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WONDER CREATURES OF THE SEA

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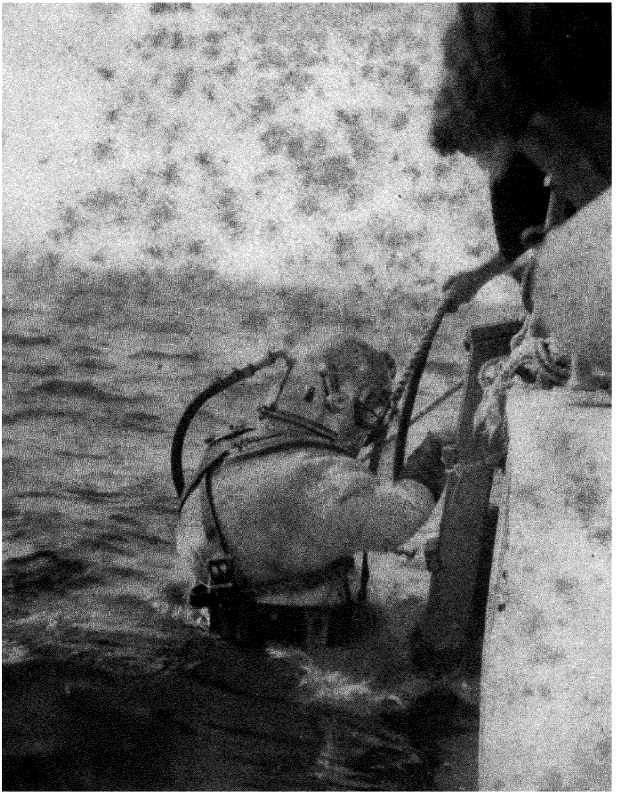

Going on a visit to the wonder creatures of the sea

WONDER CREATURES OF THE SEA

by

A. HYATT VERRILL

Illustrated by photographs and drawings by the author

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INTRODUCTION

TO paraphrase a familiar saying, "The sea is so full of a number of things." As many a person has remarked, it is extraordinary what amazing creatures inhabit the sea. Not only are these denizens of the ocean wonderful and amazing, but they are most fascinatingly interesting as well, for the sea is a world by itself, a world inhabited by living creatures totally unlike those of the land, a world that is new and unknown to most persons. A world wherein there are creatures more bizarre in form than any imaginary denizens of another planet, where there are animals more brilliant in color than any flowers of our fields or woodlands, where the myriad forms of life wage the ceaseless universal war for supremacy and self-protection and exhibit habits, traits, and ways of life more remarkable by far than those of their fellow-creatures inhabiting the land. There are animals so delicate and fragile that they appear to be made of spun glass, yet so tough and strong that they might well be fabricated from steel wire. There are others so dainty and lovely in form and coloration that they rival the fairest of flowers, yet are deadly voracious creatures more savage and more dangerous to their neighbors than are cobras or man-eating tigers on earth.

In size the denizens of this watery world range from the most gigantic creatures that exist to minute forms of life so small that they are invisible to the naked eye. And there are countless thousands of marine animals totally unknown to even the greatest scientists.

Many of the sea creatures are familiar to every one who has ever visited the seacoasts. We are all acquainted with sea-shells, some species of crabs, shrimps, lobsters, and fishes. There are few of us who have not seen sponges and corals, starfishes and barnacles, sand-dollars and sea-urchins, or at least the dried preserved skeletons of these animals.

Even these familiar forms of sea life usually interest the average person and arouse curiosity regarding them and their mode of life, yet they are by no means the most unusual, the most remarkable, or the most interesting forms of life found in the sea.

Moreover, it is not impossible or even difficult to observe and study these wonder creatures of the sea. To be sure there are many forms of sea life which inhabit deep water and therefore are beyond the reach of all but scientists equipped with specially designed apparatus for capturing them. But there are equally interesting and almost equally numerous closely related animals inhabiting our shores and shallow waters which may readily be observed, studied, and even collected if desired, by any one, and the habits of these are fully as remarkable as those of their deep-water cousins.

