego.

Fig. 175

Eulima rutila, Cpr., the Red Eulima, resembles the last species, but is very small and slender. Its color is rosy, and the base of the shell is lengthened. It has been reported from Monterey, and perhaps from other localities.

There are several other species of *Eulima*, the shells of which are small, being only a quarter of an inch in length or perhaps even less. One of these is known by several synonyms: *E. distorta*, *E. incurva*, and *E. falcata*. Its shell is curved, as all of these names indicate. It has a variety with the singular name of *Eulima yod*.

Fig. 176, $\times \frac{3}{8}$ (*)

Having studied small shells for some time we turn now to a large one, shown in Figure 176, named *Scaphella stearnsii*, Dall, Stearns's Volute. This great shell, which is nearly six inches long, comes from northern Alaska. The inner layer is purplish, while the outer, which resembles porcelain, is bluish white. Note the distinct folds on the columella.

Scaphella arnhemii, Rivers, Arnheim's Volute, dredged from Monterey Bay a number of years ago, resembles the last species, but is only half the size.

The color is yellowish, and the folds on the columella are four in number. It is to be hoped that more specimens of this fine species may yet be obtained from beautiful Monterey Bay.

We are now to consider the *Pyramidellidae*, a family of small mollusks, having turreted shells with a plicate axis. The three principal genera are *Pyramidella*, *Turbonilla* and *Odostomia*. Most of the shells are too small to attract much notice, except from experts, and a careful examination of them must be made with the aid of a microscope if they are

to be properly classified. Descriptions of a very few of the larger forms will now be given, and the names of some others which occur in our territory will be given in the alphabetical list of shells, near the end of the book. For a careful study of this family we are most happy to refer the student to Bulletin 68, of the United States National Museum, entitled, "A Monograph of West American Pyramidellid Mollusks by William Healey Dall and Paul Bartsch." It was published at Washington late in 1909, after years of careful research. To learn more about it write to the Secretary of the Smithsonian Institution.

Pyramidella adamsi, Cpr., (*P. conica*, var. *variegata*), the Obelisk-shell. This little shell is shown in Figure 177. The surface is marked with fine lines of growth. There is an external fold on the columella which is not well shown in the little cut. The shell is brownish in color, somewhat clouded. It is found in southern waters, but it is quite rare even there.

Fig. 177

Fig. 178

Turbonilla castanea, Keep, the Chestnut Turbonilla, is shown in Figure 178, the little cross denoting the true size of the shell. Its eight or ten whorls are marked with numerous fine axial ribs, and though it is so small it is a beautiful shell. Its color is chestnut brown, as might be expected from its name. It is found at San Pedro and San Diego. The general shape of all the *Turbonillas* is shown in this figure, but they differ much in sculpturing, number of whorls, and other particulars.

Fig. 179

The *Odostomias* have polished, white shells, less slender than those of the last genus. On the columella is a fold like a tooth, as their name indicates. There are a good many species, most of which are very small. One of the largest shells is rather poorly shown in Figure 179. It is known as *Odostomia satura*, Cpr., the Full *Odostomia*, (*O. pupiformis*). This shell is beautifully white, not very thick, with deep sutures

Fig. 180

and a microscopic network of extremely fine lines. It is about a quarter of an inch in length, and it ranges from Neah Bay to unknown distances.

Odostomia nuciformis, Cpr., the Nut-shaped *Odostomia*, is also a northern species, though it sometimes grows a little larger than the shell last mentioned. It is rather stout and inflated and has a large body-whorl. The shell is white and solid, and the columella has a strong fold.

Other species will be mentioned in the list, but it is hoped that these few samples will be enough

to enable young collectors to determine at least the generic name of a good many small shells.

Of a shy little Indian girl, in the village of Metlakatla, Alaska, I bought the shaggy shell, a drawing of which is shown in Figure 180. Its name is *Argobuccinum oregonense*, Redf., and it is otherwise known as *Triton*, *Tritonium*, and *Priene oregonense*, any one of which may mean the Oregon Triton. It is found in northern waters and it is a very unique species, easily recognized by its fusi-form shape, numerous varices, and its hairy, brownish epidermis. The inside of the shell is pure white. It has been reported as far south as Monterey.

Another fine Triton, a beautiful picture of which is shown in Figure 181, is named *Cymatium corrugatum*, var. *tremperi*, Dall, Tremper's Triton. The shell is spindle-

Fig. 181

shaped, the canal long and somewhat curved backward, and the operculum is oval and horny. There are large white teeth inside the outer lip. The epidermis is brown, the shell white, and the varices give the whole a somewhat triangular aspect. Its length is three and a half inches. It was taken, October, 1907, in the outer San Pedro Bay, from water forty feet deep, and it was living when captured. It greatly resembles *Triton corrugatum*, Lam., which lives in the Mediterranean Sea. It is interesting to know that quite a large number of other shells from our coast closely resemble Mediterranean species. This shell was named in honor of Dr. R. H. Tremper, of Ontario, Cal., the owner of the unique specimen, who has kindly deposited the same in the National Museum.

Another of Dr. Tremper's rare specimens is *Triton gibbosus*, Brod, the Gibbous Triton. This shell has five whorls, the suture is extremely deep, the spiral ridges finely beaded, the aperture nearly circular, the canal long, nearly closed, and curved backward. There is no epidermis, the color of the shell is dark, while the varices are brown and white. Its length is two and one-fourth inches and its breadth is one inch less than its length.

Gyrinium californicum, Hds., California Frog-shell, (*Ranella californica*), is well represented in Figure 182. This fine shell is more common in the south, though some excellent specimens have been collected in Monterey Bay. The shell is very strong and solid, and on its surface are many knobs and ridges. It appears to grow forward about half a whorl and

then pause and build up a thick lip. Leaving this ridge it goes on and completes the whorl, and then forms another varix. The result of this singular mode of building is a shell with two ridges extending from the apex to the canal, on opposite sides of the whorls, giving the front of the shell a somewhat flattened appearance. The external color is yellowish brown, but within it

Fig. 182

is white. The common length of one of these shells is three inches, though some of them grow to twice that length, and thus rank among our largest shells.

Figure 183 gives us a somewhat enlarged representation of *Pedicularia californica*, Newc., the California Pedicularia. In this shell the aperture and

Fig. 183

outer lip are greatly extended, and the spire is completely hidden. The inside of the shell is smooth and glossy, but the outside is slightly roughened. With the aid of a microscope one may see a fine system of minute lines and meshes. Its color is peculiar for a shell, being a rich, rosy pink, very beautiful. These little shells are found on the stems of sea-fans, popularly known as corals, which are brought up from tolerably deep water. To these they cling like a parasitic insect; hence their name, which really means louse-shell. When fully grown the shell may be nearly half an inch long, though most specimens are much smaller.

Fig. 184

Another fine shell found on our southern coast is the one shown in Figure 184, and which is named *Cypræa spadicea*, Gray, the Nut-brown Cowry. It is our chief representative of the great genus which is so abundantly developed in the warmer oceans. Cowries have smooth, well-rounded shells and are great favorites with the children, who delight to use them as playthings. In fact, they have a great variety of uses, taking the place of money among some of the tribes of Africa, large, mottled ones being used by old ladies to aid them in darning stockings, while certain rare and beautiful specimens were formerly worn by the favored chiefs of cannibal islands as a token of royalty. Certain it is that large, showy cowries are now used by the natives of Hawaii as bait to lure the highly prized octopus to their hooks. In the cabinet of the naturalist there are few finer collections than the drawer of choice cowry-shells. When young, the shells are thin and conical, with a short spire and a large aperture. As time goes on the outer lip increases in size and thickness, while the spire becomes completely hidden under the advancing whorls.

Coming back to our one cowry, we may say that in color the lips of this shell are white, while on the back there is a ring of dark brown, with a central part of a lighter shade of the same color. I have in my collection an unusually large specimen which is over two inches in length, but such a size is the exception. This species is found in the south, but never

in great numbers. It has also been found as far north as Monterey. When taken alive it is one of our most beautiful shells. Dead specimens, which have been knocked about and defaced, are far less bright and glossy.

The little Coffee-bean shell, *Trivia californica*, Gray, two views of which are shown in Figure 185, is eagerly sought by many children, who search in the sands

Fig. 185

for pretty treasures. Like the real coffee-bean, one side is flat, while the other is rounded and plump. The surface is marked with a dozen sharp ribs, and the long, narrow aperture is set with many small teeth. The general color of the shell is reddish chocolate, though the interior is white.

Trivia solandri, Gray, Solander's *Trivia*, is a Mexican species, but it reaches as far northward as Santa Barbara. It resembles the last shell, but is twice as large, and is marked by a deep, longitudinal canal on the back of the shell.

Trivia ritteri, Raymond, Ritter's *Trivia*, has been dredged at various points along the coast of California, chiefly in the vicinity of Catalina Island. The shell is small, white, well rounded, and is marked with about 20 sharp, narrow ridges. Its length is about ten millimeters.

Fig. 186

Somewhat like a very long and narrow cowry is our next species, named *Ovula deflexa*, Sby., var. *barbarensis*, Dall, the Pink Egg-shell, shown in Figure 186. In appearance it is unique, looking more like a roll of shell than a spiral whorl, and tapering almost

equally toward either end. The aperture is very long, the outer lip thickened, the spire concealed, and the sculpturing microscopic. The color is pink, and the length is rather less than an inch. It is found sparingly at Monterey, Santa Barbara, and elsewhere.

A small species, usually of a purple color, is named *Ovula variabilis*, C. B. Ad., the Variable Ovula. It is probable that there are still other species or varieties of this difficult genus.

Fig. 187

We have two other species somewhat resembling the cowries. The first is named *Erato vitellina*, Hds., the Veally Erato, shown in Figure 187. The shell is pear-shaped, or rather balloon-shaped, and it is quite smooth. It is of a dark reddish-brown color, though the toothed margin of the aperture is white. The ordinary length of the shell is about half an inch. Really good specimens are not numerous.

Erato columbella, Mke., the Dove Erato, Figure 188, is very small and delicate, but is well worth searching for. As shown in the figure it has a visible, but short spire, and a long aperture with toothed lips. These are white, but the back is olive-brown. Dead shells may be rather frequently found, and living specimens have been obtained at low tide.

Fig. 188

Fig. 189

Figure 189 gives us an enlarged view of *Cerithiopsis tuberculata*, Mont., the Tuberculated Horn-shell. This pretty little species has a small shell, about the length of the cross shown in the figure. The spire consists of six

or seven whorls, well sculptured, and is of a dark brown color; the sutures are conspicuous.

There are several other species of these small shells, one of which, *Cerithiopsis purpurea*, Cpr., the Purple Cerithiopsis, is reported by Berry as being rather common at Pacific Grove, though the shells are dead. The nodules on the shell are fine, and it is stained with purple, giving rise to the name.

Bittium filosum, Gld., the Threaded Bittium, is shown in Figure 190. This fine little mollusk may be found in large numbers by turning over stones at low tide and carefully searching for diminutive shells.

Fig. 190

It is seldom that a dead shell is found in such a position without a tiny hermit-crab inside, and at first glance it looks as if the shells were running away without any apparent means of propulsion. The shell is shaped like a short, stout thorn, and it varies in length from one-fourth to one-half of an inch. The whitish or brownish whorls are eight or ten in number, and are marked with slight, spiral grooves.

Bittium esuriens, Cpr., the Hungry Bittium, is "like a starved *filosum*, very narrow, the adult scarcely sculptured." It is found all along the coast.

Bittium quadriflatum, Cpr., the Four-lined Bittium, is a southern species. In shape it is a regular but very slender cone, and the whorls are marked with four equal spiral threads which coil over slight cross-ribs. There are several other species of this genus which are occasionally found, and which differ chiefly in the sculpturing of the whorls.

Seila assimilis, C. B. Adams, the Threaded Seila, has a slender shell, ten millimeters in length, consisting of ten whorls, round which run three strong spiral ridges, winding from the apex to the aperture. It lives from Monterey southward to Panama.

CHAPTER IX

SHELLS WITHOUT CANALS

It is always pleasant to find a living specimen of a mollusk about which you have been studying. To have an empty shell in your cabinet is a satisfaction, but it is much more satisfying if you can call upon the creature in his own home, observe his every-day life, see how he associates with his fellows, find out, if possible, when he gets up, what he eats for breakfast, what he is doing when the whistle blows for noon, whether he indulges in an afternoon nap, and all the other occupations and habits that he may choose to display, or that you are able to learn by watching him on the sly. By getting at these things you come to really know the animal, so far as such knowledge is possible.

It is so right through life. The boy or girl who observes, watches, examines, and gets all there is out of any subject, is the one who will probably amount to something when he has become a man or she has become a woman. It does not matter so much what the thing is; it may be a shell or a seed; a sentence, a Latin verb, or a frog pond. It may be a map, an equation, or a sermon; the thing to do is to attack it with energy and learn all that you possibly can from it. And you may be sure that there are very few things that do not conceal far more than is evident on the surface. My advice to every young

person who reads these lines is to attack each opportunity with real enthusiasm, and to learn to get a tremendous amount of fun out of the most stubborn and dry looking duty that ever stood in your pathway. Most good things in life are not like soft boiled eggs, whose shells you can crack with a teaspoon; on the contrary they are like hickory nuts, that require an anvil and a hammer if you are to get out the sweet meats, nice and whole. But this little sermon has led us far afield, so we will now return to our shells.

My first opportunity to gather any of the shells mentioned in this book occurred many years ago. The place was a shallow arm of San Francisco Bay, and the shell was the one shown in Figure 191. I shall never forget the pleasure I felt as I saw them lying by dozens and hundreds on the surface of the mud, after the tide had gone down. They seemed to be enjoying the fresh air, and displayed no anxiety for the return of what we are accustomed to call their native element. Similar species in other countries spend so much of their time in the air that they have been mistaken for land shells.

The name of this species proved to be *Cerithidea californica*, Hald., the California Horn-shell. But I was as ignorant of the proper care of the shells as I was of their name; and a pretty source of trouble they were to me, for I had not learned how to clean them correctly, a process that has been explained on a previous page.

Fig. 191

The shell in question is an inch or more in length, and consists of about ten strongly ribbed whorls. The outside is dull and black, but the inside is of a glossy brown. The aperture is entire, that is, it has no canal, and it is closed by a thin, brown, circular operculum. This species extends at least as far south as San Diego. There are several varieties, differing somewhat from typical shells, one of which, var. *pullata*, Gould, is heavily ribbed; another, var. *hyporhyssa*, Berry, is unusually smooth and tapering.

Trichotropis borealis, Br. & Sby., the Northern Hairy-shell. This species has a short spire, strongly shouldered whorls which are hairy on the ridges, and a distinct umbilicus. There are many varieties, but the average length is about one inch. This species inhabits the Arctic waters on both sides of the continent.

Trichotropis cancellata, Hinds, the Checked Hairy-shell, has a longer spire than that of the last species, consisting of about seven whorls. The epidermis, which is somewhat hairy, is light brown or grayish, and the aperture is often pink. It ranges from Alaska southward to Vancouver Island, where it is said to occur abundantly.

Figure 192 shows us an enlarged view of *Anaplocamus borealis*, Dall, the Northern Anaplocamus. This singular shell, which much resembles some that live in fresh water,

Fig. 192

comes from considerable depths off the coast of Alaska. It is bluish white in color, but it has an olive-brown epidermis.

Cæcum californicum, Dall, the California Tube-shell, is the next species to be considered. This singular species differs much from any that have gone before. The shell is a little white tube, 3 mm. long, slightly curved, and showing under the microscope that it is made up of many small rings.

Cæcum crebricinctum, Cpr., the Close-ringed Tube-shell, resembles the last species, but it is nearly twice as large, and it is marked with exceedingly fine rings, sometimes quite indistinct. Both of these species are found mostly in the south.

Vermetus lituella, Morch, is the Crooked Worm-shell. This singular mollusk has an irregular, tubular shell, which becomes attached to the side of a stone and twists itself into an ill-shaped, flattened cone. Several specimens are frequently found near one another. The shell is often angular and roughened; the aperture is circular, and is only one-eighth of an inch or less in diameter. The color, as in that of the following species, is a dingy white.

Vermetus squamigerus, Cpr., the Scaly Worm-shell, is a very much larger creature. It is extremely irregular, many specimens frequently growing together upon a rock, and looking like a heap of contorted snakes. The shell is marked throughout its length by transverse, scaly ridges. The aperture is circular, one-fourth of an inch across. If the tube were straightened it would measure some four inches or more in length. The operculum is circular. I once

found a few living specimens at Monterey, but it is rare so far north. Many of these more uncommon species may be found by wading into the water at low tide, and turning up stones or bringing them out to dry land for closer examination.

Turritella cooperi, Cpr., Cooper's Tower-shell, is shown in Figure 193. This southern species has a very slender, many whorled spire. The sutures are distinct, the aperture circular, and the outer lip sharp and thin. The color is yellowish, though it is somewhat spotted with brown. It can hardly be mistaken for any other shell. It is found on sandy beaches between tides.

Fig. 193

Tachyrhynchus tenuisculptus, Cpr., the Little Tower-shell, is like a minute specimen of the last, and is found on mud-flats along the southern coast. The usual length is less than one-fourth of an inch.

We are now to study the Littorines, or Shore-shells, for that is what the name means. They are the first shells that you commonly meet when you go down to a rocky coast, for they perch high up on the rocks where they will get only a sprinkle of spray now and then, when the waves are quite strong. They do not stay there all of the time, to be sure, and they are quite at home under water; but as a general thing they prefer a roosting place where they will be uncovered most of the time.

In general the littorines have fairly round shells, about the size of small peas. There is no canal; but

the aperture is nearly circular in shape, and it is closed with a thin, horny operculum. As you find them perched upon the rocks, quietly resting till the time of the next high tide, you will note that a little part of the "foot" of the animal must be outside the shell, to enable him to cling securely to the rock. But the portion is very small, and just how the creature fixes himself so that he will not roll off and at the same time not dry up is something to be investigated.

If you brush them off, however, the whole foot is immediately retracted, and the aperture is securely closed with the operculum. If you then put them in a bowl of sea-water or drop them into a tide-pool the little black animal quickly emerges from the shell and begins to rapidly creep along the smooth surface towards the upper air. Some of them will live a long time out of water, and can safely be sent from one port to another.

The food of these little animals is vegetable matter, especially the minute plants that form the thin green coatings upon the stones. This is scraped off by means of the little hooked teeth which grow upon the tongue, or ribbon, with which the mouth of most mollusks is provided. In respect to their food they present quite a contrast to the purples, nassas and other mollusks having siphons, that we have been considering. Those creatures are flesh-eaters, and they often use their sharp teeth as instruments to enable them to break into other mollusks' houses. And so we have a kindly feeling for the littorines

which properly live their quiet lives, without ever even attempting to murder their neighbors.

Our first species, *Littorina scutulata*, Gld., the Checkered Littorine, is shown slightly enlarged in Figure 194. The shell is usually of a greenish or brownish gray color, with more or less white bands or checks. Within the aperture the fresh shell has a decidedly purple tint. The shells differ greatly in size, young ones being very small, while you sometimes find old specimens as large as the picture.

Fig. 194, x $\frac{3}{2}$

Fig. 195, x $\frac{1}{3}$

Littorina planaxis, Nutt., the Gray Littorine, is well shown in Figure 195. This species commonly has a somewhat larger shell than the last, but it is easily distinguished by the fact that it has a flattened columella, which seems to be dissolved away by the animal in advance of the growing whorl. The shells of this species are more rounded and less finely colored than those of the last, but the two are often found closely associated. Young specimens sometimes have shells banded with white, but there need be no hesitation in determining the species, for the flattened columella is a sure mark of identity.

The third littorine, which is found in northern waters, is named *Littorina rudis*, Don., the Rough Littorine. The shell of this bold northerner, in form and size, resembles a large pea. It is easily distinguished from the last species by its rounded columella, while its general surface, instead of being nearly smooth as in the last two species, is marked with a good number of more or less developed spiral

ridges. Its color varies from white to black, but it is usually of a yellowish brown. The edge of the outer lip is always sharp and thin. I gathered a bottle of fine specimens at Old Kasaan, that strange old Indian village in Alaska. This species, which is also known as *L. sitchana*, Phil., comes down the coast as far as Puget Sound, and possibly farther. The other two are found all along the coast.

Littorina pullata, Cpr., the Dark Littorine. This little species lives on the Mexican coast, but it has been found as far north as San Pedro. The shell resembles that of *L. scutulata*, but it is of a dark, reddish brown color, sometimes checked, and there are numerous very fine spiral lines of sculpture. It was described in 1864.

Fig. 196, $\times \frac{5}{2}$ (*)

Littorina aleutica, Dall, the Aleutian Littorine, Figure 196, is found in the far north, as its name indicates. The broad pillar, or columella, of the shell is white, the aperture is dark, while the outside of the shell is yellowish brown. An end view is given in Figure 197. The pictures are considerably mag-

nified, the real diameter being about twelve millimeters.

Another shell from the same locality is shown in Figure 198. It is named *Littorina atkana*, Dall, the Atka Littorine. It is a large shell, 20 mm.

Fig. 197, $\times \frac{5}{2}$ (*)

high, and its surface is nearly smooth. Most specimens are chestnut-brown throughout, but some have bands, as is shown in the figure. The columella is broad and white.

Closely allied to the littorines are the little Chink-shells, a little picture of one of them being shown in Figure 199. Its name is *Lacuna uni-*

Fig. 198, $\times \frac{1}{2}$ (*)

Fig. 199

fasciata, Cpr., the One-banded Chink-shell. It is a very little thing, about one-sixth of an inch in length, and it consists of but few whorls. Externally it is brown and glossy, with the color broken into dots on the keel of the body-whorl. The aperture is semi-lunar in shape, and the flattened columella has a small umbilical fissure, from which circumstance it receives its name. It is well worth looking for, and may often be found on sandy shores, while living specimens may sometimes be gathered at low tide.