In fact the wonder creatures of the sea abound everywhere in all portions of the oceans, although they may be passed by unnoticed, their presence unsuspected, or even if they are observed they may be deemed uninteresting and not worth-while until our attention is drawn to them and we learn something of their strange and wonderful ways. Even persons who are lovers of Nature and quite ardent naturalists deeply interested in birds, reptiles, plants, insects, or other forms of life on land, seldom turn their attentions to the animals in the sea.

It is really remarkable that the majority of people know so little of the teeming denizens of the ocean and its shores. And it will come as a distinct surprise to many to learn how truly strange, interesting, and remarkable are the lives and habits of some of the most familiar of sea animals. A dried coral is a lovely object, but the preserved, bleached skeleton gives no hint of the coral in life, with its exquisitely formed and brilliantly colored animals covering its surface. We may come upon a stranded jellyfish washed upon the beach, but the pulpy, shapeless mass conveys nothing of the true beauty of the creature in life nor of its strange, fascinatingly interesting history. And when we dine on lobsters or eat crabs or shrimp we seldom stop to ponder on their habits and lives in the sea, but merely focus our attention on the edible qualities of their dead bodies.

Quite apart from the wonder and interest of sea creatures is their great importance to man. Many, such as the lobsters, crabs, shrimps and others, are

of tremendous food value. Sponges, as every one knows, are valuable products of the sea and are the source of a great and important industry, and every school child knows that many islands owe their existence to the industrious sea creatures whose skeletal structures are known to us as coral. For that matter much of our own land and large portions of other lands are composed of the remains of animals that once dwelt in the sea. Vast areas of our continent, such as the central portion of New York State, consist of limestone formed of fossil corals and other sea creatures. Our marble, the chalk cliffs of England, and even much of our tooth-powder, are all composed of dead creatures that dwelt in the sea millions of years ago. And perhaps, most important of all, is the fact that life on earth began in the sea.

Inconceivably long before any living creatures existed on land, the sea teemed with life, and ages before the first clumsy reptile-like beast waddled on the muddy shores of the earth, myriads of forms of animal life dwelt in the sea. Moreover, many of these immeasurably ancient forms still remain, little changed by the passing of millions of years of earth time. The mighty dinosaurs had their day and passed into oblivion. Tiny four- and five-toed horses roamed the land, and together with huge many-horned rhinoceros-like beasts, giant mastodons, titanic ground-sloths and other bizarre creatures of the past, vanished from the face of the earth and gave way to totally different forms of terrestrial life. But in the sea the same creatures that existed millions of

years before a living thing moved on land, still live their strange, interesting lives and still continue to exist little changed through the ages that have passed.

"As unchanging as the sea" is a phrase we often hear, but even the sea itself changes more than the creatures that make it their home. The oceans may eat deeply into the land or may recede as new land is formed. Where once were great continents there is now deep, unfathomable water. Where once the waves tossed or the calm surface of the sea gleamed unbroken by a speck of land, there are now great islands or even continental deserts, towering mountain-chains, and fertile fields. But the wonder creatures whose homes are in the sea remain unaffected by all these alterations of land and water. Ages and ages ago they developed the characteristics, the habits, the mode of life best adapted to their needs and to survival. And that these characteristics and habits were the best adapted to the creature's survival is proven by the fact that they still inhabit the sea so little changed from their remote ancestors of millions of years ago that no one but a trained scientist can distinguish any difference.

But quite apart from all this, irrespective of the commercial, economic, or geological importance of sea creatures, is the fact that among them we find some of the most beautiful, the most unusual, the most bizarre and fantastical, the most puzzling and the most interesting of all living creatures.

It is to point out some of these amazing features

of denizens of the sea, to arouse a greater interest in them, and to add to the popular knowledge of sea creatures that this book has been written.

It is not intended as a scientific treatise. In every case where possible, Latin and scientific names of sea animals have purposely been omitted, and there has been no attempt to classify or to arrange the various creatures according to their family relationships. In most instances, also, groups rather than genera and species have been selected, and rarely have I described the habits or characteristics of any one species unless some certain species possesses interesting or strange peculiarities all its own.

It is all very well for zoölogists to divide and subdivide a group of animals into various families, genera, species, subspecies, and varieties. Scientists find a vast amount of pleasure in doing this and are as elated when they discover some new or undescribed species of microscopic creature as though they had hit upon some practical manner of ending all wars or a sure cure for common colds. They are even more pleased, if possible, when they prove that some other scientist has made a "boner" in his classification of an obscure specimen. But the ordinary everyday man, woman, or child doesn't care a whit for the scientific status of some particular sea creature. To all but scientists the oddities, the strange habits, the beauty, or the wonder of a denizen of the sea is of far greater interest than the number of spines in its body, the precise number of plates in its epidermis, the arrange-

ment of the internal organs, or whether it has five or fifty bristles concealed in its appendages.

Any one interested in such matters may find them in the numerous scientific reports and papers, but not in this volume which is wholly concerned with the wonderful ways of wonder creatures of the sea, and mainly those which frequent the shores and shallow waters where they may be found and observed by any one.

CONTENTS

		PAGE
INTRODUCTION		v
CHAPTER		
I.	ANIMALS THAT APPEAR TO BE PLANTS	1
II.	LIFE IN A TIDE-POOL	16
III.	CREATURES THAT DWELL IN TUNNELS	26
IV.	MYSTERIOUS TRAILS	36
V.	SKELETONS THAT KEEP US CLEAN	65
VI.	OUR DEGENERATE ANCESTORS	78
VII.	COUSINS OF THE CORALS	87
VIII.	THE CREATURES WHO BUILD ISLANDS	96
IX.	A VISIT TO A CORAL REEF	107
X.	POOR SHRIMP	130
XI.	LOBSTERS AND THEIR KIN	150
XII.	SHELLY SOLDIERS	170
XIII.	FIGHTERS AND FIDDLERS	187
XIV.	CRABBED GARDENERS	213
XV.	STRANGE INFANTS	223
XVI.	QUEER CHUMS	232
XVII.	THE OLDEST INHABITANTS	245
XVIII.	CREATURES OF THE DEEP SEA	251
XIX.	FOOD FOR THOUGHT	259
INDEX		269

ILLUSTRATIONS

Going on a visit to the wonder creatures of the sea . . . . . *frontispiece*

PAGE

Bryozoans 3

Hydroids and jellyfish 10

Sea-spider 22

Sea-worms 32

Echinoderms 42

Starfishes 50

Opening sea-urchins, Barbados, West Indies, *facing* 56

Sponges 68

Clipping sponges, Nassau . . . . . *facing* 74

Ascidians 80

Corals, sponges, gorgonias and coral fishes photographed at home, at the bottom of the sea *facing* 88

Cousins of the corals 92

Venus's girdle 94

Denizens of a coral reef 116

Section of a spine of a sea-urchin . . . *facing* 124

Jaws of a starfish . . . . . *facing* 124

Surface of coral showing the homes of the coral animals . . . . . *facing* 124

Corals 126

PAGE

Shrimp 132
Squilla 146
The "Archer" 146
A big spiny lobster, Bermuda . . . . *facing* 152
Lobsters and their kin 164
Shelly soldiers 180
A walking crab 192
A swimming crab 192
Looking for sponges, Bahama Islands . . *facing* 200
Funny faces 204
Spider-crab planting weeds on its back . . . 216
Strange infants 227
More youngsters 229
Queer chums 236
A king- or horsefoot-crab 247
A fossil ancestor of the king-crab 247
A good spot to study wonder creatures of the sea: on the shore of a West Indian island . *facing* 254
Foraminifera 260

Chapter I

ANIMALS THAT APPEAR TO BE PLANTS

PERHAPS if you have visited the seashore you have amused yourself by collecting seaweeds. Few persons can resist the lure of these marine plants, for many are most delicate and dainty and others are brilliantly colored. Some are scarlet, others crimson, others purple. Some are vivid green, while others may be yellow or brown, fawn-colored or buff, or may gleam with iridescent hues of every prismatic tint.

If you have noticed these seaweeds particularly, or if you have gathered and preserved them, you may have observed that while the majority are soft and flexible, others are stiff, hard, and brittle. And no doubt it will surprise you to learn that most of these are not plants but are true animals.

In fact it is almost impossible for any one who is not a scientist to distinguish the difference between these plantlike animals and the true sea plants or algæ. For that matter even scientists are not quite certain where a hard and fast line may be drawn separating the plants and the animals.