Lacuna porrecta, Cpr., the Wide Chink-shell, resembles the last figure, but is broader and more compact. The umbilical chink is large and the outer lip is extended. It is found living on kelp.

Lacuna solidula, Lov., the Solid Chink-shell, is a species found chiefly in the north. It is large, having a shell nearly half an inch long. There are three or four whorls, smooth and strong. The umbilicus is small, the columella white in color, though the general surface is brown.

Lacuna variegata, Cpr., is the Striped Chink-shell. The shell of this species is tall, effuse, and it has a wide chink. In color it is clouded or has zigzag stripes. It lives on the coast of British Columbia, and it may be found on the green *Zostera*, or Eel-grass.

Fossarus (Isapis) obtusus, Cpr., the Obtuse Isapis, has a roundish little shell, a quarter of an inch long or less. The aperture is oval, and the outer lip is diversified by shallow, spiral grooves. There is a small umbilicus. The spire is small and few-whorled, and the color is light brown.

Fossarus (Isapis) fenestratus, Cpr., the Windowed Isapis, resembling the last species, but is marked with sharp spiral ridges, about twelve of which may be seen on the body-whorl. The outer lip is thin and the umbilical chink is small. Its length is 8 mm. and it is 7 mm. in breadth.

Truncatella Californica, Pfr., the California Looping-snail, lives about salt marshes and upon seaweeds and stones. The little cylindrical shell is smooth, light brown in color, with a horny operculum, and is less than a quarter of an inch in length. The surface is smooth, and there are distinct sutures between the whorls.

Fig. 200

A far different shell is shown in Figure 200, which gives us an inside view of the tent-shaped shell of *Crucibulum spinosum*, Sby., the Cup and Saucer Limpet. The saucer is more or less deep, brownish in color, and set on the outside with numerous

spines. The cup is small, white and triangular. This species assumes many forms, and is sometimes almost white and free from spines. It has been found as far north as Monterey, but its home is along the southern coast.

Calyptræa mamillaris, Brod., the Chinese Hat, has a white shell, of a low conical shape, running up to a point, while inside there is a twisted deck, thin and sharp, reaching nearly to the margin. Sometimes this shell has a diameter of an inch or more, though usually it is considerably smaller. It is said to extend from Puget Sound to Central America, but it is not a common shell on our coasts. It was dredged by Lowe and Roper off San Pedro. This species is also known by the name *Galerus mamillaris*.

There is a large group of mollusks whose shells are somewhat turtle-shaped, with a floor built over a part of the lower surface. When turned over they somewhat resemble a Chinese slipper, with a place for the toes of the wearer's foot. So apparent is the resemblance that they are universally called Slipper-shells.

Crepidula adunca, Sby., the Hooked Slipper-shell, Figure 201, is perhaps the commonest species. The apex is strongly recurved, suggesting the name, and the surface is brown, though the internal deck is white. Living specimens may often be found growing upon other shells, and sometimes they are found piled one upon another three deep. Young shells often have the apical hook quite pointed. Living specimens are often found

Fig. 201

perched upon the shell of the black turban, *Tegula funebralis*.

Crepidula onyx, Sby., the Onyx Slipper-shell, somewhat resembles the last species, but in favorable locations it grows to a much greater size. The surface is somewhat roughened or shaggy, and the apex is on the very edge of the shell. Beautiful specimens are found in San Pedro Bay, some of them measuring fully two inches in length and an inch and a half in breadth. The inside is a rich, dark brown, very glossy, while the deck is as white as the purest marble. There is another name, *C. rugosa*, Nutt., which is applied by some to these, or similar specimens, while by others *rugosa* is considered as a variety of *onyx*. Carpenter believed *rugosa* to be the northern form of the Mexican species, *Crepidula onyx*.

Fig. 202

Crepidula nivea, Gould, (*C. navicelloides*, Nutt.), the White Slipper-shell, Figure 202, may easily be recognized by its color, its flattened shape, and by the thin and delicate deck, which is shown in the engraving. Sometimes this mollusk makes its home upon the rock and the back of his shell becomes rough and discolored; while again living specimens may be found within the aperture of a dead spiral shell, and then the slipper is smooth, curved, elongated, and almost transparent. This species is exceedingly variable, and numerous names have been given to it and its varieties. Its shell conforms to circumstances in a remarkable manner, being straight and narrow if it lives on such a shell as that of *Glottidea albida*,

spiral and thin if found in a dead *Tegula*, and rough and expanded if exposed to the waves. It may often be found under stones. Farther to the south it is sometimes marked with brown. I have chosen the name *nivea*, as it conforms to recent usage, though there is excellent authority for combining this species with the next.

Crepidula lessonii, Brod., Lesson's Slipper-shell, resembles a long, narrow specimen of the last species. The shell, however, is thickened by a number of layers, partly detached at their edges. The color is white. There is also a short and heavy variety, known as var. *explanata*, Gould, which some consider as a distinct species.

There is a small species of this extensive genus which has received the name of *Crepidula dorsata*, Brod., the Wrinkled Slipper-shell. It is nearly circular in outline, thin and flat, with a small, curved, and partially detached deck. This wrinkled brown and white shell is about half an inch across. It is found at points all along the coast.

Crepidula aculeata, Gmel., the Prickly Slipper-shell, is a small southern form. The yellowish-white shell has a low apex, curved to one side, and its surface is diversified with many irregular radiating ribs.

Capulus californicus, Dall, the California Cap-shell, is a recently discovered species, specimens of which are occasionally found in San Pedro Bay, usually clinging to the outside of a large pecten. In shape it resembles a very large *Crepidula adunca*, but there is no deck inside the shell. Externally it has a

brown epidermis, somewhat shaggy, while within it is beautifully white. The length of this fine shell is an inch and a half.

Fig. 203

There is a series of white shells, dead specimens of which are abundant, which present a rather puzzling aspect, and which vary greatly in external appearance. They are not spiral to any extent, but appear like hollow cones, more or less flattened, with the apex to one side of the center. Some of them are singularly like a horse's hoof in shape, while others resemble Figure 203, which represents the species named *Amalthea antiquata*, Linn., the Ancient Hoof-shell, (*Hipponyx antiquatus*). Some specimens are less flattened than the picture, but all are more or less rough and scaly externally, while within you can see the muscle-scar in the shape of a horseshoe. The color is white, and the diameter is about half an inch. Occasionally living specimens may be found attached to a rock. They do not roost upon the rock directly, however, but upon a little shelly plate which the foot of the animal secretes and fastens firmly to the rock below.

Amalthea cranioides, Cpr., the Flat Hoof-shell, resembles the last species, but has a still flatter shell, with the apex somewhat near the center, instead of at one side. Dead shells of this species, and even of the last, are liable to be confounded by the young collector with the upper valves of the Chama. Both shells are frequently thrown up by the waves which sweep over rocky ledges, and they look so much alike that one might almost be excused for making the

mistake. An examination of the inside of the shell will quickly put to rest any doubt about the identity of the species, however, for the Chama has a hinge-tooth, while the Hoof-shell plainly shows the horse-shoe shaped muscle-scar. Some consider this species as only a variety of the last.

Amalthea tumens, Cpr., the Sculptured Hoof-shell, (*Hipponyx tumens*), has a much more regular shell than either of the others. The apex is recurved, and the lower part of the shell is somewhat bearded. Radial lines run from the apex to the edge, and they are crossed by lines of growth. Some specimens greatly resemble a short "horn of plenty." The shells are white in color, while the beard, if present, is light brown. The shells are seldom over half an inch in length.

Figure 204 represents a large shell named *Polynices lewisii*, Gld., Lewis's Moon-shell. It is a member of the Natica family, all the members of which are distinguished for their ferocious nature, so that they might well be called snails of prey.

Plowing along through the wet sand by means of its enormous foot, it no sooner reaches an unfortunate clam than the flint drill which it carries in its mouth is stretched out and begins to accomplish its work of destruction. The helpless clam has no means

Fig. 204

of flight from such an enemy, and if its hard shell is not a protection it is in a sad condition. And indeed the case is sad, for the limestone shell is no match for the quartz drill, and when he has reached the savory meat inside, the robber makes short work of his victim. A high-handed proceeding, no doubt; but then, it contrasts rather favorably with our way of opening clams and oysters.

The size of this shell varies greatly with its age and condition. Specimens have been found as large as six-inch globes, but such giants are not common. They are ordinarily the size of average apples. The color is yellowish white, the surface nearly smooth, and the umbilicus is large. To stop the ample aperture there is a broad, horny umbilicus, brownish in color. The genus *Polynices* includes those shells of the *Natica* family which have horny opercula.

Fig. 205

Figure 205 shows us a fair-sized specimen of *Polynices reclusiana*, Desh., the Southern Moon-shell. This species is a southern form, more smooth and less globular than the last, and it is easily identified by the thick, heavy patch of enamel which ex-

tends down the columella, and nearly or quite fills the umbilicus. The shell is very solid and strong. In color it varies between white and brown. Its average length is perhaps two inches, though many specimens are smaller. The large operculum is thin and horn-like, without any trace of solid shell.

Natica clausa, Brod. and Sby., the Closed Natica, is found on the coast of British Columbia, and in northern waters generally. It resembles Figure 204, but it is easily distinguished by its closed umbilicus and its shelly operculum.

Ampullina purpurea, Dall, the Purple Moon-shell, Figure 206, has a purplish shell, though the patches of enamel near the aperture are white, while the periostracum is olive, with darker streaks. It reaches a length of two inches and it is found in northern waters, as far as Point Barrow.

Fig. 206, $\times \frac{3}{2}$ (*)

Sinum debilis, Gld., the Frail Sinum, (*Sigaretus debilis*), has a delicate, pure white shell, very flat, with a small spire and a very large aperture. The shell is beautifully sculptured with fine rays crossing the lines of growth. Its breadth is an inch or more, and its home is in the south.

Eunaticina oldroydii, Dall, Oldroyd's Natica, resembles Figure 204 in shape, and it is marked with almost microscopic sculpturing. It has been dredged at several places along the California shore, but is still a rare species. Compared with *Polynices lewisii* its shell seems very thin and delicate, indicating that it lives in deep and quiet water. The diameter is about an inch and a half.

Fig. 207

Velutina lævigata, Linn, the Light Velvet-shell, is our next species, and its little shell is shown in Figure 207. The color is light brown, and the aperture is nearly circular. In fresh specimens a velvet-like epidermis covers the shell. It lives in northern waters.

Lamellaria stearnsii, Dall, Stearns's Lamellaria is rather poorly represented in Figure 208. It is pure white, very thin, and has so large an aperture that the interior of the shell is plainly visible. During the life of the animal the shell is wholly covered by the white, translucent soft parts of the living creature. It has been reported from Monterey and San Pedro.

Fig. 208

In *Lamellaria diegoensis*, Dall, the San Diego Lamellaria, the soft parts are bright red in color, and the little shell is 17 mm. in diameter. The animal is much larger, though it is a comparatively small creature.

And now we have come to a very important class of shells, most of which are easily collected and all of which are interesting. But before describing any of them let me have a few words with my younger readers.

Did you ever go camping in the summer? Did you and your friends ever get tired of living in one place all the year, and decide to take a tent and go out to some shady spot and have fun and fresh air and freedom for a little while? I hope so, for there is nothing quite so good as a few days of tent life to brighten up all the rest of the year.

Perhaps your tent was near a mountain stream,

where you could watch the speckled trout in the deep holes; perhaps it was in the woods, where there were great trees watching over you that had been growing for centuries; perhaps it was by the seashore, where you could lie awake at night and hear the waves pounding away on the granite rocks or breaking into foam on the sandy beach; perhaps it was in a field, or even in a back yard; but anywhere under a tent there is a charm which you cannot get anywhere else, try as hard as you may.

Now there is a whole group of mollusks which live in tents all their lives, and they always pitch their tents on the rocks. And each tent is just big enough for one camper to live in; and if the camper grows he builds on an addition to the edge of his tent, and keeps it just big enough to cover him whenever he settles down for a good night's rest.

When you went camping you set up poles and spread the tent-cloth over them, and fastened all down with ropes and pins. But our little mollusk campers make their tents of shell, and they are so stiff and firm that there is no need of poles and ropes to keep them spread.

These little campers are called limpets, and their coverings are sometimes called saucer-shells, for some of their empty tents when turned over might be used for little shallow dishes, like very small saucers. On the coast of Mexico there are some that are large enough for mush-bowls, but they do not grow so large in our part of the ocean.

The west coast of America abounds in limpets. Some species cling to rocks which are seldom covered,

others live half of their lives under water, while a few must be sought at very low tide. Their dead shells are very common objects along the coast, for they are liable to fall victims to some wandering crab if they become washed from their footing. Though they creep around somewhat they usually return to the same spot to roost, and the protecting shell is seldom lifted to any considerable distance above the object to which they cling, and when they are at all disturbed they close it down with force and rapidity. In an especial manner these helpless animals must depend on their thick, hard shell to protect them from injury.

Fig. 209

Acmaea spectrum, Nutt., the Ribbed Limpet, lives far up on the rocks where it receives only a few splashings at high tide. It is gray in color, much like the granite to which it clings. Two views are given of its shell, both of which represent unusually large specimens. Figure 209 gives a good view of the shell as it appears from above, while the other figure, 210, shows a side elevation of the same. Internally the shell is chalky-white with various dark markings, which sometimes bring out "the owl" very distinctly. Look for a picture of that bird in various shells of this class.

Fig. 210

Limpets are easily collected if they are suddenly lifted by means of a broad-bladed knife, but if they have been previously startled it is best to let them

alone, since you will be likely to break the shell if you persist in your endeavor. In some countries limpets are eaten, and vast numbers are used by the fishermen as bait. Notice carefully the broad foot, the mantle and gills, and the short head with its mouth and tentacles. If a specimen is dissected the lingual ribbon may easily be obtained from the mouth, and with a low power microscope the beautiful rows of teeth may easily be made out. After the animal has been removed from the shell observe the horseshoe-shaped muscle-scar.

Acmaea patina, Esch., the Plate Limpet, Figure 211, is one of the most common kinds. The shell is oval and flattened, with an indistinct

Fig. 211

apex near the center. From this radiate fine striae, which are often quite indefinite. The shell is also often partly overlaid with brownish sea-growths. Young specimens are sometimes prettily checked with brown and green. Within the shell there are various markings of brown and bluish-white, with a dark ring around the edge. The common length of the shell is from an inch to two inches.

Fig. 212

Acmaea pelta, Esch., the Shield Limpet, Figure 212, is more conical and pointed than the last, and the outside of the shell has about twenty-five blunt, radiating ribs. Externally it is gray or striped, and is sometimes very beautiful; the inside is mainly

white, though there is often a dark thread around the edge, and a brown spot in the center. A strange form is sometimes found in which the early growth of the shell seems to have been based on a different plan from that of the ordinary specimen, for it is smooth, brown, and has almost perpendicular sides like the limpets that grow on seaweeds; but after that it suddenly changes to the ordinary form. It is probable that this was caused by a decided change in the abode of the limpet, perhaps from seaweed to the rock.

A small, black, conical shell, supposed by Carpenter to be an abnormal growth of the young of the last species, is now known as *Acmaea asmi*, Midd., the Black Limpet. It is usually found living on the shells of the Black Turban, where its dark color keeps it from being conspicuous. It seems to be quite distinct from the last species, being only a quarter of an inch in length, while the ordinary shells of that species are fully an inch long, and sometimes more.

Fig. 213

Figure 213 shows the shell of a large *Acmaea persona*, Esch., the Mask Limpet. This shell may be distinguished by the position of the apex, which is situated very near one end, making nearly all the slope come upon one side, like the roof of an old-fashioned farmhouse. The ribs on the slope of the shell are prominent but irregular. The outside is gray or mottled, and the inside has varying amounts of brown and white. The shell is high arched, but it is always small and seldom grows to the length of an inch.

This species is generally found living where the rocks are seldom covered with water.

Acmaea scabra, Nutt., the File Limpet, is usually of a light brown color externally, while the inside is white. Sometimes the external brown is so light that it is almost yellow, while again the surface may be quite dark. The arch of the shell is generally low, like Figure 211, and there are fine, sharp, scaly ridges radiating from the apex, making the shell feel like the surface of a fine-cut file. Sometimes it is a little difficult to tell a shell of this species from one of *A. patina*, but if you can see the animal you will at once decide, for the head and mantle of the former are black, while those of the Plate Limpet are always white. The ordinary length is about an inch, and the low-arched shell is quite thin. Occasionally very aged specimens are found which have lost all their sculpture and have become very thick. They can be told, however, by the white appearance of the interior of the shell, if the fleshy parts have been removed or are lost.

Acmaea mitra, Esch., the White Cap, Figure 214, generally lives below the tide-mark and is seldom found living, though I have occasionally found them at extreme low tide. The shell is pure white, fairly thick, and has a very pleasing appearance. Many dead specimens are washed up by the waves, and they always find plenty of admirers. Often the outside of the living shell is covered with a growth of small, hard seaweeds, making it rough or irregular, but

Fig. 214

generally it is smooth. The size varies greatly, the figure representing a fairly large specimen, though occasionally an old one is found that is much larger.

Fig. 215

Acmaea incessa, Hds., the Seaweed Limpet, Figure 215, is a common species, and may be found living on the flat central ribbons of the great seaweeds which are so conspicuous along the rocky coast. The sides of the shell are flattened and nearly smooth, and the apex is rounded. The shell is of a dark brown color throughout, and looks as if it were made of horn. It is seldom quite so large as the picture represents.

When the tide is low the huge plants to which these shells are attached lie prone on the rocks, looking like a pile of feather boas. Each one of them has a very strong central rib, with numerous plumes on either side. These are mingled with egg-shaped air bladders, which serve to keep the upper parts of the plant afloat when the tide is in. It is to this flat and extremely tough central portion that the little limpets love to cling, swaying backward and forward with the swing of the billows.

There are other seaweeds which help to cover the rocks, the most common one being a stout, brownish plant, sometimes called kelp, but whose real name is *Fucus*. It is an exceedingly ancient organism, being but little changed from plants that grew in the ocean long before the time of man. Then there are others, some of them red and others green; this one, broad and strong like a piece of leather, while its neighbor

is delicate as a skein of silk. The marine plants are very interesting, every one of them, and are worthy of careful study. As we ramble among the rocks seeking after shells it is pleasant to know and admire the plants among which they are most likely to be found.

Acmaea instabilis, Gld., the Unstable Seaweed-Limpet, is larger than the last species. The shell is more limpet-shaped, but it is narrow and compressed at the sides; its surface is smooth, and its color is brown on the outside and white within. Its length is three-fourths of an inch.

Acmaea depicta, Gld., the Painted Limpet, has a very narrow shell, with straight, flat sides. In color it is nearly white, with fine brown stripes radiating from the apex. It is a little shell, being only from 6 to 12 mm. in length. It is a southern species, and it may be found at low tide clinging to the tough and narrow blades of grass which grows in certain shallow places along the edge of the sea. This so-called eelgrass is not a true grass at all, but a species of *Zostera*, which belongs to the Pondweed family. But it does produce true flowers and seeds, though they are not very conspicuous, and that is more than most of the plants which grow in salt water ever do. All the seaweeds are mere algae, and they reproduce by means of spores, which are far simpler objects than seeds. Moreover they lack certain organs, notably a vascular system, or set of little tubes, which the higher plants always possess. Cut one of the seaweed stalks across and you will see that it is very

different from such a stem as a willow possesses, with pith and rings of minute tubes.

Acmaea paleacea, Gld., the Chaffy Limpet, has a very small shell resembling that of the last species, but still narrower. It is brownish in color, without stripes, and an average specimen is 7 mm. long. *Acmaea triangularis*, Cpr., is probably a variety of the same species.

Fig. 216

The largest limpet found on our coast is the one whose shell is shown in Figure 216. Its name is *Lottia gigantea*, Gray, and it is commonly known as the Owl-shell. On the outside it is usually rough, brown and unsightly; but within it is very dark and lustrous, and it has a bluish-white center marked with

brown. In many specimens the part within the big muscle-scar greatly resembles a horned owl sitting upon his perch. The shell is rather flat, and the apex is near one end. The length of the shell is sometimes as much as three inches, though commonly it is much less. When properly polished, these shells make very pretty bowls for ornamental spoons.

CHAPTER X

TOPS AND TURBANS

We now come to a great group of shells quite unlike any that we have previously considered. In the first place the shells of nearly all of these mollusks are lined with a more or less iridescent mother-of-pearl. In some species the prevailing color of it is green and in others it is red, while in a few the shell is nearly white; but in any case if you turn the shell in the sunlight you will get glimpses of rainbows with their varying tints, sometimes feeble but never absent. In most cases this feature of the inner shell remains not only long after the death of the animal, but long after the shell itself has crumbled into scales and fragments, through exposure to the weather.

The ordinary colors of shells are usually quite permanent but they differ materially in certain respects. Some colors are found only on the surface of the shell, or at most they penetrate but a very little distance. Others go down deep and seem to be made by a mixing of the dye with the substance of the shell, as it is moulded by the mollusk artist. A good example of this is seen in the Purple-hinged Pecten, which has been described on a previous page, in which the rich color remains in the little fragments of the shell that may be found among the sands of the beach.

But the iridescent colors of mother-of-pearl are due to quite another cause. There is no dye-stuff about it; nothing but extremely thin layers of shell overlapping one another like the shingles of a microscopic roof. But these projecting shingle-ends so shiver the beams of sunshine into their primary colors that the white light is sent off in its parts, red, blue, green and other tints, just as we see them in the rainbow. And therefore as we turn the shell so as to bring its surface to the eye at a new angle we get changes of color, because we get a different reflection. Many sea-shells are nearly white, some have distinct but solid colors, but the shells described in this chapter, together with the pearl oysters and a few others are the true pearl-makers of the world.

Many of the shells of these pearl-makers take the form of turbans or tops, and each little creature has a special front door which he closes whenever he particularly desires to be alone. The apertures of nearly all of these shells are nearly circular, and are wholly without canals; which is a pretty good proof that the inmates should be classed with the vegetarians. The opercula of a few of our species are solid and shelly, while in most species they are more like a scale of horn. We begin our descriptions with those of the first kind, and it happens that our very first shell is an exception to the general law, and has a perfectly white interior, without a rainbow of any kind.

Fig. 217

Phasianella compta, Gld., the Pheasant-shell, Figure 217, may sometimes be found alive on sea-grass, though dead shells are more common. When alive, there is a dull

epidermis which obscures the beauty of the shell, which is richly painted with little zigzag stripes of red, brown and white. There is also a little white, solid operculum, almost hemispherical in shape, the convex side being outward. The length of the whole shell is from 3 to 6 millimeters.

Astræa undosa, Wood, (*Pomaulax undosus*), the Wavy Topshell, Figure 218, is a southern species, which sometimes grows to a great size. The whorls are

Fig. 218

crossed and varied with numerous wavy ridges, and the base is ornamented with beaded circles. The shell is of whitish pearl and is covered with a brown, fibrous epidermis. The operculum is horny within, while the shelly outer part is strengthened by two heavy, curved ribs. The cut represents a medium sized specimen, but they are sometimes as much as four inches in height.

Astræa inæqualis, Mart., (*Pachypoma inæquale*), the Red Top-shell, Figure 219, has a big, strong, brick-red shell, with a hard operculum, somewhat like that of the last species, but lacking the ribs. Living specimens are seldom found near the shore, but dead shells, somewhat broken, are often

Fig. 219 (*)

thrown up by the waves, especially around sunken ledges. It is said to be more abundant in the vicinity of Vancouver Island, where the Indians formerly used the white opercula for ornamental purposes. The base of the shell is marked with deep, concentric furrows. The shells of this species are quite variable, some specimens lacking the sculptured fillet shown in the engraving below each suture, while the form of other specimens is much depressed. The picture represents an unusually large specimen.

Concerning the name of this species and that of the last, it is proper to remark that the old names, which are inclosed within parentheses, can be used with great propriety still. The proper name of the genus is now considered to be *Astræa*, which was given by Bolten in 1798; while the name *Pachypoma*, given by Gray in 1850, is now reckoned as the name of a subgenus. Sometimes the names of both genus and subgenus appear, and Dr. Dall writes the name of this species "*Astræa* (*Pachypo-*

ma) inaequale." If the name of the genus only appears the name of the species should agree with it in gender, hence the different endings which may sometimes be a little confusing to one who is not familiar with the Latin language.

From a large shell we turn to a very small one, *Leptothyra carpenteri*, Pilsbry, the Red Turban-shell, shown in Figure 220. The whorls of this little shell are few in number, and they are marked with fine, distinct, spiral ridges. The little operculum is solid and shelly. The color is reddish, sometimes distinct and sometimes banded or faded. This species may be found at low tide, living upon rocks, but the hermit crabs bring up many more dead specimens.

Fig. 220

Leptothyra baccula, Cpr., the Berry Turban-shell, is shaped like the last, but it is smaller, being only one-eighth of an inch in diameter. It is nearly smooth, dark or ashy in color, and it is found in the south, especially around Catalina Island.

Norrisia norrisii, Sby., the Smooth Turban-shell, Figure 221, is another southern species. The shell is quite smooth and is of a rich brown color; the rim of the umbilicus, however,

Fig. 221

is curiously tinted with a bright green. The brown operculum is very shaggy, and the animal is beautifully tinged with red. Taken as a whole this is a very beautiful and interesting species. The figure represents a comparatively large specimen. One very small specimen was found by Berry in Monterey Bay at a depth of twelve fathoms, but I have never seen it upon the shore so far north.

Fig. 222

Some of our choicest shells belong to the next genus, and one of the prettiest of all is named *Calliostoma annulatum*, Mart., the Ring Top-shell. Figure 222 represents a large specimen of this shell, which is thin and delicate, light brown in color, while the sutures are marked with a rich line of purple, and the whorls are traced with sculptured points. It is seldom found on the beach, but is obtained from the seaweed at some distance from the shore. Too delicate to bear the beating of the surf upon the rocks, its home is in deep water, where it clings to long seaweeds near the surface, though when the weather is rough it sinks to more quiet abodes.

Quite similar in general form and habits is the Channeled Top-shell, *Calliostoma ca-*

Fig. 223 $\times \frac{1}{3}$ (*)

naliculatum, Mart., an enlarged view of which is shown in Figure 223. The shape of this shell is strictly conical, and the flattened whorls are girdled with deep spiral channels, which lie between raised ridges. The surface is ash-colored, though the shell is rainbow-tinted within. The thin exterior layers may very readily be removed by a weak acid if one wishes to examine the deeper structure of the shell.

Figure 224 presents to us another shell of this genus, *Calliostoma costatum*, Mart., the Blue Top-shell. This species is smaller than either of the preceding members of the genus, and it lives nearer the shore. Hence we should naturally expect to find that it

Fig. 224

had a thicker and stronger shell than the others, and in this we are not disappointed. It has four rounded whorls, marked with fine spiral ridges. The thin, reddish brown outer coat is readily removed, showing the blue pearly layer underneath. This process is often accomplished naturally, and broken shells especially show more or less of the blue coloring, especially round the apex.

I have found very fine living specimens hanging from the roof and walls of a rock grotto after it had been left empty of water by the retreat of the early morning tide. I have also gathered them from the long seaweeds that grow near the rocky shore. The length of one of these shells is three-fourths of an inch. The horny operculum is perfectly circular, and the aperture of dead shells is often inhabited by a thin variety of the White Slipper-shell.

Calliostoma gemulatum, Cpr., the Gemmed Top-shell, is of a conical shape, the whorls of the shell being ornamented with spiral strings of granules or beads, each whorl having two principal rows, with several smaller ones. The color of this southern shell is gray, with some dark cross stripes running down from the apex. Its height is only 15 mm. or less and it is seldom found in large numbers.

Fig. 225, x $\frac{5}{2}$ (*)

Calliostoma gloriosum, Dall, the Glorious Top-shell, Figure 225, is the name of the fine species which is occasionally found on the California coast. The engraving shows no color painting, and as it is so much enlarged the granules appear much too prominent. The color of specimens found in

Monterey Bay is light salmon, while around the sutures and the angle of the lower whorl is a chain of roundish dark spots, with the lighter spaces between them. In San Pedro Bay the shells are darker. The height of a grown specimen is fully an inch.

In the first edition of this book this species was called *C. supragranosum*, Cpr. The latter name, however, proves to belong to a rare species having a much

smaller shell. It is light chestnut-brown in color, with a peripheral circle of alternating chestnut and white spots. It is found in the south, especially on the breakwater at San Pedro, and may be known as the Granose Top-shell.

Calliostoma tricolor, Gabb, the Three-colored Top-shell, is well shown in Figure 226, while Figure 227 gives a magnified view of another specimen. The shell is conical, its five whorls little raised but marked with delicate spiral sculpturing. The

Fig. 226

Fig. 227, $\times \frac{1}{2}$ (*)

background of yellowish gray is ornamented with fine spiral threads of color, broken into alternate joints of purple and white, thus giving it the three-colored aspect. It is a southern shell and is

obtained by dredging. Figure 226 represents a large specimen.

Calliostoma variegatum, Cpr., the Variegated Top-shell, Figure 228, was originally described from a very small specimen taken in Puget Sound.

Fig. 228, $\times \frac{3}{4}$ (*)

Of late years, however, it has been found off San Pedro, where specimens reach an altitude of over an inch. The top of the growing shell is rose-colored, and the rest is yellowish white, but as age advances it gradually loses its brightness and appears of a yellowish pink, with pearly iridescence showing through.

Fig. 229, $\times \frac{1}{3}$ (*)

Calliostoma platinum, Dall, the White Top-shell, is shown, somewhat magnified, in Figure 229. This fine species was dredged by the "Albatross" expedition from a depth of about half a mile of water near the Santa Barbara Islands. The shell is large, very thin, polished, and of a whitish color, tinged with green or blue.

Figure 230 represents another rare shell dredged off the coast of southern California. Its name is *Calliostoma turbinum*, Dall, the Turbaned Top-shell. It is a small species, the shell being only 12 mm. high. The body of the shell is waxen, showing nacre, and it is ornamented with certain small flamules of dark brown not shown in the engraving.

Fig. 230, $\times \frac{1}{2}$ (*)

Calliostoma splendens, Cpr., the Shining Top-shell, is shown very greatly magnified in Figure 231. This species of mollusk has a small shell, about the size of a small pea. It is of an orange-chestnut color, with fleshy or bluish nacre. It is a rare shell, found at Monterey and southward and has sometimes been considered to be only a variety of *C. costatum*.

Fig. 231, x $\frac{1}{4}$ (*)

Turcia caffee, Gabb, the Coffee-brown Top-shell, (*Thaliota caffee*). This is a rare shell, resembling a *Calliostoma*, but it has two folds on the columella, which forms a distinguishing mark. The whorls are flattened, the sutures deep and bearded, the epidermis coffee-brown in color, and the nacre, or mother-of-pearl, of a greenish tint. Its greatest height is 19 mm. Its home is on the California coast.

Fig. 232

Margarites pupilla, Gld., the Little Margarites, (*Margarita pupilla*), Figure 232, is a northerner living in Puget Sound, but sometimes coming further south. It is yellowish brown or ashen in color, and its four whorls are marked with spiral ridges. The umbilicus is distinct, but small, and the aperture is nearly circular. Its height is sometimes as great as half an inch.

Margarites helicina, Fabr., the Helix Margarites, (*Margarita helicina*), is decidedly arctic in its

tastes, living on the shores of northern Europe, eastern America, and around Bering Strait. The shell is umbilicate, thin, flesh-colored, polished and shining. It is a little affair, its height being only 6 mm., and its diameter a little more.

Margarites lirulata, Cpr., the Lirulate Margarites, (*Margarita lirulata*). This very variable species has a globose-conical shell, solid, purplish, or more or less variegated. The surface sometimes has spiral ridges, or lyrae, though sometimes it is nearly smooth. The suture is impressed, the body-whorl convex beneath, the aperture oblique and very iridescent within. The diameter is 4 or 5 millimeters. This species, which lives chiefly in the middle north, includes forms which were formerly known as *Gibbula succincta*, *Gibbula parcipecta*, and several other species.

Fig. 233, x $\frac{2}{3}$ (*)

Margarites vorticifera, Dall, the Flattened Margarites, Figure 233, has its home in Bering Sea and adjacent northern regions. The shell is decidedly flattened, and is of a salmon-pink color, very pearly, and has a diameter of nearly an inch.

We now come to the genus *Tegula*, under which is the subgenus *Chlorostoma*, which literally means Green-mouth, the reference

being to the pearly tint of the aperture. It is a very important genus for our coast, some of the species being represented by innumerable specimens, though others are comparatively rare. In our description both the older and the newer name will be given, so that there will be no confusion.

Tegula funebris, A. Adams, (*Chlorostoma funebre*), the Black Turban-shell, Figure 234, is extremely common on the central coast of California. Its shell is strong, for it lives on the rocks midway between high and low tides, where it frequently gets a vigorous lashing by the waves. In some places it is so abundant that I have seen rocks almost black with them, all ages and sizes lying close together.

Fig. 234

On my first visit to the seaside I wanted them all, so I gathered specimens and cleaned shells for hours. Two very natural results followed: first, that there remained apparently as many as there were before I began operations; and second, that on subsequent visits I gathered few. But whether we collect them or merely watch their movements and study their habits, they soon become like old friends to anyone who has learned the pleasant art of putting himself in sympathy with the lower animals.

The color of the shell is dark purple, almost black on the outside, and there is a greenish-white pearly layer beneath. The whorls are four in number, of which the uppermost one or two are fre-

quently somewhat eroded. The body-whorl is puckered near the suture, the umbilicus is nearly closed, and the columella is set with two little white knobs near its base. The common length of the shell is less than an inch, but sometimes old specimens are found which are considerably higher.

The variety *subaperta*, Cpr., differs from the regular form in having more prominent spiral ridges, which are usually more roughened, and in having a prominent umbilical pit. It lives in the Vancouver district.

Fig. 235

Tegula gallina, Fbs., (*Chlorostoma gallina*), the Speckled Turban-shell, well shown in Figure 235, is a southern species, with a solid shell, mostly black in color, but finely mottled with a lighter shade like the feathers of a speckled hen, as its name indicates. Var. *tincta*, Hemphill, has a streak of yellow on the base, just below the columellar teeth.

Tegula brunnea, Phil., (*Chlorostoma brunneum*), the Brown Turban-shell, Figure 236, is a fine species, living on the rocks which are exposed only at very low tide, or on the seaweed. It has a handsome, rich brown shell, with a portion of white around the aperture.

The lines of growth are very oblique, and are easily recognized. The figure represents a large specimen,

Fig. 236

though occasionally very old specimens are found that are even larger.

Tegula aureotincta, Fbs., (*Chlorostoma aureotinctum*), the Gilded Turban-shell, is a southern species with a shell resembling the last figure. There are however, a few quite prominent spiral ridges with more or less wavy crossings. The color of the shell is gray, or sometimes almost black. The distinguishing feature is a large umbilicus, which is marked with a bright yellow stain, a circumstance which doubtless suggested the name of the species. The diameter of the shell is about an inch.

Tegula montereyi, Kien., (*Chlorostoma montereyi*), the Monterey Turban-shell, was formerly known as *Chlorostoma pfeifferi*. The shell of this rare species is strictly conical, with whorls almost perfectly flat. The circular base likewise is flat and nearly smooth, though marked with almost obsolete spiral lines. The columella does not spread around the umbilicus, which is funnel-shaped, white within, and its edges defined by an angle. The color is light brown or olive, and the height of the shell, which about equals its diameter, is an inch or more.

Tegula pulligo, Mart., (*Chlorostoma pulligo*), the Dusky Turban-shell, much resembles the last species. Its seven whorls are flattened, its base slightly convex, smooth without lining, obliquely streaked, concave and white around the deep and wide umbilicus, which gradually expands and is partly covered with a white callus, and has no spiral ridge within. The color is dull purplish or brown, often appearing orange when worn. The height of a large specimen

is 35 mm., and its breadth is 32 mm. Specimens from Monterey have been found which are distorted in form and dark red in color. The ordinary form is found around Vancouver Island, though the species seems to have a wide range.

Fig. 237

Tegula viridula, var. *ligulata*, Mke., (*Chlorostoma viridulum*), the Banded Turban-shell, is well shown in Figure 237. It is the same shell that was formerly called *Omphalius fuscescens*. It has a strong, solid, turban-shaped shell, whose rusty brown whorls are banded with raised spiral lines. These lines are broken or beaded, and sometimes are dotted with black, giving the shell a very characteristic appearance. The operculum, as in nearly all of the species of this group, is thin, horny, and circular. The umbilicus is large and distinct, while the lower part of the circular aperture is marked with rounded knobs.

Solariella peramabilis, Cpr., the Lovely Solariella, has a small turban-shaped shell which is greatly ornamented with delicate sculpturings. The aperture is perfectly round, and the whole shell appears like a growing tube coiled around an open umbilicus. The spiral ridges of the whorls are crossed by innumerable fine lines. Externally the shell is gray, while within it is rainbow colored. From one-fourth to one-half of an inch across. It

Fig. 238, $\times \frac{1}{2}$ (*)

has been dredged in moderately deep water off Catalina Island.

Solariella oxybasis, Dall, the Pointed Solariella, Figure 238, has an acute spire, a small umbilicus, and an angulated aperture. Its altitude is 13.5 mm., and it was dredged off the Santa Barbara Islands.

Turricula bairdii, Dall, Baird's Turban-shell, Figure 239, is one of the finest deep-water species that has been discovered recently. The shell is large, thin, somewhat eroded at the apex and covered elsewhere with a light yellowish-brown epidermis, slightly inclined towards green. Many specimens were obtained by the "Albatross" expedition off San Clemente Island, in water 300 to 400 fathoms deep. The figure represents a specimen of average size, but some are quite a little larger.

Fig. 239 (*)

Fig. 240, $\times \frac{1}{2}$ (*)

Gibbula canfieldi, Dall, Canfield's Turban-shell, Figure 240, is an extremely rare shell. In fact, until recently, only two specimens were known; one of which was collected at Monterey by Dr. Dall, and the other by Mr. Button, of Oakland. It occurs also as a fossil. Possibly some reader of this book may discover it anew. The color of the shell is pearly, with bronze-yellow pencillings arranged obliquely to the suture. The height is ten millimeters.

Fig. 241, x $\frac{7}{1}$ (*)

Halistylus pupoides, Dall, the Pupa Sea-style, Figure 241, is another species that is seldom found in California, though it is plentiful in British Columbia. It has a little shell only 6 mm. long, and its appearance is well shown in the greatly magnified engraving.

Liotia fenestrata, Cpr., the Windowed Liota, has a small, flattened, whitish shell, cut into numerous square pits by the crossing of ribs and lines. Its diameter is one-eighth of an inch.

Liotia acuticostata, Cpr., the Sharp-ribbed Liota, is smaller than the last, less flattened, and is marked with sharp, spiral ridges, but without cross-lines; its color is whitish.

Vitrinella williamsoni, Dall, Williamson's Vitrinella, Figure 242, has a small, white, depressed shell, 5.5 mm. in diameter. Its surface is polished. It was found on the beach at San Pedro, and was named in honor of Mrs. M. Burton Williamson, of Los Angeles.

Vitrinella oldroydi, Bartsch, Oldroyd's Vitrinella, resembles the last, but is smaller and relatively thicker; it has three and three-fourths whorls. It has been found at San Diego, San Pedro and

Fig. 242, x $\frac{7}{1}$ (*)

farther south. It was named in honor of Mrs. T. S. Oldroyd of Long Beach.

Vitrinella eschnauri, Bartsch, Eschnaur's *Vitrinella*, is about the same size as the last, but the whorls stand higher and are thin; it is glassy and almost transparent. The diameter is about two millimeters. It was named for Mrs. Eschnaur, who dredged it at Terminal Island, though the type was collected by Mrs. Oldroyd at San Pedro. And so these three little shells represent three ladies, all of whom live in Los Angeles or in that vicinity.

CHAPTER XI

PIERCED SHELLS AND CHITONS

We have now come to the largest and finest shells on the coast. They are locally known as Abalone-shells, while the translation of the scientific name makes them "Sea-ears."

Fig. 243

Figure 243 represents our most beautiful species, *Haliotis fulgens*, Phil., the Green Abalone. The shells of this genus are truly spiral, but the whorls are extremely flattened, and the diminutive spire is almost concealed at one end of the body-whorl, while the oval aperture is nearly as long and broad as the shell itself.

Near one edge of the shell is a series of holes, which serve as outlets for the water which has passed over the animal's gills, together with any waste par-

ticles which may pass along in the current. As the shell increases in size some of the holes become closed from the inside, while new ones are formed at the edge of the growing shell.

If we look within we shall find the most highly colored portion of the shell near the center, where the huge muscle which controls the foot has been detached. This great foot can cling to a rock with surprising force, and the animal must be taken unawares if an easy conquest is expected. In no case should the fingers be inserted between the shell and the rock; for though no fatal results might occur, as are sometimes reported, it is true that much pain and inconvenience would probably be caused.

The internal organs of the abalone are very interesting for dissection, particularly the mouth parts, or "buccal mass" as these organs are called. There is a ribbon-like tongue as long as your finger, and it is thickly set with flinty hooks, sometimes called teeth. By means of these teeth the animal rasps its vegetable food into fine shreds fit for swallowing. Then there are the gills and the mantle, the heart and the digestive organs; but a very large part of the animal consists of the great central muscle.

This species is essentially a southerner. I have seen one living specimen at Monterey and have heard rumors of another one, but they are seldom found so far north. All of the abalones are rock-loving animals, and they must be sought where the clefts of the ledges afford them an opportunity to hide from their enemies, at least while they are young. Later in life they may be found planted upon rocks, their

backs covered with sea-mosses and other growths, so that they might easily be overlooked by one who was unacquainted with their habits of concealment.

The shell of this species is quite thin, and it is diversified externally by low spiral ridges of a dark and dull color. Within, a whole rainbow is condensed in one of these magnificent shells, though the shades of green are most conspicuous. The coloring of the center is particularly fine, resembling a peacock's tail. There are about six open holes near one side of the shell, and its length is about the same number of inches.

Var. *walallensis*, Stearns, occurs at Gualala, a small seaport in Sonoma Co., Cal. It is more elongate and flattened than the typical form, and it has a paler nacre. Its length is four inches, and its breadth is rather less than three.

Fig. 244

Haliotis rufescens, Swains., the Red Abalone, is shown in Figure 244. The beauty of these shells has caused them to be very widely distributed,

and though their comparative abundance in California makes us somewhat careless of them, still they are among the most beautiful objects ever gathered from this coast. The outer layer of the shell pro-

THE RED ABALONE
Haliotis rufescens, page 244

jects over the pearly inner layer, and makes the fine red edge, so much prized in perfect specimens. The back is somewhat roughened, and is often overgrown with vegetation. The holes are large, usually three in number, and the muscle-scar is prominent. The shell sometimes grows to a length of nine inches, or more.

All parts of this mollusk are valuable. The Chinese dry the meat and use it for food, and it must be confessed that the great muscle makes a most delicious soup. The shells are sold by the ton, and are largely exported to Europe, where they are made into buttons or used for various kinds of inlaid work. So persistently have these animals been gathered that they are much more rare than they were a score of years ago, and laws have been made to protect the species from extinction.

The Black Abalone, *Haliotis cracherodii*, Leach, is shown in Figure 245. It is smaller and more abundant than the last species. The back is quite smooth, marked

Fig. 245

only by lines of growth. The spire is very short, the holes five to nine in number, though I have seen a specimen that was without any. The color of the outside is greenish-black, while the inside is beautifully iridescent, without inclining to any definite

color. Live specimens, varying from one-fourth of an inch to six inches in length may be found at low tide, clinging to the rocks, particularly in the most inaccessible cracks, and under heavy boulders.