Most of the plantlike animals we find in the sea or clinging to the rocks along the shores belong to two groups known as the *Bryozoans* and the *Hydroids*.

Of the two, the bryozoans are most frequently noticed, for while they are no more abundant than the hydroids they are usually larger and more conspicuous, while many forms are not at all like seaweeds and usually prove a puzzle to those who notice them. These are the most abundant of all the seventeen hundred named species of bryozoans, or "moss animals" as the name means. You can scarcely find a rock, pebble, sea-shell, crab, lobster, or a bit of seaweed that does not have colonies of moss animals upon it.

Many are very beautiful things, spreading over the rock or other object in sheets of dainty white or pink lace; others appear like frost crystals. Some resemble fern leaves or delicate moss painted in white, gray, or lavender upon a pebble or sea-shell, while still others are soft and gelatinous, reminding us of the slime-molds of our woodlands (see *Wonder Plants and Plant Wonders*). All of these are moss-like or lichen-like species which adhere closely to the objects to which they are attached. But there are many other species which form clusters of slender branches borne on upright stalks. Many of these are flexible and fairly soft and closely resemble true seaweeds, while others are composed of alternate sections of hard calcareous material and segments of flexible horny matter. Very frequently these are most lovely, delicately tinted with rose-pink, pale-orange, or madder-purple, but the color is mainly in the fleshy animal matter and when dead and dried these bryozoans are usually pure white.

As they closely resemble small corals they are commonly known as *Corallines*. On our own coasts they are seldom large or conspicuous, but in tropical and semitropical seas they grow to fairly large size and are very abundant. Many a visitor to the Bahamas

Bryozoans

1. Cellularia
2. Cellularia, enlarged
3. Encratea, enlarged
4. Membaripora, enlarged
5. Sea-mat
6. Sea-mat, enlarged
7. Bird's-head bryozoan
8. Tubular bryozoan
9. Lace "coral" bryozoan

or the West Indies has proudly exhibited specimens of delicate "coral" which in reality were merely large clusters of corallines or bryozoans. There are also hard calcareous seaweeds, often called "corallines," but it is not at all difficult to distinguish these coral-

like plants from the animal forms or to separate the softer weedlike bryozoans from true algæ if we examine them through a pocket-lens, for all bryozoans consist of great numbers of individual cuplike or saucer-like cells, each containing a living animal with slender hairlike tentacles.

Only by viewing these wonderful creatures through a lens or a reading-glass can we appreciate their true beauty. Even the so-called *Sea-mats*, which look like scraps of brown paper scattered upon the beach, are wonderful structures as revealed by the lens. Unattractive as they appear to the naked eye, they become transformed when viewed through a magnifying-glass, the flat brownish surface being composed of layers of tubular cells placed back to back in such a marvelously orderly manner that they give the effect of having been stamped out by machinery.

But it is among the harder encrusting or branched species that we find the most beautiful and interesting revelations. Some are composed of innumerable graceful cups that appear made of opalescent glass; others are vase-shaped and seem formed of finest porcelain. Some species are built up of countless tubes that have the iridescent sheen of mother-of-pearl, and as we focus the lens on a fernlike branch of another specimen we fairly gasp in amazement. No wonder we are surprised at what we see, for the plantlike growth is a bryozoan belonging to the genus known as *Bugula* and each of the cells covering the multitude of branches bears the exact replica of a bird's head with the bill constantly opening and closing. So perfect

is the resemblance that we almost expect to hear chirps and twitters issuing from the countless throats, and would scarcely be surprised should the wonder creature burst into song.

Hours, even days might be spent examining the moss animals in a single tide-pool or adhering to a single rock, for no two species are alike and all are equally beautiful and surprising.

But interesting and wonderful as are these plant-like animals they are not nearly so interesting nor astonishing as are the other plantlike creatures known as hydroids. Unlike the bryozoans, the hydroids never form mats or sheets but are all erect or branched animals. Neither are they hard nor calcareous, but are soft and flexible and are even more like true seaweeds than are any of the moss animals. In fact many a seaweed collector has gathered specimens of these creatures in the belief that they were algæ. But if we examine a hydroid under our lens we will discover that the stems, branches, and "leaves" bear delicate saucer- or cup-like "fruits" and dainty "flowers," while a slender "vein" or tube of animal matter runs through the stem and branches connecting all the various portions of the amazing creature.