When examined in a large jar of sea-water, as all of these animals should be if there is an opportunity, a living specimen presents many interesting points for study, particularly its broad foot, its fringed and sensitive mantle, its mouth and eyes and slender tentacles. Care must be taken to change the water very often, if the animal is to be kept alive any length of time, as it is very sensitive to confinement and rapidly uses up the dissolved oxygen in a jar of water.

Haliotis corrugata, Gray, the Corrugated Abalone, resembles *H. rufescens* in size and color, but the shell is nearly circular, thick, high arched, and externally corrugated. It has only two or three open holes, but these are quite large, and the central muscle impression is wide and very brilliant. It is a southern species, and it is usually found beneath the low water mark.

Haliotis assimilis, Dall, the Threaded Abalone, is now considered to be a distinct species, instead of a mere variety. It lives in deep water, from Monterey to San Diego. A specimen from the latter port measures four inches in length and three and a quarter in breadth. It has seven open holes, and the exterior of the shell is marked with many threads, like tapestry carpeting. There is a moderate furrow below the line of holes. The spire is short but quite distinct, and the body of the shell is high

arched. Externally the shell is reddish, while the inside is smooth and silvery, without visible muscle-scar. The shell is tolerably thick, and appears very compact and solid.

Quite in contrast with this species is the next, *Haliotis gigantea*, Chem., the Japanese Abalone, which seems to have followed the warm ocean current down past the Aleutian Islands, and to have reached the central part of the California coast; but it became smaller as it progressed, so that here it does not deserve its original name, though there seems to be no sufficient reason for separating it, even as a variety. My best specimens came from the west coast of Vancouver Island, the largest measuring five inches in length. In shape it appears long and narrow when compared with other species. The shell is thin, the edge sharp, the spire quite prominent, the surface uneven, while the four open holes are large and surrounded by high walls. The interior is very iridescent, a light color prevailing, and the muscle-scar is not distinct.

After the shells that have several holes, which we have just considered, there come a number having only one opening, which answers the same purpose, that of allowing a free outward passage from the interior of the

Fig. 246 (*)

shell. And first we will consider *Puncturella major*, Dall, the Greater Puncturella, shown in Figure 246. It is not a common shell, but it shows the features of the genus in a fine manner. Its color is white, its internal margin is crenulated, and the posterior slope is slightly arched. This fine large shell was dredged in Bering Sea.

Puncturella galeatea, Gould, the Helmet Puncturella, is an inhabitant of Puget Sound and the adjacent waters. It is much smaller than the last species, having a shell that is conical and elevated, being about as high as it is broad. The fissure at the summit is narrow, and internally there is a little pit on each side of the hole-channel. Its color is grayish white, and its length is ten millimeters.

Puncturella cuculata, Gld., the Cap Puncturella, is found in Puget Sound and also at Monterey. Presumably it exists at various locations between these two extremes. The shell is oval, obliquely conical, ribbed, the wedge-shaped puncture opening towards the shorter side. The color of the shell is white, though the outside is liable to be somewhat dingy. My specimen from Monterey measures about an inch in length and half an inch in height.

Puncturella cooperi, Cpr., Cooper's Puncturella, resembles *P. galeatea*, but the internal plate is solid and plane. The shell is small, being about nine millimeters in length. It has been found at Catalina Island.

Submarginula yatesii, Dall, the Monterey Trough-shell, is an extremely rare shell, two views of which are shown in Figure 247. A few speci-

mens have been obtained from the Bay of Monterey, but it is found in very few cabinets. The shell

Fig. 247 (*)

is large, strong, grayish-white in color, and it has many radiating ribs. Note the trough which extends from the apex to the margin, and which passes between the heels of the horseshoe-shaped muscle-scar. The shell is 51 mm. in length and 13 mm. in height.

Figure 248 represents the shell of one of our most common species, *Fissurella volcano*, Rve., the Volcano-shell. Dead shells are abundant and attractive, and living specimens, with yellow

Fig. 248

foot and red-striped mantle, may often be found on the rocks at low tide. The shell is about an inch in length, and is oblong conical in form; the red stripes on its sides, running down from the small, oblong hole at the top, suggests streams of red-hot lava issuing from the crater of a volcano. The coloring

appears plainest on dead shells; the live ones are darker, smoother and less brilliant. Var. *crucifera*, Dall, is a southern form, found at San Pedro and San Diego, which has four broad white rays starting from the apex, the posterior one becoming rapidly V-shaped. The ground color is brownish gray.

Fig. 249

Fissuridea aspera, Esch., the Rough Keyhole-limpet, is well shown in Figure 249. This shell is quite conical, with a small, oval hole at the top, very different from the nar-

row, oblong slit of the last species. The edge is wrinkled, the outside color is gray, with dark, purplish rays running down from the apex, while the interior is white. The common size is rather less than that of the cut, though some old specimens are very much larger.

Fissuridea murina, Dall, the White Keyhole-limpet, is the next one of this interesting series that we are to consider. This species has a much smaller and more delicate shell than that of the last one, though in some respects they resemble each other. The shell is oblong in shape, with curved ends. The roundish oval hole is one-third of the shell's length from one extremity, and there are numerous fine ribs, checked by concentric ridges. The color is pure white, at least in dead specimens, and the length is about 15 mm., a little less than the diameter of a silver dime.

A greatly reduced view of *Lucapina crenulata*, Sby., the Great Keyhole-limpet, is shown in Figure 250. This is by far the largest and finest of the American Fissurellidæ.

Fig. 250, $\times \frac{1}{2}$

Though this shell is often over four inches in length, the animal is much longer, and somewhat resembles a brick, both in shape and size. It has a huge yellow foot, and a black mantle that nearly conceals the white shell which rests upon the animal's back. The edges of the shell are covered by a fold of the mantle, and its true size is not shown until this fold is dissected away.

This fine shell is marked with many radiating ribs and concentric lines of growth. It has a large, oblong hole to one side of the center, around which, internally, is a thick rim of enamel. The crenulated, or scalloped, edge of the shell is a marked feature, and suggested its specific name. Internally the shell is of a pure glossy white, but the outside is somewhat dingy. This great mollusk is seldom found near the shore, as it lives below the tide-mark, and it must ordinarily be gathered by dredging.

Lucapinella calliomarginata, Cpr., the Southern Keyhole-limpet, is a small species, living below tide-mark, and is occasionally found from San Pedro southward. The shell is low arched, with a rather

large, oblong hole, and roughened ribs. The margin is crenulated, the interior white, and the exterior gray or marked with dark rays; the length is 19 millimeters.

Fig. 251

Megatebennus bimaculatus, Dall, the Spotted Keyhole-limpet, Figure 251, was formerly called *Fissurellidæa bimaculata*.

These long names apply to a little shell which occasionally grows to a length of 16 mm., though many specimens are much smaller. The hole is very large for the size of the shell, and on either side of it are dark rays, making the two spots, from which circumstance it is named. Sometimes the whole shell is colored, with darker rays on the sides. The interior is white, though sometimes the spots show through. This species is reported from British Columbia as living on the rootlike holdfasts of the great seaweed, *Macrocystis*. It also occurs much farther southward, though it is a comparatively rare shell. The animal is much larger than the shell, part of which is concealed by the mantle.

There are very odd creatures living under the stones which lie along the rim of the ocean. If you go down at low tide and turn the rocks over, one by one, you will be surprised at the number of singular beings which stare up at you in blank amazement, and then rush away into obscure places, as fast as their ten or fourteen legs will carry them. Others cannot run, but in sheer helplessness wait for your kind decision to do them no harm, and their very inertness appeals to your sympathies. While the saucy crabs waste no time in ceremonies, and the

sea-worms creep away as fast as possible, the poor mollusks can only cling to the rock for protection, or curl themselves up into the smallest space and the most secure condition which their instinct can dictate.

When you visit the seaside you will want to examine all these harmless little inhabitants of the ocean, and among them you will probably early discover some specimens of our next group of mollusks, the Chitons, or sea-cradles, as they are sometimes called. The anatomy of these animals is similar to that of the limpets, but they seem less highly developed, and are probably descended from a very ancient race. They are peculiarly sluggish creatures, and they live in cracks and crannies of the rock or else under stones, away from all scenes of activity.

But the peculiar feature that distinguishes them is the fact that the shell of the Chiton consists of eight parts, instead of a single shield. These parts, or valves, run across the body and overlap one another, like shingles on a roof. They are highest in the center, and they end in a leathern mantle which runs around the body, and which is highly contractile. This being the case, their shells cannot be preserved with the same ease as those of the limpets, for the mantle must be dried while the valves are in their natural position.

Probably the best way to prepare fine specimens is to bind the living animal upon a piece of shingle or lath as it rests extended in a pan of sea-water. It can then be placed in warm fresh water, and after

the lack of salt has destroyed life and the muscles have lost their contractility, the animal may be unbound, the viscera removed with a sharp knife, and the parts to be preserved may be placed in a flat position to dry. Sometimes it is best to fit in a piece of wood, the size of the parts removed, to prevent shrinking while the mantle is drying.

There are very many species of Chitons found on this coast, many of which are seldom collected, and it is quite beyond the scope of this work to attempt to describe them all. The best work to consult for full descriptions is the *Manual of Conchology*, published by the Philadelphia Academy of Natural Sciences, Vols. XIV and XV. A score or more of the most common species will now be mentioned, with descriptions of the ones that will most likely be collected. It should be remarked that some species are very small, less than half an inch in length, while others are two or three inches long, and the giant of the class is known to attain a length of nearly a foot. The figures were all drawn so as to represent good-sized specimens of the species which they illustrate.

Lepidopleurus nexus, Cpr., the Joined Chiton, has a small, ashen-white shell, with valves gothic arched. Its length is 7.5 mm., and it was dredged near Catalina Island.

Lepidopleurus internexus, Cpr., the Inter-joined Chiton, has a shell similar to the last, but it is smaller, and the valves are orange-colored. Its length is 4.5 mm., and it comes from Santa Barbara.

Tonicella lineata, Wood, the Red-lined Chiton, is shown in Figure 252. This species is a beautiful

representative of this great group of mollusks. The valves are smooth, moderately arched in the center, and are chiefly of a light reddish color. This background of color is crossed by wavy or zigzag lines of dark brown, bordered above with white, making the fresh specimen an object of great beauty. The mantle border is smooth, thin and delicate, and it is of a yellowish-brown color. The length is about one inch.

Fig. 252

Tonicella marmorata, Fabr., the Marbled Chiton, has an oblong shell with valves elevated and rather acutely angled. Its color is buff, closely sprinkled with dark red; surface apparently smooth, but microscopically granulated; length, 27 to 40 mm. This species lives in the Atlantic and also in the north Pacific.

Tonicella submarmorea, Midd., the Red-spotted Chiton. Valves rather depressed, apparently smooth but microscopically full of granules; color, rosy or yellowish-white, painted with spots and flamules of red; length, 38 mm. From Fuca Strait past the Aleutian Islands to Japan.

Trachydermon hartwegii, Cpr., Hartweg's Chiton, has a low, oval shell, very closely and microscopically granulated, and sometimes bears wart-like granules irregularly scattered over the surface. Externally it is of a dull olive-green, while internally the color is an intense blue-green; the length is about an inch. It is found along the whole coast, from Vancouver Island southward.

Chatopleura gemmea, Cpr., the Gem Chiton, is found at Monterey. The shell is oblong, elevated, red, olive-ashen, or yellow. The girdle is narrow, leathery, sparsely clothed with short hairs that are easily rubbed off, and the valves are not smooth. It is a little creature, having a length of 16 millimeters.

Fig. 253

Ischnochiton magdalenensis, Hds., the Gray Chiton, is shown in Figure 253. This large and very common species may be found under rocks at low tide, and it can at once be recognized by its worn or roughly sculptured, low-arched valves, which are whitish internally, and gray or somewhat tinted externally. The mantle border is darker and is covered with minute, solid scales. The foot of the animal is yellow. When taken from the rock it has a habit of curling up

into a ball. The figure represents a good-sized specimen.

Ischnochiton conspicuus, Cpr., the Conspicuous Chiton, resembles the last species, but is larger, more richly colored, with pinkish valves; while the mantle is densely beset with short bristles, giving it a velvety appearance. The length of this southern species is sometimes over 90 millimeters.

Ischnochiton mertensii, Midd., the Red Chiton, has an oval, elevated shell, with angular dorsal ridges and straight side slopes. The color is red,

varying in hue from orange to dark red-brown, and it is sometimes blotched with white. The valves are richly sculptured and are very beautiful when examined with a lens. The mantle border is covered with fine rounded scales; the length of the creature is from an inch to an inch and a half. It is essentially a northern species, reaching from Sitka to the middle of California.

Ischnochiton regularis, Cpr., the Regular Chiton, is shown in Figure 254. This is truly a regular structure, for the constant breadth is half the length, and the ends are semicircles. The valves are sharply arched and are marked with very fine sculpturing. By the aid of a lens the border is seen to resemble very fine beadwork. The outside is olive or slaty blue, and the interior is light blue; the length is 35 millimeters.

Fig. 254

Callistochiton palmulatus, Cpr., the Palm Chiton, has small, high arched valves, marked with raised sculpturing. The anterior valve has eleven ribs, while the posterior one has seven very strong ones, bifurcated behind. Its color is dark brown, and its length is 11 mm. It is found at Monterey and Santa Barbara. The variety *mirabilis*, Pils, has the last valve enormously thickened. The interior is bluish white. The variety comes from San Diego.

Callistochiton crassicosatus, Pilsbry, the Thick-ribbed Chiton, has an elevated, oblong shell, the lusterless surface of which is green or brown. The front valve has seven very strong ribs; the posterior valve

is also elevated, the hinged area not higher than the area in front of it. The interior of this shell, which is found at Monterey, is bluish white in color, and the length is a trifle less than an inch.

Fig. 255

Nuttallina californica, Nutt., the California Chiton, Figure 255, is a very common species, living high up on the rocks which are left bare by the tides, and hiding in crevices which are ordinarily covered by a growth of seaweed. The coarse, rough valves are often much eroded, but where the surface is presented it is of a dark color, and is sculptured with fine granules. The girdle is covered with short, stiff spinelets of a dark color. The foot of the animal is reddish, and the interior of the valves is bluish-green. The length of a well grown specimen is an inch and a half.

The true *Nuttallina scabra*, Rve., the Scaly Chiton, is a southern species, much resembling the last, but having the individual valves very much shorter in proportion to their width. The color of the valves is lighter and more variegated.

Mopalia muscosa, Gld., the Mossy Chiton, is shown in Figure 256. This very variable species extends from the far north to San Diego. It may generally be readily recognized by its hairy mantle-

Fig. 256

border, which resembles a fringe of stiff moss. The outside of the valves is sculptured, but this fact is often obscured by growths of seaweed or other organisms. The interior of the valves is of a bluish-green color, while the outside is dark or grayish. Some years this species is quite common, and good specimens may be found in rocky places between tide-marks at the time of lowest water.

Mopalia hindsii, Sby., Hinds's Chiton, is the next species to be considered. Its shell is much depressed, and the surface is nearly smooth. The girdle has only a few short hairs. The color is olive, while the interior is white, with short crimson rays under the beaks. Its length is two inches. It is found in San Francisco Bay and along the coast of central California. By some of the best authorities this is considered as only a variety of the last species.

Mopalia lignosa, Gld., the Woody Chiton, is well shown in Figure 257. This fine species has its distinguishing lines clearly brought out in the figure, which represents a large specimen. The valves are light green in color within, while on the outside they vary from almost white to dark green. They are also marked with narrow brown lines, which slant

Fig. 257

from the apex of each valve. The girdle is generally quite rough, but sometimes we find it nearly smooth. This species ranges from Vancouver Island to Monterey. It should be remarked that specimens have been found connecting this species with the last two, so that by Pilsbry it is considered to be only a subspecies. The difficulty of drawing hard and fast lines will be appreciated by any one who makes a study of this group.

Mopalia ciliata, Sby., the Hairy Chiton, has also been sadly confused with other species. It is brighter colored than *M. muscosa*. The girdle is wide, yellow or brown, somewhat clothed with curling, strap-like brown hairs, which bear near their bases a bunch of minute, white, acute spines. It extends along the coast from the far north to Monterey. The variety *wosnessenskii*, Midd., has a shell elongated, the back roundly arched, olive to drab in color, and with faint sculpture. It has been found at Sitka and Olympia.

Fig. 258

From those which it is difficult to classify we pleasantly turn to a very distinct species, *Placiphorella velata*, Cpr., the Veiled Chiton, shown in Figure 258. This singular species is more nearly circular than any of its relatives on this coast. At the anterior end the mantle projects considerably, forming a distinct veil, which is set with scattering hairs. The valves are low arched, of a dull reddish color without, but whitish within. Its length is 30 to 50 mm., and it is found from Humboldt Bay southward.

Katherina tunicata, Sby., the Black Chiton, Figure 259, was named in honor of Lady Katherine Douglass, who first sent a specimen to the British Museum. The shell is oblong and elevated, the valves being mainly covered by the black, leathery girdle. This singular arrangement of the parts is so striking that a specimen cannot be mistaken for any other species. Think of a smooth, black skin, rounded like a whale's back, and set along the center with eight little shelly plates, and you will get the idea. The plates, where they are not exposed, are white; elsewhere they are dark brown or discolored.

Fig. 259

The figure shows the appearance of a small specimen, for they sometimes grow to a length of three inches. This species thrives especially in the far north, but it ranges southward as far as Catalina Island. The soft parts are salmon colored, at least in the northern specimens. It is eaten raw by the natives of the northwest coast.

Amicula pallasii, Midd., the Concealed Chiton, has a shell nearly concealed by the hairy mantle, which is almost circular, and which covers the back of the animal except for eight small holes. This mantle, or girdle, bears unequal bunches of reddish hairs. Its length is 67 mm., and it lives in far northern waters.

We close our description of these creatures with a few words concerning the largest one of all, named *Cryptochiton stelleri*, Midd., the Giant Chiton, which has already been referred to on a previous

Fig. 260

page. Figure 260 represents only one of the eight white valves, all of which are wholly concealed under the hard, gritty, reddish-brown mantle. These single valves are found much more often than the complete animal, and from

their peculiar shape they are often called Butterfly-shells. The single valves of other species are often found too, but none of them begin to be as large as these. The whole creature is a huge and heavy affair, six, eight or even ten inches in length. When properly cleaned and dried the mantle and valves much resemble a toy boat. The Chinese are peculiarly expert in curing and preparing specimens, which find a ready sale in the curio stores. They have even been made into shades for electric lamps, and are of a rich brown color, quite different from other materials.

This huge Chiton lives all along the western coast, ranging from Japan to the Santa Barbara Islands. Complete specimens are seldom collected from the shore, for the creature lives just below the lowest tide-mark.

CHAPTER XII

AIR-BREATHING SNAILS AND SLUGS

We must now leave the sea and all the plenitude of life that finds its home along the shores of the ocean, and search for the molluscan forms that live upon the dry land. By their very nature, however, we need not expect to find them where there is no chance to obtain considerable moisture, for in dry climates they are liable to perish, even if once introduced. So we will search for them in the shade of forests, around springs and brooks, in damp, dark places where the sun seldom shines, and especially along the borders of the ocean, where there is a great abundance of foggy weather; for though we sometimes wish that the fog would blow away, we must remember that the same dripping, heavy fog means life to the snails, as well as to many plants.

Most snails have an aversion to sunlight, especially if it is bright, and so they come out of their lurking places and secure their food in the night, and when morning has come and you go out to look for them they have disappeared. Perhaps your young peas and pansies have disappeared also, and nothing is left but a shining film of dry mucus, which glistens in the morning sunshine and clearly tells you what has been going on during the hours when you were asleep in your bed.

All of the snails need air, though not in very large quantities, for they are proverbially slow in their mo-

tions and were never known to really get out of breath. But in spite of their deliberation they accomplish quite extensive results, if you give them time enough. It is a favorite joke of the citizens of some brisk town to declare that the inhabitants of a rival city do not eat snails because they cannot catch the pesky creatures, presumably because the snails are more fleet of foot than the aforesaid neighbors. They are eaten, however, in some parts of the world, and are esteemed a great delicacy. Most of the snails breathe by means of a simple lung, or air-sack, which opens on the right side of the body, as is plainly shown in the picture of the yellow slug, Figure 264.

Fig. 261

Figure 261 represents the Northern Selen, *Selenites vancouverensis*, Lea. It represents, however, a sinistral form of the shell; but when viewed in a looking-glass it appears in the more natural form. This remark will apply to other figures in so far as one might wish to see how a reverse shell would look. Nearly all of our univalve shells are dextral, or right-handed; a few, like the Physas, are always left-handed, or sinistral. A good many tropical shells show more diversity in their method of coiling, and some specimens of the same species will turn to the right, while others will "per-versely" roll the other way. In Figure 102 we have a good example of a sinistral shell.

Some specimens of this Selen grow to a considerably larger size than the figure. The epidermis is yellowish green, while the interior of the shell is white. There are five whorls, the last one being flat-

tened above, at the aperture, as is shown in the figure. A dark colored variety is found in Alaska. As the name indicates, this species makes its home about Puget Sound, but it also extends down to California, and eastward to Idaho and Montana. The var. *keepi*, Hemphill, is a perfect miniature of the type, and is reckoned as an extremely small variety of the same. It is sparingly found in the Contra Costa hills, back of the city of Oakland.

Selenites sportella, Gld., the Sportive Selen, is decidedly smaller than the normal form of the last species. Its color and shape are similar, but it is marked by sharp growth-striae. The difference is most plainly seen on the base of the shell, which in the last species is smooth, while in this it is decidedly striated. This species lives near the coast, all along our western border.

Figure 262 shows us a basal view of *Selenites voyana*, Newc., Voy's Selen, (*Macrocyclis voyana*). Notice the wide umbilicus and the triangular aperture. The shell is thin, translucent, very light horn-colored, and has fine lines of growth. This species lives along the California coast.

Fig. 262

Selenites hemphilli, W. G. Binney, Hemphill's Selen, is a small species, half an inch across, thin, glossy, marked by irregularly impressed lines of growth, without any trace of revolving lines. This shell is also known as *Circinaria hemphilli*. Its home is in Oregon.

Selenites durantii, Newc., Durant's Selen, is a little affair, only 4 mm. across, widely umbilicated,

flattened, light yellowish-brown, striated. Var. *caelata*, Mazyck, is about the same size, but has very coarse, rough, irregular ribs, best seen from the under side. It is found on the California coast and islands.

It may be well to remark that all of the Selens are said to have very vigorous appetites; they should not be placed with other snails, for if they are thus confined the other snails are apt to mysteriously disappear—all but their shells.

The members of the genus *Limax* are true slugs; i. e., they are naked, crawling mollusks, looking like snails without shells. It is indeed true that they have rudimentary shells concealed in their mantles, but these are not easily observed. Several of our species have come over from Europe, and are settling down in America more to their satisfaction than to ours. Among the various species we mention first, *Limax maximus*, Linn., the Great Limax. This creature grows to a length of four inches. In color it is light brown or ashen, with rows of round spots alternating with black stripes. It has been reported from San Francisco, Los Angeles, and other coast cities.

Limax agrestis, Linn., the Field Limax, is another unwelcome immigrant, now thoroughly naturalized. Its color varies from whitish to black, through various shades of yellow and amber. It is usually about an inch long, but when fully grown it is nearly twice that length.

The upper side of the animal is marked with longitudinal, shallow furrows, darker than the general surface, while between these are little tubercles, giving it the appearance of mosaic work. When

touched it secretes a glutinous mucus. It is liable to become a great pest in gardens, doing most of its ravages in the night season.

Limax campestris, Binney, the Lawn Limax, is closely related to the last species, but it is smaller, more semi-transparent, and does not so readily secrete mucus. It is about an inch long, the body is cylindrical, the mantle oval and fleshy, the back tubercled and furrowed, the foot narrow and whitish. It has no spots or markings, and it varies in color from amber to black. I have sometimes seen great numbers of these little black slugs upon the lawn at Mills College, especially in the spring time.

Limax hewstoni, J. G. Cooper, Hewston's Limax, is found in San Francisco, Los Angeles, and other places. It is a dark colored slug, two inches long, the back being strongly ridged and higher than the front of the body. The height of the body is twice the width of the foot, the base of which is whitish in color.

Vitrina pfeifferi, Newc., Pfeiffer's Glass-snail, is a little mollusk resembling a slug, but with a small, shining, greenish-white shell of three whorls, 5 mm. in diameter. The aperture is large, the lip thin, and the shell too small to admit the whole animal. It is generally found at high altitudes, in California and eastward.

Several species of the genus *Zonites* and its allies now follow in our train of study. They are all small, having spiral shells, usually with rounded whorls and an open umbilicus.

Vitrea cellaria, Mull., (*Zonites cellarius*), the Cel-

lar *Zonite*, is a European species, but it has become widely distributed, even on the Pacific Coast. The shell is very much depressed, thin, fragile, and pellucid; the epidermis is greenish-yellow and polished, and the base is rounded. The little snail that builds and inhabits this shell is of a light blue color, very pretty and quite active. It is a snail that follows civilization, and delights to live in cellars and damp places about buildings. Most of the snails of the world resent the intrusion of man into their haunts, but this one affiliates with him and is pleased to remain about his habitations. So far as I know it never does any harm, and it seems to get its living from the mould that is found in cellars and in wet places. The diameter of the shell is from six to twelve millimeters. The larger variety is classed by some as *Vitrea draparnaldi*, Beck.

Zonites arboreus, Say, the Bush Zonite, has a spire of four or five whorls, so much flattened that the shell appears nearly like a circular disk. The shell is smooth, amber-colored, very thin, and almost transparent. Its diameter is three or four millimeters. This species, which hides under leaves and among bushes, inhabits many parts of North America.

Fig. 263, x $\frac{1}{2}$ (*)

Zonitoides puggetensis, Dall, the Seattle Zonite, is represented in Figure 263 very greatly enlarged, for the real diameter is only 1.5 mm. This

little shell was collected under leaves near Seattle by Mr. P. B. Randolph. It is of a dark, reddish-brown color, and it has a silky luster.

Pristoloma lansingi, Bland, Lansing's Zonite, is found in damp places under leaves, in Oregon and Washington. The little shell is scarcely 3 mm. in diameter, but it has five or six whorls, a rather elevated spire, but no umbilicus. The lower end of the narrow aperture is almost immediately beneath the apex. In appearance it is shining and dark horn-colored.

Pristoloma stearnsi, Bland, Stearns's Zonite, has a similar range, but also reaches into Alaska. It resembles the last species, but is more elevated, more striate, and it has seven whorls. Its diameter is 4 mm.

During the months when rain falls upon the Pacific Coast a stranger is apt to be startled by meeting specimens of a yellowish slug of a remarkable size; but old residents are used to them and are not at all disturbed, though very few express any appreciation for the slippery things. In damp and shady places they are active all of the year, though in the time of summer drought they are seldom seen in the fields. A picture of a half-grown specimen is given in

Fig. 264

Figure 264. They frequently reach a length of six inches or more, and look as if they were exceedingly well fed. While speaking of food we may remark

that they are especially fond of orange peel, and they will be pretty sure to find it if a piece is left near their haunts, a fact indicating that they have a keen sense of smell. It is a common sight to observe three or four healthy specimens gathering around one piece of orange peel. They are also fond of milk, and will be found in the morning gathered around pussy's saucer which was left out in the yard over night.

The name of this species is *Ariolimax columbianus*, Gld., the Great Yellow Slug. Occasionally a specimen is found that is partly covered with large dark spots, but at best it is only a spotted form of the main species. I have seen this spotted variety near the Russian River, in Sonoma County. A variety *stramineus*, Hemphill, of a light straw color is described as existing on Santa Cruz Island.

Two other species, *Ariolimax californicus*, J. G. Cooper, and *Aphallarion buttoni*, Pils., & Van., cannot readily be distinguished from *A. columbianus* by external characteristics, though they differ internally, particularly in the genitalia.

Ariolimax niger, Cooper, the Black Slug, has a body long and narrow, blunt in front and tapering but little behind. When crawling the animal is some two inches in length, but when at rest, as it may be found under old boards and similar places, it is so contracted that it is hardly one inch long. Its color is quite dark, sometimes being nearly black, especially on the upper surface of the body; but I have found specimens which are very much lighter, almost an ashy gray. This species is common in central California.

Ariolimax hemphilli, W. G. Binney, Hemphill's Slug, is a small, slender, flesh-colored slug, with a pointed tail, which was first collected at Niles, Cal., though it probably lives in the neighboring parts of the Santa Clara valley.

Hemphillia glandulosa, Bl. & Bin., the Hemphillia, is a curious little mollusk that lives in Oregon and Washington. When extended it is an inch or two long; but on its back is a hump, and on the hump is a shell, brownish, flattened, and scale-like, one-fifth of the length of the animal. The color is smoky white, with dark brown blotches running from the mantle to the foot.

Binneya notabilis, Cooper, the Binneya, is a curious Mexican form found on Santa Barbara Island. The shell is ear-shaped, light, thin, and horn-colored. It is not large enough to cover the snail-shaped animal. The shell is from 7 to 14 mm. in length.

Pyramidula asteriscus, Morse, the Star Snail, is a very small creature, the shell being about one sixteenth of an inch in diameter. When examined with a microscope it shows a low spire and a large umbilicus, while its four whorls are marked with many sharp cross-ridges. Its color is brown. It is widely distributed, living in wet grass, from New England to California.

Pyramidula lineatus, Say, the Lined Snail, has a discoidal shell an eighth of an inch across, in which the four whorls are coiled up almost in the same plane, with raised lines revolving upon them. It is found all over the United States.

Fig. 265

Oreohelix strigosa, Gld., the Mountain Snail, is the most numerous of all the snails found between the Rocky Mountains and the Sierra Nevada Range. It assumes very many forms, some of which have been described as separate species. One of these forms is shown in Figure 265, which by some would be classed as *O. Haydeni*, Gabb. Concerning this point I quote from Mr. Binney, who says, "I have received from Mr. Henry Hemphill specimens of *Helix Haydeni* with the animal, and so variable that I am convinced of its being a variety of *strigosa*." Mr. Pilsbry inclines to a separation of the species, though admitting their close relationship. As the forms are so difficult of separation I see no advantage in such a book as this of trying to distinguish between them. The specimen for the figure was selected from a large number of typical shells, because it seemed to be intermediate between the greatly varying forms.

The Mountain Snail abounds especially in Idaho and Utah, and some varieties are found far up on mountain sides, even as high as 8500 feet. The shell has a broad umbilicus, a nearly circular aperture, and a sharp lip. The whorls are about five in number, and in most specimens the spire is low. The average diameter is about three-fourths of an inch, though some varieties are much smaller.

Perhaps no other shell in the country has so many varieties as this mountain snail. Some of them are almost smooth, some ribbed spirally, others transversely. Some are nearly white, others are marked

with brown stripes. Very many of the varieties have received names, such as *cooperi*, *hemphilli*, *gouldi*, *castanea*, and *multicostata*, but it would be out of place in this small volume to attempt to describe them all. If any of my readers have an opportunity to collect and study these snails, they will have a very interesting opportunity to compare the different forms.

One of the most marked varieties, which we shall even consider as a distinct species, is *Oreohelix idahoensis*, Newc., the Idaho Snail, a view of which is given in Figure 266. The shell is small, strong and white. The whorls are crossed by many blunt ribs. Its diameter is about half an inch.

Fig. 266

Oreohelix elrodi, Pilsbry, Elrod's Snail, is another of this series, and is found in the Mission Mountains of Montana. The last whorl of this shell has an acute, peripheral keel, for which reason it is believed by some to be identical with the California species, *Epiphragmophora circumcarinata*, Figure 269. The shell is nearly an inch across.

Patula solitaria, Say, the Solitary Snail, is essentially an eastern species, being particularly abundant near the Ohio River. Nevertheless it is found in Idaho, Oregon and Washington. The shell is low, and has five whorls, a large, circular umbilicus, and a sharp outer lip. It is of a yellowish brown color, and the whorls are banded with two dark brown stripes with a lighter one between them. Its diameter is three-fourths of an inch or more.

Punctum conspectum, Bland, is the Dial Dot-

shell. One morning a few years ago I was surprised to find the marble sun-dial on the lawn all dotted with little groups of these microscopic snails. I gathered a number, and soon afterwards they disappeared as suddenly as they had come. I have never seen them since, though I presume they still live among the grass roots. Under the microscope the shell is very pretty, having a moderately elevated spire of four whorls, which are marked with fine cross ribs. The umbilicus is large, and the shell when inverted looks like a shallow bowl. The shell is dark horn-colored, and is about as large as the head of an ordinary pin. The variety *pasadenae*, Pilsbry, is widely umbilicated, and is without the spaced riblets, or has them very slightly indicated. Its diameter is two millimeters. It was found in a garden at Pasadena, and presumably it had gone there to admire the flowers, even as my specimens had climbed the college dial to find out the time of day.

Punctum randolphii, Dall, Randolph's Dot-shell, has a minute, reddish brown shell, with a dull silky lustre. Its four whorls are quite elevated, and the umbilicus is small. It is very minute, having a diameter of less than 2 mm. It is found under leaves, near the city of Seattle.

Helix aspersa, Mull., the Spotted Snail, is a European species which was introduced into this country many years ago. It seems to thrive about settlements, quite unlike most of our native species, and in some places it has already become a source of much annoyance, eating garden flowers and vegetables altogether too freely. It is very easy to raise broods of

the young of this species in a snailery, which may be constructed somewhat like a small hotbed. The old ones lay eggs freely, the eggs looking like little pearls, and the young snails feed readily upon lettuce and cabbage leaves, reaching full size in about two years. I once reared a large number in this way, but at length I was obliged to dispose of them for fear that they would escape and do injury. I am now trying the experiment with our native Cypress Snail, Figure 270, and my only fear is that they will not do well in captivity. Any of these experiments are interesting, however, and I would advise the boys and girls to try to raise such snails as naturally live in their neighborhoods, and other harmless species.

The shell of the Spotted Snail is large, about an inch in diameter, nearly globular, thin, and marked with wrinkles. The color is brownish gray, with bands of chestnut and threads of yellow, giving the shell a spotted appearance, from which fact it takes its name. This species, as well as some others, is used for food by the French, and it is not unlikely that the first ones were brought to this country for the purpose of propagating them for domestic uses. It is said that the first colony was established in the city of San Jose.

We begin our study of a most interesting division of the old genus *Helix*, which included all of the common land snails, by examining the picture of a fine specimen of *Epiphragmophora fidelis*, Gray, the Faithful Snail, as shown in Figure 267. The long name given to this division of snails simply means "epiphragm-bearer," and the epiphragm which he

bears is the door which the snail constructs across the entrance to his shell when he goes into retirement, as many of these creatures do during some part of the year. In the dry regions it is during the summer, and in the colder parts of the coast it is during the time of frost and snow. This epiphragm is not a permanent affair like an operculum, but it is constructed of dried mucus and resembles white blotting paper. Sometimes there are several layers, one behind the other. When more favorable conditions for the active life of the snail arrive he loosens these layers of paper and pushes them out of the way. The next season he constructs new ones.

Fig. 267

The fine species of which Figure 267 gives a good idea, lives mostly in the north, and is especially abundant in Oregon and Washington. The shells vary in size and color, but the larger ones are an inch and a half in diameter. The color is generally dark beneath, but it is lighter and more or less banded above. Albino specimens have been found. The animal has a tinge of red in its complexion, and altogether I know of no more beautiful combination of form and color than is seen some misty morning in summer, when this fine snail is found extended on a cushion of fresh green moss, beneath the protecting foliage of an old forest tree. Such a combination I once saw in one of the parks of the city of Seattle. It is needless to say that I did not disturb the beautiful crea-

ture, and I hope that he or his descendants are living there to this day.

Epiphragmophora infumata, Gld., the Smoky Snail, is commonly reckoned as a variety of the last species, but it is so different that I prefer to consider it as distinct. It lives along the northern coast region of California, and is said to be found in the canyons upon the buckeye trees. In size it is similar to *E. fidelis*, but the shell is much depressed and flattened, and the body-whorl has a sharp, angular edge, or keel. The shell has a peculiar cloth-like surface, and is of a nearly black color throughout. The umbilicus is distinct, and the aperture very oblique.

Epiphragmophora mormonum, Pfr., the Mormon Island Snail is shown in Figure 268. The shell is large and depressed, the surface glossy, and the brown edge is girdled

Fig. 268

with white. There is a large umbilicus, and the lip is recurved. This species lives in the Sierra Nevada Mountains, and was first named from specimens taken on Mormon Island in the American River. It does not live in Utah, as one would at first suppose.

There are several varieties. Var. *cala*, Pils., is smaller and less depressed. It is dark reddish-brown in color. The types are from the Calaveras Big Trees. Var. *buttoni*, Pils., resembles the last in color, but the shell is more depressed, and the surface is set with little prominences that bear golden brown hairs. Var. *hillebrandi*, Newc., is sometimes reck-

oned as a distinct species. The shell is yellowish horn-colored, with a chestnut band bordered with white. In fresh specimens the shell is hirsute. This variety also comes from the mountain region.

Fig. 269

Epiphragmophora circumcarnata, Stearns, the Keeled Snail, is shown in various aspects in Figure 269. This species was described by Dr. Stearns as a variety of *E. mormonum*, but it seems too distinct to remain as such. The shell is widely umbilicated, flattened, angulated, and it bears a peripheral keel. Besides this there are many cross-ribs, parallel with the lines of growth. It is a rare species from Tuolumne Co., Cal., possibly identical with *Oreohelix elrodi*, from Montana.

Cypress Point is a projection of land, a few miles south of Monterey, which looks out boldly upon the broad Pacific Ocean. The huge waves come rolling in and beat themselves into spray against its rugged cliffs, and the sweet breath of the ocean pours over the flattened treetops and then rushes on across the hills, carrying health and vigor to the parched interior of the State. There is no more delightful spot on this beautiful earth than this same "Point of the Cypress Trees," and whoever

visits it carries away a picture of mingled wildness, sublimity, and beauty.

It is well named; for here, within the compass of a few score acres, is the diminishing home of the cypress trees of California. From this little spot came the seeds which have developed into hundreds of miles of verdant hedges, and tens of thousands of beautiful trees.

The parent trees are venerable specimens, blown by the strong sea-breezes into the most fantastic forms. Here is one on the very edge of the bluff; its trunk is horizontal, and its thick leaved top slants up from the ground like the moss-covered roof of an ancient farmhouse. Here stands another, grim and solitary, with a gnarled and twisted trunk, upholding a close reefed sail of bright green foliage. And there is a little group of them, kneeling together towards the east, like pious pilgrims; yet showing by their defiant limbs, which are bent and knotted like the arms of wrestling giants, that though the proud west wind has brought them to their knees, still their spirit is not broken, and that they continually throw back his challenge, and that they will never yield their ground till the last green leaf has withered on their scant and flattened tops.

In the midst of all this mingling of the beautiful and the picturesque is the home of a very humble but very interesting mollusk, named *Epiphragmophora dupetithouarsi*, Desh., the Cypress Snail, shown in Figure 270. During the summer months I have sought them under the old cypresses, and have found them quietly sleeping under old logs,

behind pieces of loose bark, among the twigs forming a wood-rat's nest, and in other out of the way places. Many empty shells I also found, to my great regret, for each had a hole in the side or near the apex, showing that the owner's life had been violently taken away. For this act of vandalism the blue jays were evidently responsible to a large extent, and even while I was collecting my few specimens, these saucy birds stormed and scolded in the trees, as if I was the real robber and not they themselves. I verily fear that these reckless marauders, combined with their confederates, the ground squirrels, will speedily rob Cypress Point of one of its chiefest attractions.

Fig. 270

However, I took away a number of specimens of the dormant snail, as well as a good many of the

best shells which the jays had dared to desecrate, and after their long summer's sleep I placed some of the former in a fernery and sprinkled them with water. After a few hours they slowly pushed themselves out into the open world and became quite lively for snails, and seemed to enjoy their state of captivity to a reasonable degree. One of these captives posed for his picture one fine day, and you see the result in the engraving.

The shell is umbilicated and seven-whorled; the spire is low conical, and the outer lip is but slightly thickened. The peristome is whitish, but the shell is dark chestnut, with a still darker band, which is

edged with equal stripes of light yellow. The animal is slate-colored, and its surface is covered with numerous little elevations. The diameter of the shell is about three-fourth of an inch, though specimens are occasionally found that are somewhat larger. During the past summer a box of fine live specimens was given me by a lady in Pacific Grove, who had found a fine colony of them in her garden. I have placed these in a snailery, and hope to induce them to live and multiply.

Epiphragmophora sequoicola, Cooper, is the Redwood Snail. This species resembles the last in size and general form, but it has a more elevated spire. The surface of the shell is not smooth, but is somewhat roughened by cross lines, while the upper whorls have many crowded granulations. It is found in wooded regions in the vicinity of the coast, near Santa Cruz.

Epiphragmophora traskii, Newc., Trask's Snail, comes from the coastal regions of southern California. It has a small umbilicus, six whorls not greatly elevated, which are dark horn-colored, and bear a chestnut band that is edged on both sides with white or yellow. The surface is marked with microscopic striae. The diameter of the shell is usually less than an inch. There are several varieties.

Epiphragmophora carpenteri, Newc., Carpenter's Snail, comes from San Diego and Mexico. It resembles the last species, but has a more delicate shell. It is a decidedly southern form of snail.

Epiphragmophora coloradoensis, Stearns, the Colorado Snail, was originally found near the Grand

Fig. 271, $\times \frac{1}{2}$ (*)

Canyon of the Colorado, opposite the Kaibab plateau, at an elevation of 3500 feet. The views of the shell given in Figure 271 are magnified to twice their real diameter, but they give the form with great detail. The shell is rather fragile, and varies from pale horn-color to white, with a reddish brown band.

Epiphragmophora exarata, Pfr., the Furrowed Snail, is a species which resembles a small specimen of the next species. The shell is yellowish in color, with a narrow band of chestnut, and the surface is decidedly plowed up with fine transverse furrows. There are seven whorls, ending in a white, slightly reflected lip. This species is from the coast region of

California, both north and south of San Francisco. Its diameter is about an inch.

Epiphragmophora arrosa, Gld., the Dented Snail, shown in Figure 272, has a fine, large, and rather solid shell. The seven whorls, which are yellowish-brown in color, are banded with a

Fig. 272

dark stripe, sometimes wider than is represented in the cut. The shell is quite rough, with furrows and hammer marks, and the umbilicus is distinct, though partly covered with the reflexed peristome. The home of this species is along the coast of central California, especially in Marin County. I found several fine specimens there in the summer-time by turning over the dry leaves under the buckeye trees.

Epiphragmophora californiensis, Lea, the California Snail, is shown in Figure 273. The original specimens of this much disputed species came from Monterey, and that is where it now grows to perfection. It loves sand and sea-air and *Astragalus* leaves, and in summer it may be found near Point Pinos, buried in the sandy soil, underneath the abundant clumps of Rat-tleweed. The figure represents an unusually large specimen. The shell is thin, delicate, and almost globular in form; it is of a light horn-color, with a dark band.

Fig. 273

While the shell just described is almost spherical, a number of varieties exist which diverge from the typical shape very materially. In fact, it has been a disputed point whether they are at all related, but as the general trend of modern research inclines in the direction of unity, they will be so classified in this book. If anyone prefers to consider them as distinct species he will have many good reasons for his opinion.