We will also discover that the "flowers," which resemble daisies or pinks or even single dahlias in miniature, are in reality living animals, and that the symmetrically arranged "petals," white or delicately tinted with rose or blue, purple or yellow or green, are fleshy tentacles that constantly move about, expanding and retracting as they seize invisible micro-

scopic organisms and convey the tiny morsels to the disclike mouths of the ever-hungry creature. But we have only commenced to discover the many wonderful features of these plantlike animals, for each of the "fruits" and "flowers" on a single plant is an individual whose entire life is devoted to performing one certain function and nothing else. Thus one form of "blossom" does nothing but eat; another which appears like an unopened bud or a seed capsule is the hydroid nursery. In many of the hydroids this is the most remarkable feature of these truly wonderful creatures, for instead of producing eggs or young hydroids, as we might expect, the hydroids' "fruits" ripen and produce free-swimming jellyfish.

At maturity, when the "fruits" are "ripe," they break open to reveal a number of thin, slightly convex discs resembling a pile of saucers fastened together at the center. Presently one of these little saucers breaks away, and turning upside down becomes transformed into a living jellyfish that goes swimming off with its tiny tentacles trailing behind it. One after another the "seeds" within the opened pod swim away, their bodies opening and closing like miniature umbrellas.

If we should watch these hydroid-born jellyfishes through their life-cycle we would discover an even more amazing thing, for when fully grown these free-swimming *Medusæ* or jellyfishes lay eggs which swim about by means of minute hairs or *Cilia*. But instead of developing into other jellyfishes, as any one might expect, they come to rest upon rocks or other objects,

attach themselves firmly, and grow into plantlike hydroids.

All hydroids do not, however, produce jellyfishes, nor do all jellyfishes lay eggs which become hydroids. Many of our commonest species of hydroids produce young hydroids instead of free-swimming jellyfishes, while many of the commonest jellyfishes lay eggs which develop directly into other jellyfishes.

Many of the hydroids which do *not* produce jellyfishes are fully as beautiful as the species which do develop medusæ, and when viewed through a pocket-lens they appear like lovely feathery-leaved plants covered with delicate star-shaped flowers. Some species creep and twine about like trailing vines, others stand stiffly upright like miniature trees, while others resemble clusters of ostrich plumes. In color they may be brown, yellow, pink, red, green, or nearly black, and some species have dark stems with silvery shimmering branches that resemble fir trees after a sleet storm.

Although the majority of these hydroid plant-animals are fairly small, many grow to large size and after heavy storms clusters a foot or more in height may be found washed up on our beaches. The giant of all the hydroids is a Japanese species which lives in fairly deep water and has enormous branches covered with flower-like polyps four feet in length and with tentacles extending for two feet or more about the central disc. According to a Japanese legend, these huge growths guard the secret bower of a beautiful

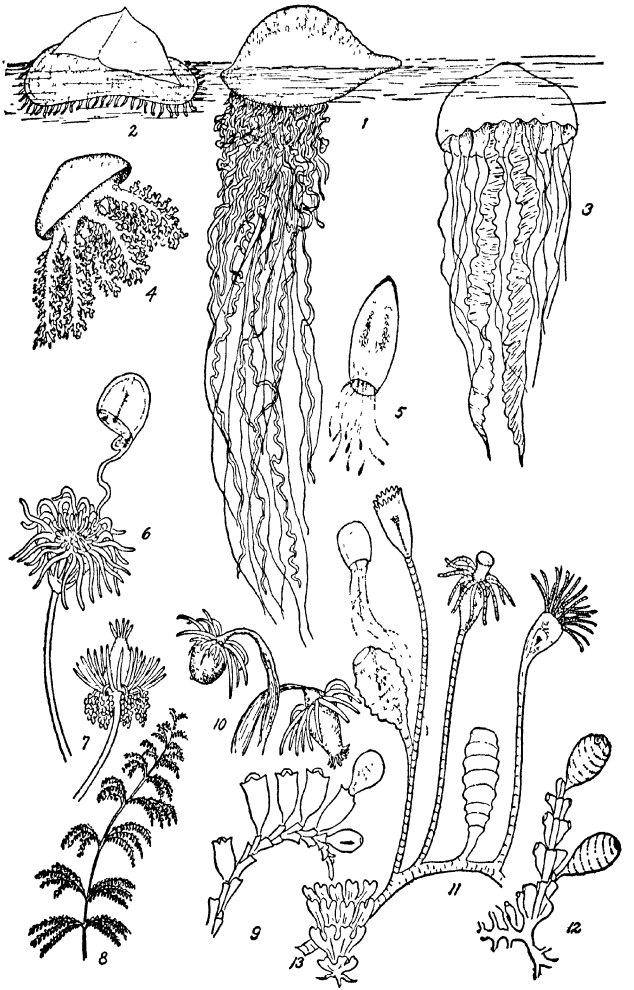
sea nymph who hides beneath the clustering branches and living blossoms of the hydroids.