Var. *nickliniana*, Lea. Shell minutely umbilica-

ted, rather thin, faintly indented and granulated; ash-yellow with a chestnut band, lip white, reflexed at the base. Whorls six, spire moderately elevated, diameter one inch. It lives near the coast of central California.

Var. *ramentosa*, Gld. The surface of the shell is cut up into innumerable checks, which are shown by a lens to consist of little oblong grains, arranged parallel to the lines of growth. The epidermis of the young ones is studded with little bristles. Diameter about three-fourths of an inch. This form is found in Alameda Co., Cal., and in adjacent regions.

Var. *diabloensis*, J. G. Cooper, has a flattened shell, umbilicated and thin, with regular malleations arranged in revolving series, like dents caused by the blows of a small hammer. Diameter rather less than an inch. From the Coast Mountains of central California, being named from its occurrence near Mt. Diablo.

Var. *contracostae*, Pils., is smaller than the last variety, yellowish straw-colored, only slightly malleated, outer lip thickened. From Byron Hot Springs, Contra Costa Co., Cal.

Epiphragmophora ayresiana, Newc., Ayer's Snail, is a species from the islands of Santa Rosa, San Miguel and Santa Cruz. The shell is quite strong, six-whorled, and it has a considerably elevated spire and a distinct umbilicus. Microscopic striae may be traced upon the shell. It is of a brown or chestnut color, and it is usually girdled

with a broad, dark band. Its diameter is three-fourths of an inch.

Epiphragmophora tudiculata, Binney, the Bruised Snail, has a large shell, rather thin, marked with numerous indentations; umbilicus nearly or completely closed, peristome white, and thickened near the umbilicus. The six whorls are of an olive brown color, and a rather wide band with a lighter space above and below it encircles the body-whorl. Its diameter is upwards of an inch. This is a southern species, being found about San Diego, also ranging through Tulare and adjacent counties to the Sierras. Var. *umbilicata*, Pils., shell smoothish, malleation weak, umbilicus widely open, diameter 27 mm.; from San Luis Obispo Co., Cal.

Epiphragmophora gabbi, Newc., Gabb's Snail, comes from San Clemente Island. The shells are about the size of large peas, thin, light horn-colored, with a dark band. Var. *facta*, Newc., is more solid and compact; shell, whitish, peristome yellowish, thick and reflected. From Santa Barbara and San Nicolas Islands.

Epiphragmophora rufocincta, Newc., the Red-banded Snail, is a small species from Catalina Island. The shell is smooth, thin, with a low spire. Horn-colored, with the ever present band of chestnut which marks so many of the California snail shells. The diameter is 17 mm.

Epiphragmophora intercisca, W. G. B., the Horseshoe Snail, has a shell strong, solid, with lines of growth distinct and crossed by spiral lines cutting the surface into little blocks. The aperture is oblique and shaped like a horseshoe. The color is white or

brown, sometimes obscurely banded; diameter 22 mm. From San Clemente and Santa Cruz Islands.

Fig. 274

Epiphragmophora tryoni, Newc., Tryon's Snail, is shown in Figure 274. The shell is strong and solid, globose conical, with a rounded apex and five regular whorls. The surface is reticulated, or cut into fine checks by the crossing of spiral threads and the lines of growth. The color varies from white to brown and the whorls are often banded, while the upper half of each whorl is usually darker than the corresponding lower half. The animal is said to be black. Chiefly from Santa Barbara Island.

Epiphragmophora kelletii, Fbs., Kellett's Snail. The shell consists of six whorls, the spire is rather low, and the umbilicus is nearly closed. Shell smooth, color varying from whitish to brown, usually mottled, with a dark ring around the center of the body-whorl. Diameter about an inch. From Catalina Island, where it is reported as plentiful on and under old cactus branches.

Epiphragmophora stearnsiana, Gabb, Stearns's Snail, is sometimes called a variety of the last species. The shell is narrowly umbilicated, solid, with fine incremental striae. Whitish, with ash-colored spots and a brown band. Found on the seaward side of Point Loma, San Diego, where most of the specimens are dead, and in Lower California.

Epiphragmophora arnheimi, Dall, Arnheim's Snail. This small snail is found in Contra Costa Co., Cal., near San Pablo. Its diameter is 18 mm.

The suture is deep, also the umbilicus, while the lip is unusually thick for the size of the shell.

Glyptostoma newberryanum, W.

G. Binney, Newberry's Snail, is a very distinct species, found in southern California, particularly around San Diego. A basal view of a small specimen is shown in Figure 275, but large ones grow to a diameter of an inch and a half. The spire is flattened, and the umbilicus is very large, distinctly showing the coil of rounded whorls. The lip of the aperture is thin and acute, the whorls are six in number, and the color of the shell is dark brown, sometimes almost black. It is quite distinct from any other shell.

Fig. 275

Fig. 276

Polygyra townsendiana, Lea, Townsend's Snail. This distinct species, whose fine large shell is shown in Figure 276, is a true northerner, being found mostly in Oregon, Washington, and even much

farther to the north. The shell is strong, the spire but little elevated, the color yellowish or brownish, sometimes mottled. Peristome like a white horse-shoe, umbilicus large and distinct. The surface is marked with many microscopic spiral lines, which are crossed by roughened ridges. Var. *ptychophora*, A. D. Brown, is found in Idaho and eastern Oregon. The shell is nearly smooth and is of a light horn-color, but it has the regular markings, and the broad,

white peristome of the typical specimens; diameter, 20 mm.

Fig. 277

Polygyra columbiana, Lea, the Columbia Snail, Figure 277, is a species which extends from Alaska southward into California. Whorls six, umbilicus small, peristome reflected, aperture ear-shaped. In some varieties, as shown in the cut, there is a small white tooth on the inner wall of the aperture. The figure is of the natural size. The shell is light horn-colored, and the epidermis on the upper whorls is set with short, stiff, microscopic hairs. Var. *armigera*, Ancy, is smaller, more globose and convex beneath, and more beset with hairs, which are arranged in very oblique rows. Var. *labiosa*, Gld., has a nearly circular aperture and widely reflected peristome.

Polygyra devia, Gld., the Devious Snail, is a species which lives in Oregon; it has also crossed the Cascade Mountains and entered Idaho. The shell is horn-colored or brown, solid and six-whorled. The peristome is white, wide, and bent back at right angles to the wall of the aperture. There is a distinct white tooth on the inner wall of the aperture, and sometimes one or more waves on the peristome. There are several varieties which range from half an inch to a whole one in diameter.

Polygyra mullani, Bland, Mullan's Snail, was at one time considered as a small variety of the last species, but it is now believed to be distinct. The shell is shining, with a thin epidermis covered with minute spiral lines and tubercles. The aperture is

three-lobed, and the umbilicus is partly covered by the lip. The shell is dark horn-colored, and the diameter is half an inch. This species is especially found in eastern Washington and Idaho.

Polygyra loricata, Gld., the Mailed Snail, has a little shell only a quarter of an inch in diameter, but its five and a half whorls are very distinct. The umbilicus is small but deep, and the spire is low and dome-shaped. Aperture irregular, with white tooth on the columella and two thickened spots on the outer lip; surface horn-colored. Found in California near San Francisco, and also in the Sierras.

Polygyra mearnsii, Dall, Mearns's Snail, is shown in Figure 278. This shell is of a pinkish-brown color, and the details of its structure are well brought out in the three figures. Its diameter is about half an inch. It is found in Arizona and New Mexico.

Vallonia pulchella, Mull., the Beautiful Vallonia, is a little mollusk whose shell consists of four rounded whorls arranged in a flattened spiral form. The umbilicus is large and open, the aperture nearly circular, the peristome white, reflected, and forming a nearly complete circle. The shell is whitish, thin, and in our variety is usually marked by cross-ribs. Its diameter is barely an eighth of an inch. This species is very widely distributed. A few years ago it suddenly appeared in

Fig. 278, $\times \frac{3}{2}$ (*)

Los Angeles, in the yard of Dr. Stearns. It has been reported from Oakland and many other localities in California, also from Utah and adjacent states.

Vallonia costata, Mull, the Ribbed Vallonia, is another very small species, the shell being only 2.5 mm. in diameter. Horn-colored, nearly flat, umbilicated, with regularly set membranous ribs, and fine striæ between them. It has about the same range as the last species.

A genus of medium sized mollusks living chiefly in New Mexico was named by Professor Pilsbry *Ashmunella*, in honor of the late Rev. E. H. Ashmun, of happy memory, who united with his clerical duties the enthusiasm of the naturalist. The shells in general are about half an inch across, horn-colored, with five or six whorls, a small but distinct umbilicus, and a white, reflexed outer lip. Some of them were formerly referred to the genus *Polygyra*. In this book I shall not attempt to name them all, but will mention a few, specimens of most of which were sent me by Mr. Ashmun himself.

Fig. 279, x $\frac{2}{3}$ (*)

Ashmunella rhyssa, Dall, the Wrinkled Snail, is shown in Figure 279. The shell consists of six rounded, yellowish whorls, which are crossed by very numerous wrinkles. The reflected peristome is white, and immediately behind it the shell is considerably constricted. It was collected in the

White Mountains of New Mexico by Rev. E. H. Ashmun. The diameter is 17 millimeters. Some of the specimens of this species have a white tooth on the columella, as is shown in the figure; in others it is very small or absent altogether.

Ashmunella pseudodonta, Dall, the False-toothed Snail. Figure 280 gives us two enlarged views of this shell. I have a specimen which is nearly

Fig. 280, $\times \frac{1}{2}$ (*)

Fig. 281, $\times \frac{1}{2}$ (*)

three-fourths

of an inch across in its largest diameter. It is distinctly horn-colored, but is nearly smooth, showing lines of growth but no ridges. It has a very faint beginning of a tooth. Other specimens are smaller, and more nearly resemble the figure.

Ashmunella ashmuni, Dall, Ashmun's Snail. Three enlarged views of this pretty little shell are given in Figure 281. The diameter is 14 millimeters. The horn-colored whorls are crossed by a great number of very fine lines of growth. One of my specimens shows a very

small elevation on the columella, as if it were the beginning of a tooth. The reflected peristome is not pure white, but partakes of the shade of the shell. Altogether it is a very pretty species; the well defined umbilicus, the distinct and clearly defined whorls, and the rich color making it one of the most attractive of our smaller snails. It comes from Bland, New Mexico, at an elevation of 8,000 feet above the level of the sea.

Ashmunella levettei, Bland, Levette's Snail, (*Polygyra levettei*), has a shell that is umbilicated, thin, shining, translucent, obliquely striated, with seven whorls. Aperture with a transverse parietal tooth, with teeth on the lip also. Peristome pale chestnut-colored, diameter 17 mm. It is found near Santa Fe, N. M.

Fig. 282, $\times \frac{1}{2}$ (*)

Ashmunella chiricahuana, Dall, the Chiricahuana Snail, (*Polygyra chiricahuana*), is shown in a magnified form in Figure 282. The shell is depressed, thin, polished, and of a dark brownish color. The lip is strongly reflected and the aperture is destitute of teeth; diameter 18 mm.; from Arizona and New Mexico.

Cochlicopa lubrica, Mull, the Brilliant, (*Ferussacia subcylindrica*), is shown in Figure 283. The little creature to which this shell belongs lives

chiefly in forests, concealing itself under leaves and the bark of dead trees. It is about the size and shape of a grain of wheat, thin, dark horn-colored, very bright and glistening.

This species lives in Europe, where it is known in France as "la brillante," also in the Eastern states, Alaska, Oregon, and Utah, and it has even been collected on Grizzly Peak, back of the University of California.

Fig. 283

Fig. 284

The members of the old genus *Pupa* are mostly very small, though some of them grow to a fairly good size. The shell shown in Figure 284 is a representative of this great division of land shells. The picture is small enough, but even the little cross beside it is too large for truth. The name is *Vertigo californica*, Rowell, the California Pupa. The shell is brown, and on the sides of the aperture are four tiny white teeth. It lives in various parts of California on the mainland, and two varieties live on Catalina Island.

The Pupae belong to a very ancient family, as we know from the fact that a little fossil shell belonging to this genus was found in a coal mine in Nova Scotia, and is reckoned as the oldest land shell ever discovered. They take their name apparently from their resemblance to the cocoon of an insect, which in turn is supposed to resemble a doll. Many of these shells are exceedingly minute, measuring less than two millimeters in length. They are usually found in lowly positions, such as among grass roots, under old cacti, in river drift and similar positions.

The shells are so very small that only a few of them will be mentioned.

Fig. 285, $\times \frac{1}{2}$ (*)

HoloSPIra arizonensis, Stearns, the Arizona Pupa, is shown in a magnified form in Figure 285. The shell is really but half an inch long; the figure, however, brings out the details of its structure. In color it varies from dingy-white to pale-horn. It was collected at Dos Cabezas, Arizona.

Some of the species of the old genus *Pupa* are now known as *Bifidaria*, among which we may mention *Bifidaria armifera*, Say, the Armored Pupa. This species is found all through the East; it has also been collected in New Mexico. It is relatively quite large, being from 2 to 4 mm. in length. It resembles Figure 284, but has six or seven whorls, and the aperture is almost filled with projecting teeth.

Figure 286 gives a view of the shell of *Succinea ovalis*, var. *haydeni*, W. G. B., Hayden's Amber-snail. In general it may be said that the Amber-snails are rather small mollusks, which love moisture, though they do not often enter the water. The yellowish shell of this species is long, thin, and few-whorled. The aperture is very large and from its base you can look inside the shell to its very apex. The spire is small and consists of three delicate

Fig. 286

whorls. The length of the whole shell is three-fourths of an inch. The specimen from which the drawing was made was collected near Salt Lake, Utah.

Succinea avara, Say, the Greedy Amber-snail, Figure 287, has a smaller shell than the last species. It is delicate and horn-colored, and the figure is rather larger than the real shell. This species is reported from Idaho and southern California. Several varieties of this species live on the Santa Barbara Islands.

Fig. 287

Succinea rustica, Gld., the Rustic Amber-snail, is found in Oregon, California, and Nevada. The shell is thin and fragile, of a pale greenish horn-color; surface rough and without luster, spire acute, length half an inch.

Succinea oregonensis, Lea, the Oregon Amber-snail. Shell one-fourth of an inch in length, though sometimes longer, thin, yellow, rather coarsely striated, with an aperture two-thirds the length of the shell.

Onchidella carpenteri, W. G. Binney, Carpenter's Onchidella. This is a little creature shaped like a short, fat Limax, with the ends rounded and the upper surface arched. The coriaceous mantle overhangs the locomotive disk. The body is smoke-colored, and its length is one-fifth of an inch. It lives near the water, and is found from the Straits of Fuca to Mexico.

Onchidella borealis, Dall, the Northern Onchidella, is but little larger than the last species. The surface of the creature is black, with dots and

streaks of yellowish-white; its foot is light-colored, also the muzzle and tentacles. It is found at Sitka, and on Vancouver Island.

CEPHALOPODS

At this point we will briefly consider our members of the highest class of mollusks, the Cephalopods. They are rather poorly represented on our coast, though one species at least exists in great numbers. Shells of a Paper Nautilus, *Argonauta pacifica*, Dall, are sometimes washed ashore on the Santa Barbara Islands. They are white, thin and delicate, and are very different from ordinary shells. A much more common species of this class is the Octopus, or Devil-fish, or Cuttle, of our coast, *Polypus punctatus*, Gabb, small specimens of which are frequently captured alive in little tide-pools, though in the open sea it grows to startling dimensions.

The Octopus is one of the most remarkable creatures of the sea, and many are the tales, true and otherwise, which have been told of his structure and his actions. He has eight long, active legs, without bones or stiffness, which are arranged like the rays of a starfish. Above the center of the star is the bag-shaped body, and near the junction of the body and legs is the head, with its two staring eyes, its parrot-like beak, and its siphon pipe, by means of which the creature can propel himself backward through the water.

It is an active animal at times, creeping briskly over the stones at the bottom of the water, or swimming rapidly with its legs trailing behind. It has

the power of changing its complexion at will, looking pale and ash-colored when it is near sand, flushed and angry when among red seaweeds, and dark and bluish whenever such a color will best serve its purpose of concealment. There is no magic in his transformations, either, for he is only controlling the multitudes of little paint bags that lie in his skin, and making any desired tint prominent, or concealing them all. At any rate, there are few more interesting creatures to watch in an aquarium, or even in a jar of sea-water, than a young cuttle. Small specimens have legs some two or three inches long, while large ones weigh a hundred pounds or more.

The true scientific names of the next two species are at present quite uncertain, though it is probable that both species will be placed in the genus *Loligo*, and that other changes may be found necessary. The names used in a former edition are, however, provisionally retained.

Ommastrephes tryoni, Gabb, is the common Squid of Monterey and other fishing ports. They used to be caught in vast numbers by the Chinese fishermen of the above named city, and the houses and boats belonging to the fishing village were a very picturesque addition to the sights of the coast. The men went out at night, when the bay was quiet, some of their boats bearing huge torches, while the others were provided with scoop-nets. The silly squids rise to the surface to see the light and are easily captured. Next day they are spread out to dry, some of the best on racks, but most of them on the parched grass of a field. From time to time they are turned, and

when thoroughly cured they are packed in huge bales and sent to China for food. The average length of the common squid is about eight inches. It differs from the Octopus by having shorter legs, and a long, straight body, with an arrow-shaped tail. It is this long body that contains the white muscle which is so highly prized as food.

Another squid, *Ommastrephes gigas*, d'Orb., is occasionally taken at Monterey, which measures fully a yard in length. Its body is stiffened by a transparent "pen," shaped somewhat like a large feather. Other cuttles contain the "cuttle bones" which we feed to our canary birds; they also have bags of ink, or sepia, and so the Cephalopods are sometimes called the "Literary Family of the Sea."

CHAPTER XIII

SHELLS OF LAKES AND STREAMS

By Harold Hannibal

The fresh-water mollusks include both Gastropods and Pelecypods. They may be distinguished from most other shells by having a greenish or brownish horny epidermis covering the shell, to protect it from the corrosive acids in the waters in which they live. Unlike the land and marine shells, they have been little studied, and many interesting things can be learned by anyone who takes the trouble to observe them. Most of the species are not common or are found at but few localities. For this reason the writer has selected for description only some of the more wide-spread and particularly interesting forms, but representing nearly all the genera.

For convenience the distribution is given by drainage basins or systems. The Columbia System includes the entire Columbia, Fraser, and Umpqua Basins. The Utah System includes the eastern portion of the Great Basin which drains into the former Lake Bonneville. The Nevada System includes the western portion of the Great Basin draining into the former Lake Lahontan, and the Owens Basin and Mojave Desert in California. The Klamath System includes the Klamath and Rogue Basins, the Sierras

north of Yosemite Valley, and the Coast Ranges south to San Francisco Bay. The Coast Range System includes the coastal drainage south to Point Conception, the Sacramento-San Joaquin Valley, and the west slope of the southern Sierra Nevadas. The Los Angeles System includes the coastal drainage of southern California south to the San Pedro Martir Mountains in Baja California. The Colorado System includes the drainage of the Colorado River above The Needles. The Arizona System includes the Gila and Salton Basins and the Colorado Delta.

THE NAIADS OR RIVER MUSSELS

(*Unonidæ*)

In almost any large perennial stream or lake are to be found members of this interesting group. They are especially abundant both in species and individuals in the tributaries of the Mississippi River, for those streams flow over limestone which dissolves and forms abundant material for their shells. They often attain a large size; some species are as big as this book. Of late years an enormous industry has developed of collecting these shells for the purpose of making pearl buttons and as a result their numbers have been terribly depleted and laws are being enacted to protect them. Since only large, heavy shells are used, collectors on this coast need not worry, for our species are too few in numbers, too small, and too fragile. Pearls are often found in these mussels; the writer has obtained them in both

Gonidea and *Margaritana*. They are seldom of value however.

The Naiads have a very interesting life history. The young, called glochidia, after being hatched in the parents' gills are thrown out into the water in vast numbers. The glochidium is a minute, curious creature, armed with hooks, and hangs suspended by a byssus from some aquatic plant. An unwary fish bumps against it; immediately the glochidium clings to it by its hooks. It remains attached about three months when it has grown a shell and become so heavy that it falls to the bottom. Then it grows into an *Anodonta* or whatever its parents were. Many die to one which survives, but the Naiads are prolific and keep up the species while this peculiar method serves to distribute them.

One warm day while on a collecting trip, I stopped at the bridge over the San Lorenzo River below Felton, Cal., and prepared to investigate the clammy mysteries of the river. This river is a splendid stream, broad and clear, running between high banks lined with willows, alders, and other water-loving trees. After the dusty road it felt good to wade along in the cool water and feel the clean sand-grains sift across one's toes. Whoop! A startled bluejay flew screaming from a neighboring tree where he had been suspiciously eyeing me. I bared my arm, reached into the water, and picked up a dark object partly buried in the bottom. Shaking the sand off I held up a fine specimen of *Margaritana margaritifera*, Linné, the Pearly Naiad, Plate I, Fig. 4. It

was covered with a glossy mahogany epidermis except at the umbos, where the sand grains had worn nearly through the stout shell. Opening it with my knife, I beheld a lining of an orange as brilliant as an *Eschscholtzia*. Dropping it into my bag I continued my wading. Another! Opening this I found it a beautiful royal purple. A third was an exquisite pale blue, a blue no artist might duplicate. As I look at the faded shells now I think how elusive is nature and how impossible to more than imitate her.

The shell is elliptical with one central tooth at the umbo in the right valve, and two in the left. In some specimens these are small, in others large and there is a trace of lateral teeth. It is the only species on the Pacific Slope that has more than a suggestion of teeth. The pearly interior is purple, orange, blue, pink, or green. The color is very fugitive. The shells of this and other Naiads should be rubbed with a very little vaseline and wiped dry with a bit of cotton. This will prevent them from cracking and preserve the color in a measure if kept in the dark.

This species delights in clear, swift streams where it lies partly buried in the gravel or sand bottom. Found in the Columbia, Klamath, Utah, Nevada, and a few places in the Coast Range System, also in New England, Europe and Asia.

Anodonta cygnea, Linné (*A. oregonensis*), the Swan Naiad, Plate II, Fig. 7, with its numerous forms, is one of the most common, widely distributed, and variable river mussels, which is saying

a good deal. Hence it has been described on this Coast and Europe under over a hundred names. The American varieties are discussed by the writer elsewhere and the three best marked retained; these are the typical form, *A. c. beringiana*, Midd., and *A. c. impura*, Say.

The typical shell is buff or green-brown, inflated, sub-elliptical, with low umbos, and a straight, narrow, toothless hinge-line. Within it is iridescent blue or pearly-white. This form is the common one in Eurasia and the Columbia and Klamath Systems. It is found occasionally farther south.

The common southern form, *Anodonta cygnea impura*, Say (*A. wahlamatensis*, *A. nuttalliana*, *A. californiensis*), the Winged Naiad, Figure 288, is

Fig. 288

disco-triangular, flattened, light green or brown outside, iridescent or pearly within, and has a pronounced posterior wing. It inhabits streams and lakes in the Utah, Nevada, Coast Range, Los Angeles and Arizona Systems, also the western drainage of Mexico. It is found less commonly as far north as British Columbia.

A species resembling an *Anodonta* and long

Fig. 289

classed with them is *Gonidea angulata*, Lea, the Pacific Naiad, Figure 289. This lacks the hinge-teeth except as rudiments, is rather pointed in front, somewhat triangular, and is unequally divided by a carina or angle extending from the umbo to the lower posterior corner of the shell. Pearly within, nacre blue, pink, or yellow brown. Specimens with ova are a brilliant copper color which, however, soon fades after death.

Found in the Columbia, Klamath, and Coast Range Systems, usually in clay banks or beds of streams.

THE SPHERE AND PEA SHELLS

(Sphæridæ)

In springs, lakes, and streams having a mud bottom are found small shells distantly related to the Cardiums of the ocean. They are curious little fellows and have interesting habits and peculiarities of distribution.

One of the largest on the Pacific Slope is *Sphærium dentatum*, Haldeman, the Harrowed Sphere-shell, Plate II, Fig. 5. It is moderately inflated, oblong-elliptical, with low umbos set somewhat forward. The shell is covered with low growth ridges. It lives in lakes and streams in the Columbia, Klamath, and Nevada Systems.

Musculium resembles *Sphærium* but the shells are thin, light colored, and usually have a little cap or calyculæ on each umbo.

One June day, while on a collecting trip near Tehama, in northern California, I called to my friend, an odd little German, to stop as we came to a large pool at the roadside. Unhooking my net, I jumped off my wheel to collect a few shells. The net consisted of a heavy wire ring about six inches across with a piece of burlap sewed into it forming a shallow bag. A smaller loop of the wire an inch or two across served to hold it by, and made it convenient to carry on the handle-bars of my wheel. Scooping the net full of mud, I shook it carefully under the water, picking sticks, leaves, and gravel out by hand while the mud washed through, leaving only fine

sand and grit. Lifting the net out, I was surprised to find a common Eastern *Musculium*, *M. partumeium*, Say, Pl. 1, Fig. 5, among the spoils. This was a find and I gathered many specimens, dumping them into a tobacco-tin along with grit, etc., to be sorted out on my return, when dry.

This species appears to be an old settler for it has turned up since at a number of places on the coast. The shape is nearly circular, except it is squared off posteriorly. It is not generally very inflated and the umbos are low. Found in pools and lakes probably all over northern and central United States and southern Canada.

Raymond's Calycul shell, *Musculium raymondi*, J. G. Cooper, Pl. I, Fig. 3, differs from the preceding by its trigonal shape and high inflated umbos. Its habits are similar and it is found in the Columbia, Klamath, Nevada and Coast Range Systems. Its identity has been suggested with *M. rhykolti*, a European species which is said also to occur in the Eastern States.

Pisidium abditum, Haldeman, the Hidden Pea-shell, Plate I, Fig. 1, is a tiny fellow found in springs, quiet streams, and ponds all over North America. Like most widely distributed species it is rather variable and has been given a number of names. It is rather small for the genus, ovate, rather inflated, with low nearly central umbos, and it is usually brown in color.

Pisidium compressum, Prime, the Trigonal Pea-shell, Pl. I, Fig. 2, differs in being very inflated and trigonal, with high umbos. It is yellow or brown

in color and has similar habits to the last. Found over most of North America.

There are numerous other species in this family on the Pacific Slope but they are only known from a few localities.

THE POND SNAILS

(*Hygrophila*)

This is the best represented group on the coast and contains many species. All have thin horny shells and differ from the Pleuroceridæ and succeeding families by breathing by lungs instead of gills and by the absence of an operculum. They are found in lakes and streams as well as ponds.

(*Lymnæidæ*)

The largest of this group is *Lymnæa stagnalis*, Linné, the Pond Lymnæa, Figure 290. This species is distinguished by its long slender spire and large body whorl. All the members of this genus and especially this species live in quiet streams or lakes. Found in Eastern North America, Eurasia, and the Columbia, Klamath, Nevada, and Utah Systems.

The Marsh Lymnæa, *L. palustris*, Müller, Figure 291, is one of the most abundant and widespread of the pulmonates. It occurs in Europe, Northern Asia and all over North America from the Yukon tundras nearly to Mexico. It does not occur in the Los Angeles

Fig. 290

Fig. 291

or Arizona System but is found in all the others. It is rather variable but can usually be easily recognized. It is large, with the length of the aperture about equal to the height of the spire, which is not so slender as that of *L. stagnalis*. The shell is often marked by fine spiral lines and again by malleations giving it an appearance of mosaic. It is dark horn-color.

Lymnæa ohrussa, Say, the Narrow-mouth Lymnæa, Pl. III, Fig. 7, resembles small specimens of the last but has a narrower aperture, thinner shell and lacks the spiral lines. It is found on confervæ in rapid streams, ponds and often in merely moist places, in the United States and southern Canada. On the west coast it occurs as far south as the Colorado, Utah, Nevada, and Coast Range Systems.

Lymnæa cubensis, Pfeiffer, the Cuban Lymnæa, Pl. III, Fig. 4, and its several varieties are among our most common shells, but are usually overlooked as they are seldom found in the water, but usually near it or on floating algæ. They have a straight reflexed pillar; some are stubby and some are slender; some have a nearly closed umbilicus and some a wide open one. The following table will perhaps explain their relations better than a lengthy description. In general the forms with an open umbilicus are not found north of the Coast Range System, while the forms with a closed umbilicus do not range south of it. Inhabits the Antilles, Florida, Mexico, and nearly the whole United States west of the Mississippi River, replacing *Lymnæa caperata* of the Eastern States.

	UMBILICUS NEARLY CLOSED, SHELL HORNY, NORTHERN IN DISTRIBUTION	UMBILICUS OPEN, SHELL USU- ALLY PORCELLAINOUS, SOUTHERN IN DISTRIBUTION
STUBBY ↑ ↓ SLENDER	var. <i>sonomacensis</i> , Pilsbry, Pl. III, Fig. 5, Sonoma Lymnæa.	var. <i>cockerelli</i> , Pilsbry, Pl. III, Fig. 2, Cockerell's Lymnæa.
	<i>L. c. bulimoides</i> , Lea, Pl. III, Fig. 1, Bulimus Lymnæa.	<i>L. cubensis</i> , Pfeiffer, Pl. III, Fig. 4, Cuban Lymnæa.
	var. <i>sancti-josephi</i> , Hannibal, Pl. III, Fig. 6, San José Lymnæa.	var. <i>bryanti</i> , Baker, Pl. III, Fig. 3, Walker's Lymnæa.

(Planorbidae)

In the hills east of Madrone, Cal., are two pretty little lakes of great depth set end to end on top of a high ridge. About them is a dense growth of oaks and other trees. It is an ideal place to go and spend the day alone with nature, lounging in the shade, listening to the birds and myriad insect life, and watching the ever-changing colors of the forest. One wonders at the hurry and worry of life. Oh, to live like the lotus-eaters! Suddenly the fickle sun sets in a blaze of glory behind the Santa Cruz Mountains. Five miles to the depot and no supper till you get home.

In these Twin Lakes occur fine specimens of *Planorbis trivolvis*, Say, the Three-whorled Planorbis, Figures 292 and 293, a common species found all over North America. The shell grows about itself in a horizontal coil with a flat umbilicus and depressed spire. It is over an inch across and marked by fine growth ridges. Found in quiet streams, ditches, and lakes. There are a large number of so-

Fig. 292. X 93

Fig. 293

called species including *P. ammon*, based on physiological deformations of this; Fig. 293 is a fairly normal specimen while Fig. 292 is a common deformation.

Planorbis opercularis, Gould, the Operculum-like Planorbis, Plate II, Figs. 8, 12, is a small species with a flat spire, deep narrow umbilicus, and a keel at the edge of the flattened upper surface. In var. *planulatus*, W. Cooper, Pl. II, Fig. 10, the keel is more blunt and medial. Var. *centervillensis*, Tryon, Plate II, Fig. 9, lacks the keel, but the shell can be distinguished from the next species by its deeper whorls and narrow umbilicus. Found in the Columbia, Klamath, Utah, Nevada, and Coast Range Systems in streams and lakes.

Planorbis parvus, Say, the Dwarf Planorbis, Pl. II, Fig. 11, is about the same size as the last but is saucer-shaped, has very compressed whorls, and a broad umbilicus. Found among algæ and roots in streams and lakes over North America, north of Mexico.

(*Ancylidæ*)

Ancylus (*Lanx*) *patelloides*, Lea, the Mottled River-limpet, Pl. II, Fig. 1, (including *L. altus* and *A. newberryi*) is elliptical with a moderately elevated, nearly central apex. It is albino, reddish-brown, or with radiating markings within. Lives on rocks and other shells in rapid streams and lakes in the Klamath System.

Ancylus fragilis, Tryon, the Fragile River-limpet,

Pl. II, Fig. 2, is a very small species living on stems of water plants in the Coast Range System. It is elliptical, black, and has a high apex at one end. A distorted second year growth has been called *Gundlachia californica*.

Ancylus caurinus, Cooper, Pl. II, Fig. 3, is a small, elliptical species living in the Columbia System. It has been confused with the last but the apex is not so high and is more central; color light or dark, shell glossy.

Newberry's Keel-shell, *Carinifex newberryi*, Lea, Figure 294, is a peculiar Planorbis-like species related to the next. It has a nearly flat spire with flat topped whorls, keeled at the edge. The aperture is triangular and the umbilicus funnel-shaped. It grows to over twice the size of the figure. Lives in lakes and streams in the Utah, Nevada, and Klamath Systems.

Fig. 294, x $\frac{1}{2}$

The Puff-bubble, *Pompholyx effusa*, Lea, Pl. II, Fig. 4, has a thin shell, very low spire, closed or nearly closed umbilicus and is not carinate. It has several doubtful varieties which are probably physiological. Inhabits streams and lakes in the Columbia, Klamath, Utah, and Nevada Systems.

(*Physidae*)

The genus *Physa* is one of the most puzzling of our shells. A great many species have been described, and a number are usually recognized. The writer has recently studied a large series of specimens from all over the United States and has decided

that there is but one species, *Physa heterostropha*, Say, the American Pocket-shell, Fig. 295, which

Fig. 295

has slightly impressed sutures and a curved pillar. In the south it is replaced by *P. h. osculans*, Haldeman, the Southern Physa, Pl. III, Fig. 17, which has a straight pillar and impressed sutures. There are a great many forms some of which are shown in Pl. I, Fig. 5, and Pl. III, Fig. 16, 18. They are due to physiological causes. In general specimens from streams are slender, while those from lakes usually have a shorter spire and more inflated whorls. They are also liable to be distorted and develop shouldering, irregularities of the whorls, and vertical costæ. The thickness of the shell varies a great deal, for it depends on whether the snail obtains sufficient lime. This species is found from Alaska to Central Mexico. *Heterostropha* is found in the Columbia, Colorado, Utah, Nevada and Klamath Systems, while *osculans* occurs in the Colorado, Utah, Nevada, and Klamath Systems, and farther south. Occasionally specimens of each are found beyond their range.

Aplexa hypnorum, Linne, the Moss Physa, Figure 296, differs from the true Physas mostly in anatomy. The shell is heavy and glossy, with the spire equal in length to the aperture, and the sutures not impressed. This is a boreal species, occurring in Eurasia and Canada and the Columbia, Utah, and Colorado Systems.

Fig. 296

PLATE I.

Fig. 1. *Pisidium abditum*, Haldeman, (x 2), Readville, Mass., p. 306.

Fig. 2. *Pisidium compressum*, Prime, (x 2), Mohawk, N. Y., p. 306.

Fig. 3. *Musculium raymondi*, J. B. Cooper, (x 2), Likely, Pitt River Valley, Cal., p. 306.

Fig. 4. *Margaritana margaritifera*, Linné, (x $\frac{2}{3}$), San Lorenzo River, Felton, Cal. p. 301.

Fig. 5. *Musculium partumcium*, Say, (x 2), Staten Island, N. Y., p. 305.

Fig. 6. *Physa heterostropha*, Say, (form known as *P. lordi*), (X 1), Chelsea, Quebec Province, Canada, p. 312.

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PLATE I

PLATE II.

Fig. 1. *Ancylus (Lanx) patelloides*, Lea, (x 1), Pitt River above Copper City, Cal. p. 310.

Fig. 2. *Ancylus fragilis*, Tryon, (x 2), San Francisquito Creek, Stanford University, Cal., p. 310.

Fig. 3. *Ancylus caninus*, W. Cooper, (x 2), Umpqua River, Elkton, Ore., p. 311.

Fig. 4. *Pompholyx effusa*, Lea, (x 1), Link River, Klamath Falls, Ore., p. 311.

Fig. 5. *Sphaerium dentatum*, Hald., (x 1), Susan Creek, Honey Lake Valley, Cal., p. 305.

Fig. 6. *Valvata humeralis*, Say, (x 2), Dewitte, Honey Lake Valley, Cal., p. 316.

Fig. 7. *Anodonta cygnea*, Linné, (x 1), Dalles, Columbia River, Ore., p. 302.

Fig. 8. *Planorbis opercularis*, Gould, (x 2), Mountain Lake, San Francisco, Cal., p. 309.

Fig. 9. *Planorbis opercularis* var. *centervilleensis*, Tryon, (x 2), San Filipe, San Benito Valley, Cal., p. 310.

Fig. 10. *Planorbis opercularis* var. *planulatus*, Cooper, (x 2), Freeport, Wash., p. 310.

Fig. 11. *Planorbis parvus*, Say, (x 1), Artesian Belt near San Jose, Cal., p. 310.

Fig. 12. *Planorbis opercularis*, Gould, (x 2), Mountain Lake, San Francisco, Cal., p. 310.

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PLATE II

PLATE III.

Fig. 1. *Lymnæa cubensis bulimoides*, Lea, ($\times \frac{3}{2}$), Berkeley, Cal., p. 309.

Fig. 2. *Lymnæa cubensis* var. *cockerelli*, Pilsbry, ($\times \frac{3}{2}$), Lake on Cinder Cone, Susanville Road, Lassen National Forest, Cal., p. 309.

Fig. 3. *Lymnæa cubensis* var. *bryanti*, Baker, ($\times \frac{3}{2}$), Bardsdale, Santa Clara River Valley, Cal., p. 309.

Fig. 4. *Lymnæa cubensis*, Pfeiffer, ($\times \frac{3}{2}$), Bardsdale, Cal., p. 308.

Fig. 5. *Lymnæa cubensis* var. *sonomaensis*, Pilsbry, ($\times \frac{3}{2}$), (immature specimen) near Paine's Creek, Rocky Plains, Cal., p. 309.

Fig. 6. *Lymnæa cubensis* var. *sancti-josephi*, Hannibal, ($\times \frac{2}{3}$) (type), Artesian Belt, near San Jose, Cal., p. 309.

Fig. 7. *Lymnæa obrussa*, Say, ($\times \frac{3}{2}$), Wrights, Santa Cruz Mts., Cal., p. 308.

Fig. 8. *Vivipara malleatus*, Reeve, ($\times 1$), Artesian Belt, Cal., p. 317.

Fig. 9. *Goniobasis plicifera*, Lea, (physiological form called *G. acutiflosa*) ($\times 1$), Springs, upper Willow Creek, near Eagle Lake, Cal., p. 313.

Fig. 10. *Goniobasis plicifera*, Lea, (normal form) ($\times 1$), Paine's Creek, Rocky Plains, Cal., p. 313.

Fig. 11. *Paludestrina longinqua*, Gould, ($\times 2$), old gold mines, Cuyamaca Mts., Cal., p. 314.

Fig. 12. *Flummicola seminalis*, Hinds, ($\times 1$), Klamath River, Keno, Ore., p. 315.

Fig. 13. *Amnicola micrococcus*, Pilsbry, ($\times 2$), Fletcher's Spring, near Goose Lake, Cal., p. 314.

Fig. 14, 15. *Paludestrina protæa*, Gould, ($\times 2$) (Fig. 14 normal), Indio, Colorado Desert, Cal., p. 315.

Fig. 16. *Physa heterostrophæ osculans*, Hald. (physiological form called *P. humerosa*) ($\times 1$), Indio, Colorado Desert, Cal., p. 312.

Fig. 17. *Physa heterostrophæ osculans*, Hald. (normal form) ($\times 1$) ditches, Artesian Belt, near San Jose, Cal., p. 312.

Fig. 18. *Physa heterostrophæ osculans*, Hald., (lake form) ($\times 1$), Ontario, Cal. p. 312.

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PLATE III

THE BROOK SHELLS

(Pleuroceridæ)

This group, distantly related to the *Cerithiums* of the ocean, is found only in North America. Their great center is in the Tennessee and Alabama River Systems where several genera and a great number of species are found. One genus, *Goniobasis*, is represented by two species on the Pacific Slope, of which one is common and widespread.

Goniobasis plicifera, Lea, the Western Brook-shell, Pl. III, Fig. 10, is rather thin, slender, green, brown, or black, with shallow sutures. When perfect it is nearly two inches in length, but the spire is nearly always gone and the hole plugged up so it has quite a stumpy appearance. In the normal form the shell has smooth rounded whorls, but there are a number of forms decidedly different in appearance which have long passed as distinct species. All of these the writer has found to be abnormal, due to the presence of certain mineral salts in the water in which they live; the different forms being due to different salt constituents. Two of the most striking are figured in Figure 297, and Pl. III, Fig. 9. There are several others. This species includes *G. bulbosa*, *G. rubiginosa*, *G. acutiflora*, *G. nigrina*, *G. draytoni*, *G. circumlineata*, *G. occata*, and several others.

Fig. 297

G. plicifera lives in swift streams and springs in the Columbia and Klamath Systems. Professor Keep says, "Their inhabitants are dark-skinned,

happy creatures that love to live in cool, clear water, where the green algæ grow and the banks are edged with ferns and water-weeds. I gathered them in abundance from a little stream of most delicious water that bursts out from the base of a dry hill, just north of the village of Sisson in northern California. Evidently there are concealed passages leading from the dry hill up to the great snow-fields on the flanks of Mount Shasta, for after you have climbed far up beyond the timber-line and are walking over the great expanses of white you can hear the gurgling of little streams under your feet and you know that the melting drifts are sinking down into the bosom of the mountain to reappear among the groves and meadows that mark the boundaries of the Upper Sacramento."

THE LAKE AND FLOOD SHELLS

(*Amnicolidæ*)

These tiny fellows are operculate as are also the Pleuroceridæ and succeeding families. They have a closed or nearly closed umbilicus and are usually greenish or brownish. Some live in streams and some in lakes and springs.

Amnicola micrococcus, Pilsbry, the Desert *Amnicola*, Pl. III, Fig. 13, is a small species of the desert region. It has a chunky green-brown shell with inflated whorls and a closed umbilicus. It is about the size of a capital O. Found in springs in the Nevada System.

Paludestrina longinqua, Gould, the Western *Paludestrina*, Pl. III, Fig. 11, is about the size of a

small o and has a more elevated spire than the preceding; sutures impressed. It lives in springs, lakes and mountain streams in the Klamath, Nevada, Utah, Coast Range, Los Angeles and Arizona Systems. *P. stearnsiana* and *imitator* are identical. They were founded on live specimens while *P. longinqua* was described from bleached specimens from the Colorado Desert, possibly distorted by alkali waters.

Paludestrina protea, Gould, the Variable Paludestrina, Pl. III, Figs. 14 and 15, is well named. It is about the same size but always more slender than the last, sometimes attenuate. It is normally smooth, but forms from alkaline springs and lakes are often spirally ridged, vertically plaited or both. On the Colorado Desert in Southern California, the white bleached shells of this species blow before the wind in countless millions. In former times this desert was the bed of a large lake. The species must have swarmed in it. Found in lakes and hot springs in the Utah, Nevada, and Arizona Systems, also Mexico and New Mexico.

The Tawny Flood-shell, *Fluminicola fusca*, Hald., Figure 298, is about the size of a pea. It has a short spire and the shell is quite solid and a dark bluish black. Found in streams in the Utah System.

Fig. 298

Fluminicola seminalis, Hinds, the Brown Flood-shell, Pl. III, Fig. 12, is a thinner green-brown species found in similar situations in the Klamath System. It has a more elevated spire.

Figure 299 represents *Fluminicola nuttalliana*,

Fig. 299

Lea, Nuttall's Flood-shell. It is a more slender species than either of the preceding; yellow-brown or dark colored. Habitat similar; found in the Columbia System.

THE VALVE SHELLS

(*Valvatidæ*)

This group contains the single genus *Valvata*. They have small, umbilicate shells with rounded or angular whorls of a green, pellucid, or brown color and live in lakes and ponds.

Valvata virens, Tryon, the Green Valvata, Figure 300, is a species found in the Coast Range System. It is light to dark green with a fairly high spire and a deep rather narrow umbilicus. The whorls are rounded and smooth.

Fig. 300, x $\frac{3}{2}$

Valvata humeralis, Say, the Western Valvata, Pl. II, Fig. 6, is blue-green or brown. It is smooth, somewhat flattened beneath, has a broad umbilicus and a flat-topped somewhat elevated spire. Found all over the West Coast and in Mexico. According to Dr. Pilsbry the form on the Pacific Coast south to Sonora should be known as *Valvata humeralis californica*, Pils.

THE VIVIPAROUS SHELLS

(*Viviparidæ*)

This group of large shells is not native on the Pacific Slope, but is found in the Eastern States and Eurasia, and one species has been introduced.

The young are born alive as in the Sphæridæ instead of developing from eggs.

Vivipara malleatus, Reeve, the Four-lined Vivipara, or Japanese Rice-snail, Pl. III, Fig. 8, is a large species which has been planted for food, at many places where there are Asiatic settlements on the Coast. Its flourishing progeny are by birth American citizens, and so we must consider them. The shell has green or brown inflated whorls, marked by four revolving lines of minute punctures, two above, one at, and one below the suture. In juvenile specimens the whorls are carinate but in adults they are rounded. It is known so far in ditches and streams in the Coast Range System but has been reported from the markets of Victoria, B. C. Japan.

FALSE SHELLS

Among the material gathered by young collectors are often small bivalve crustacea, Phyllopods and Copepods which when dead greatly resemble Sphæridæ. To see them swimming around when alive will soon convince one they are not mollusks. The shells are very thin and made of chitin which will burn readily. This is a simple way to distinguish them. Caddice-fly larvæ often make spiral nests of sand grains. The great Doctor Lea once described one of these as *Valvata arenifera*.

This closes the descriptions of the most puzzling of our West American shells. To some they may not be of interest because they are so plain, so variable, so near at hand, and so little known; but to

those who have the true scientific spirit they are just as interesting as the marine and land forms and more is to be learned about them. The writer will be glad to undertake to identify material sent to him at Stanford University, Cal.

Plate I is from drawings by the writer. Plates II and III are from photographs by Mr. John Howard Paine, who made a number of fine conchological finds while dredging in San Pedro Harbor. They speak for themselves. The writer would acknowledge his indebtedness to Professor Keep for the privilege of contributing to his excellent book.

BIOGRAPHICAL INDEX

ADAMS, ARTHUR (A. Ad.). A distinguished English student and writer. One of the authors of the celebrated work on "Genera of Recent Mollusca," published about fifty years ago.

ADAMS, PROF. CHARLES B. (C. B. Ad.). 1814-1863. Professor of Natural History in Amherst College, Mass. He was an extraordinary worker, and collected a very fine cabinet of shells, still preserved at that college. He wrote chiefly on the shells of Panama, which region he carefully explored.

ARNOLD, RALPH, 1875—. A California geologist who has written extensively on fossil and recent shells.

BARTSCH, PAUL, 1871—. A writer upon modern shells, mostly the smaller species. He is connected with the National Museum at Washington, D. C.

BINNEY, AMOS, 1803-1847. He was a native of Boston, but died in Rome. He was a successful merchant and an ardent lover of nature. He wrote chiefly on the Land Shells of the United States, and left money for the publication and distribution of his unfinished works, which were completed by Dr. Gould.

BINNEY, W. G., (W. G. B.). Son of the above, and author of a volume on "American Land Shells."

BLAND, THOMAS. A naturalist of New York, who gave much attention to species of land mollusks.

BRODERIP, WM. J., (Brod.). An English naturalist who published several popular works on Zoölogy, from 1847 to 1857.

BUTTON, FRED. L., 1856—. An Oakland, Cal., lawyer, who is much interested in Conchology, and who has a very fine cabinet of shells.

CARPENTER, PHILIP P., (Cpr.) 1819-1877. A very distinguished English conchologist who spent considerable time in America. He studied the shells of the West Coast, and made careful reports to the British Association, one of which was reprinted by the Smithsonian Institution in 1872.

CHEMNITZ, (Chem.). A German naturalist of the 18th century.

COCKERELL, T. D. A., 1866—. An enthusiastic naturalist; born in England; now a professor in the University of Colorado.

CONRAD, TIMOTHY A., 1803-1877. A distinguished American writer upon recent and fossil shells. He was born in New Jersey.

COOPER, DR. J. G., 1831-1902. A noted California conchologist and writer who made a particular study of land mollusks.

DALL, WM. H., 1845—. One of the foremost of American naturalists. He has long been at the head of the Department of Mollusks in the U. S. National Museum.

DESHAYES, GERARD P., (Desh.), 1796-1875. A

French naturalist whose publications date from 1835 onward.

DIXON, CAPT. GEO. An English sea captain, who published in 1789 an account of his voyage around the world.

D'ORBIGNY, (D'ORB.), 1802-1857. A French naturalist and writer upon mollusks.

DONOVAN, EDWARD, (Don.). A very voluminous English writer on insects, shells, etc. He lived in the early part of the last century.

DRAPARNAUD, PROF. JACQUES, (Drap.), 1772-1806. His writings were chiefly upon the land and fresh-water mollusks of France.

DUCLOS, (Ducl.). A French naturalist who flourished in the middle of the 19th century.

ESCHSCHOLTZ, (Esch.). The distinguished naturalist who accompanied the Russian explorer, Otto von Kotzebue, from 1815 to 1826. He visited this coast and collected valuable scientific material.

FORBES, PROF. EDWARD, (Fbs.), 1815-1854. An English scholar and writer. With Hanley, he published in 1853 the "History of British Mollusks."

GABB, W. M., 1839-1878. A noted American naturalist; at one time paleontologist for the California State Geological Survey.

GMELIN, JOHANN F., (Gmel.), 1709-1755. A German professor at Tübingen. He edited an edition of Linné's *Systema Naturæ*.

GOULD, DR. A. A., (Gld.), 1805-1866. He was a native of New Hampshire, but spent most of his life in Boston, in the practice of his profession, yet

he found time to write much upon Natural History, particularly upon mollusks. His advice to a young naturalist who had more enthusiasm than riches is full of golden thoughts: "You must go ahead and earn your living, and use your leisure for study, as I have done, only don't wait for the leisure to be greater; do something, if but little every day; otherwise, when wealth or age give you greater leisure, your interest will have faded and your opportunity will be gone."

GRAY, JOHN E., 1800-1875. For nearly fifty years he was connected with the British Museum, and finally became its keeper. He wrote valuable catalogues of the same.

HALDEMAN, PROF. S. S., (Hald.). Born in Penn. in 1812. He became a distinguished writer and teacher. His writings on mollusks refer chiefly to fresh-water species. He wrote also upon philology.

HANLEY, SYLVANUS, (Hanl.). An English naturalist, associated with Prof. Forbes.

HEMPHILL, HENRY, 1830—. A student and collector of mollusks, particularly of this coast and of Florida. He has probably collected more specimens than any other man now living. He is spending his old age with his daughter, in Oakland.

HINDS, RICHARD B., (Hds.). The English naturalist, who accompanied Sir Edward Belcher on his voyage round the world, in "H. M. S. Sulphur," from 1836 to 1842.

INGERSOLL, ERNEST. Naturalist of the U. S.

Geological Survey of the Territories, under Prof. Hayden.

LEA, ISAAC, LL. D., 1792-1886. Dr. Lea's ancestors came over from England with William Penn. Most of his life was spent in Philadelphia, where he was connected with a large publishing house. His writings are very voluminous, relating chiefly to the *Unionidæ*, or River Mussels.

LEACH, DR. WM. E. Curator of the Natural History Department of the British Museum, during the early part of the last century.

LINNE, or LINNÆUS, CARL VON, (Linn.), 1707-1778. The great Swedish naturalist and author of the modern system of scientific nomenclature. His early life was full of difficulties, but when he became professor of Botany at the University of Upsal, his department soon became filled with eager students. He wrote many valuable works, and received great honors.

MACFARLAND, FRANK M., 1869—. A professor in Stanford University, whose special work upon mollusks is with the sea-slugs, or Nudibranchs.

MEEK, F. B., 1817-1876. A naturalist whose work was largely with fossil shells, especially those of California.

MERRIAM, PROF. JOHN C., 1869—. A distinguished geologist and teacher, connected with the University of California. His special work is with vertebrate fossils.

MIDDENDORF, DR. A. TH. V., (Midd.), 1815-1894. An early scientific writer upon the shells

of this coast. His reports were published in St. Petersburg, from 1847 onward.

MORCH, OTTO A. L., 1828-1878. Part of his writings, on the *Vermetida*, were published in London in 1861.

MORSE, PROF. EDWARD S. A distinguished Eastern writer upon Zoölogy. He was born in Maine, in 1838.

NEWCOMB, DR. WESLEY, (Newc.), 1808-1892. An American naturalist and collector of one of the finest cabinets of shells in the country. It is now at Cornell University. He once lived and explored in the Hawaiian Islands and in California.

NUTTALL, PROF. THOS., (Nutt.), 1786-1859. His birth and death both occurred in England, but he spent most of his life in America, being Professor of Natural History in Harvard College from 1822 to 1834. Many shells were named for him by his contemporary, Timothy A. Conrad.

OLDROYD, MR. and MRS. T. S. Noted conchological collectors and students, living at Long Beach, Cal. Their beautiful collection of shells will be permanently located in Los Angeles.

ORCUTT, CHAS. R. A naturalist and writer, who has studied extensively in the vicinity of San Diego and northern Mexico.

PFEIFFER, LOUIS, (Pfr.). A German conchologist of note, author of numerous works published from 1847 onward.

PHILIPPI, R. A., 1808-1904. Another German naturalist, who lived to a great age.

PILSBRY, HENRY A., 1862—. An eminent conchologist, connected with the Academy of Natural Sciences in Philadelphia, and living author of the "Manual of Conchology," which was begun by Tryon.

PRIME, TEMPLE. An American naturalist who studied the smaller fresh-water bivalve mollusks. His chief work was published by the Smithsonian Institution in 1860.

RAYMOND, PROF. WM. J., 1865—. A teacher of Physics in the University of California, who is also an authority on the mollusks of this coast.

REEVE, LOVELL A., (Rve.), 1808-1865. A London author and publisher of extensive and beautiful conchological works.

ROWELL, REV. JOSEPH. An aged clergyman of San Francisco, who has described several new species, and who has collected a fine cabinet of shells.

SAY, THOMAS, 1787-1843. One of the earliest and most distinguished of American naturalists, a native of Philadelphia. His work had a most healthful influence on the cause of scientific investigation.

STEARNS, ROBT. E. C., 1827-1909. A noted conchologist, spending his early life in Boston, but most of his mature years in California. He wrote many articles upon shells, and continued his interest in the subject to the close of his life.

SOWERBY, GEO. B., (Sby. or Sowb.). Three generations of English conchologists and conchological artists bore this name. They were born respectively in 1783, 1812, and 1843.

SWAINSON, WILLIAM. An English naturalist, author of "Exotic Conchology," published in London, 1821-1835.

TRYON, GEO. W. JR., 1838-1888. An American conchologist, author of the first few volumes of the "Manual of Conchology," and of other important works. He lived in Philadelphia, and was a prominent member of the Academy of Natural Sciences.

VALENCIENNES, (Val.). A French naturalist, living during the first half of the last century.

WOOD, WILLIAM. A London author and Natural History book-seller. He published many books on shells, from 1818 onward.

GLOSSARY

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ADDUCTOR, a muscle to draw shells together . . .	22
APERTURE, the opening of a univalve shell	119
BIVALVE, a mollusk with two shells	20
BRACHIOPOD, a peculiar animal with two shells, sometimes classed with the mollusks	13
BRANCHIAL, relating to the gills	124
BYSSUS, a bundle of fibers, for anchoring	38
CANAL, the channel or tube of a shell	119
CARNIVEROUS, flesh-eating, like the Murex	119
CHITON (kí-ton), a flat mollusk having eight shells	253
COLUMELLA, the central post of a shell	119
CORALLINE, a small, stony seaweed, resembling coral	7
CORDATE, heart-shaped, like the Cardium	72
CORIACEOUS, tough and leathery	295
CORRUGATED, marked with ridges	165
CRENULATED, marked with small scallops	251
DEXTRAL, opening on the right side	119
EPIDERMIS, the outside coating of a shell	23
ESCUTCHEON, the depression behind the beaks of certain bivalves	80
FORMALDEHYDE, a preservative fluid	141
FUSIFORM, spindle-shaped, pointed at both ends .	119
GASTEROPOD, a snail-like mollusk	118
GENUS, a group of similar species	60

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GLOBOSE, round and full, like a globe.....	55
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HERBIVEROUS, vegetable-eating, like the com- mon snail	119
HINGE-TEETH, interlocking projections on cer- tain bivalve shells.....	22
HOLDFAST, the root-like parts of a seaweed....	101
IRIDESCENT, showing the colors of the rainbow.....	224
LIGAMENT, the elastic tissue at the hinge, which holds bivalve shells together.....	22
LUNULE, a heart-shaped depression.....	22
MOLLUSK, one of a great class of invertebrate animals	9
NACRE, iridescent shell, like mother-of-pearl....	232
NULLIPORE, a kind of small, stony seaweed....	219
NUDIBRANCH, a mollusk with naked gills.....	123
OPERCULUM, the door of a univalve shell.....	212
PALLIUM, the skin, or mantle, of a mollusk....	21
PELECYPOD, a bivalve mollusk, with ribbon-like gills, a lamellibranch.....	20
PERIOSTRACUM, the outer coating of a shell....	23
PERISTOME, the rim of a shell's aperture.....	287
RETICULATED, marked with net-work.....	129
RHINOPHORES, certain sense-organs, probably of smell	125
SERRATIONS, ridges resembling saw-teeth....	41
SINISTRAL, opening on the left side.....	264
SINUS, and inward curve, or bay.....	23
SIPHON, the breathing tube of a mollusk.....	21
SPECIES, a distinct type of organisms.....	14

SPHEROIDAL, somewhat like a sphere.....	283
STRIAE, fine parallel lines or furrows.....	144
SUTURE, the angular meeting line of two whorls.	119
TENTACLES, the two feelers of a mollusk.....	125
UMBILICUS, the hole round which the whorls of a univalve shell revolve.....	119
UMBO, the beak of a bivalve shell.....	22
UNIVALVE, a mollusk with one shell.....	118
VARIETY, a subdivision of a species.....	283
VARIX, a periodically formed ridge or variation.	191
VENTRICOSE, swollen, well developed.....	97
WAMPUM, shell-money, used by the Indians...	126
WHORL, one complete turn around a shell.....	119

APPENDIX

Note. This *Alphabetical List* contains the names of small or uncommon shells which occur on this Coast, most of which are not described in this edition of *West Coast Shells*. It was chiefly compiled by Mrs. Ida S. Oldroyd.

Acanthochiton diegensis, Pils.

Acmaea patina, var. *nuttallina*

ochracea, Dall.

pintadina, Gld.

scutum, Esch.

Acmaea pelta, var. *elevata*

cassis, Esch.

hybrida, Hemphill

nacelloides, Dall.

Acmaea scabra, var. *limatula*, Cpr.

morchii, Dall

picta, Hemphill

Actæon painei, Dall

Adeomelon stearnsii, Dall

Æsopus myrmecoön, Dall.

Alabina californica, Dall and Bartsch

cerithoidea, Dall

tenuisculpta, Cpr.

tenuisculpta, var. *diegensis*, Bartsch

Alexia setifer, Cpr.

Alvania purpurea, Dall

Amphisphyræ subquadrata, Cpr.

Amphithalamus inclusus, Cpr.

Ancylus newberryi

Asthenotherus villosior, Cpr.

Bythinella nuclea, Lea

Bittium acicula, Stimp.

armillatum, var. *ornatissimum*, Bartsch

esuriens, var. *multifilosa*, Bartsch

fortior, Cpr.

munitum, var. *munitoides*, Bartsch

oldroydii, Bartsch

Boreotrophon bentleyi, Dall

Cæcum cooperi, Cpr.

hemphilli, Stearns

magnum, Stearns

Callistochiton decoratus, Cpr.

Cerithiopsis carpenteri, Bartsch

connexa, Cpr.

cosmia, Bartsch

metaxæ, Cooper

pedroana, Bartsch

stephansi, Bartsch

Cardium fucanum, Dall

Circinaria transfuga, Hemp.

affinis, Dall

Clathurella canfieldi, Dall

sculpta, Dall

Clistaxis polystrigma, Dall

Columbella carinata, var. *hindsii*, Rve.

petravis, Dall

Conulus fulvus, Müller

Crassatella fluctuata, Cpr.

- Crenella affinis*, Dall
Crepidula nivea, var. *glottidiarum*, Dall
Cryptobranchia concentrica, Midd.
Cuspidaria obesa, Lov.
 pectinata, Cpr.
 striata, Jeff.
Cyclostrema diegensis, Bartsch
Cyclostremella californica, Bartsch
Cythara densistriosa, Cpr.
 fusconotata, Cpr.
Daphnella fuscoligata, Dall
Dentalium carpenterianum, Dall
 megathyris, Dall
 valicolens, Raymond
Diaphana californica, Dall
Discinisca strigata, Brod.
Epitonium acrostephanus, Dall
 catalinæ, Dall
Erato mangeriæ, Mke.
Eulima lowana, Dall
 randolphi, Van.
 solitaria, C.B.Ad.
Gibbula optabilis, Cpr.
Goniobasis silicula, Gld.
Helicella ventricosa, Drap.
Ischnochiton biarcuatus, Dall
 scabricosta, Cpr.
Kennerlia filosa, Cpr.
Lacuna unifasciata, var. *aurantica*, Cpr.
Lasaea rubra, var. *subviridis*, Cpr.
Leda cuneata, Hanley

Lepidopleurus nexus, Cpr.

oldroydi, Bartsch

Leptothyra paucicostata, var. *rubra*, Dall

Limnæa atkana, Dall

desidiosa, Say

Lithophagus attenuatus, Desh.

Littorina grandis, Midd.

Liostraca varians, Sby.

Lunatia draconis, Dall

pallida, Brod. & Sby.

Lyonsia inflata, Conr.

nitida, Conr.

Mangilia painei, Dall

fancheræ, Dall

Malletia californica, Dall

Margarita lirulata, var. *subelevata*, Cpr.

pupilla, var. *salmonea*, Cpr.

Menetus opercularis, Gld.

Metaxia diadema, Bartsch

Mitra dolorosa, Dall

lowei, Dall

Microphysa ingersollii, Bland

Miralda californica, D. & B.

Modiolus demissus, Dillwyn

Mopalia imporcata, var. *lowei*, Bartsch

muscosa, var. *acuta*, Cpr.

Murex painei, Dall

Myoforceps aristatus, Dillwyn

Odostomia atossa, Dall

(*Miralda*) *armata*, Cpr.

(*Chrysallida*) *cincta*, Cpr.

oldroydi, D. & B.

inflexa, D. & B.

Parthenia quinquecincta, Cpr.

Patula cronkhitei, Newc.

chiricahuana, var. *ashmuni*, Dall

Pedipes liratus, Binney

Periploma sulcata, Dall

Pecten whiteavesi, Dall

Physa sparsistriata, Tryon

bardi

traski, Tryon

virgata, Gld.

Pholadidea sagittata, Stearns

Pisidium æquilateratus, Prime

Phasianella compta, var., *producta*, Cpr.

Planorbis borealis

deflectus, Say

executus, Say

oregonensis, Lea

Polygyra sanborni

devius, var. *binominatus*, Tryon

blandi, Hemp.

catus, Hemp.

cognatus, Hemp.

navadensis, Stearns

Psephidia salmonea, Cpr.

Pupa columbiana, Sterki

Rissoina exilis, Tryon

oldroydii, Dall

Rochefortia tumida, Cpr.

Scissilabra dalli, Bartsch

- Scala berryi*, Dall
 clathratula, Ad.
 sawinæ, Dall
Seila montereyensis, Bartsch
Serridens oblongus, Cpr.
Semele incongrua, Cpr.
Siphonaria vernalis, Dall
Solariella unda, Dall
Sphenia californica, Conr.
Spisula alaskana, Dall
Styliferina acicula, Stimp.
 tenuisculpta, Cpr.
Tachyrynchus californicus, Cpr.
Terebratalia obsoleta, Dall
Thracia plicata, Conrad
Tornatina recta, D'Orb.
Trachydermon flectens, var. *montereyensis*, Bartsch
Trichotropis kelseyi, Dall
Tritonofusus kelseyi, Dall
Turbonilla auricoma D. & B.
 crebrifiliata, Cpr.
 gracilior, C. B. Ad.
 lowei, D. & B.
 morchii, D. & B.
 kelseyi, D. & B.
 panamensis, C. B. Ad.
 serræ, D. & B.
 stearnsii, D. & B.
 simpsoni, D. & B.
 tenuicula, Gld.

Turris catalinæ, Raymond

diaulax Dall

halcyonis, Dall

rhines, Dall

Valvata mergella, Westerlund

Vermetus squamigerus, var. *pennatus*, Morch

Vitrea arborea, Say

Vitrinella alaskensis, Bartsch

berryi, Bartsch

complanata, Cpr.

stearnsi, Bartsch

Yoldia ensifera, var. *plena*, Dall

Zonites lansingii, Bland

shepardi, Hemphill

stearnsii, Bland

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ADDITIONAL NOTE

The Cephalopods of this coast are now being studied by S. S. Berry, of Stanford University, who will publish a report. He states, Dec., 1910, that there will probably be at least a dozen species.

Ommastrephes gigas, page 298, should be *Dosidicus gigas*, D'Orb.

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Prepared by Ward's Natural Science Establishment
for Whitaker & Ray-Wiggin Co.

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