Although most of these plantlike animals are flexible and may easily be mistaken for seaweeds, there are certain hydroids which are so hard, rigid and stonelike that any one not a scientist would consider them true corals. These are known as *Millepores* and are the so-called *Elk-horn corals* abundant in the Florida Keys, Bermuda, and the West Indies. The dried skeletons of these hydroid colonies are pure white or slightly tinted with buff or fawn-color, but in life they are beautiful reddish-brown, burnt orange, or purplish-red, with the tip of each delicate branch a lighter shade, the color being in the gelatinous animal matter on the exterior of the calcareous mass. Although to the naked eye the surface appears almost smooth and unbroken, yet if we examine it closely we will find it is covered with minute openings or pores of two different sizes. Each of these is a separate animal forming a unit in the communistic colony. And like the "flowers" on the smaller plantlike hydroids, they are of two kinds: the larger polyps or animals devoting their lives to devouring food to nourish the whole colony, while the smaller polyps are mouthless but are provided with tentacles and stinging threads with which they capture prey to feed their ever-hungry fellows and to protect the helpless living mouths from enemies.

All of these hydroids are stationary and fixed and are as firmly rooted as any true plant, even if their offspring may be free-swimming jellyfishes. But there

are still other hydroids which are never attached to any object but swim about in the sea. Many of our larger "jellyfish" are really hydroid colonies supported by a "body" or float. One of the best-known and most wonderful of these strange sea creatures is the *Portuguese man-of-war.* Abundant in all tropical seas the rainbow-hued bladder-like floats of this creature always attract attention as they drift hither and thither, bobbing about on the waves like fleets of fairy boats. But the lovely little vessels of rose, blue, purple, and gold are deadly dangerous things, for beneath them are masses of long multicolored tentacles bearing stinging organs so poisonous and powerful that they will disable and may even kill a man. Even when the creature is dead and washed up on the shore the stinging tentacles may inflict serious injuries, and a single fragment of a tentacle coming in contact with a swimmer's body will sting like a vicious hornet.

Only a few of the countless tentacles streaming below the gorgeous float are capable of stinging, however, for the Portuguese man-of-war is an entire colony, a true communistic aggregation of numerous individuals each performing one certain duty for the benefit of the whole. Some of these serve as guards or police and are armed with "lasso-cells" or stinging organs. Others are flask-shaped bodies and do nothing but eat, while others which resemble clusters of small berries are kept busy producing eggs to form more Portuguese men-of-war to add to the vast fleet. There are also organisms whose duty is to repair damages



Hydroids and jellyfish

and to add constantly to the size of the structure, while finally there are the sailors, the "crew" of the living craft, who steer and sail their strange ship.

You may think that these soap-bubble-like floats drift aimlessly at the whim of wind and ocean currents. If so, you are greatly mistaken, for under normal conditions the strange craft are actually sailed and are handled so skilfully by the communities they support that they even make headway against the wind, or may be "hove to" and caused to remain motionless. How is this possible? you ask. By means of the trailing tentacles, and the peculiar shape of the transparent float. One end of this is much larger and blunter than the other, while a rather stiff ridge or "sail" extends along the upper surface. All the tentacles and organisms of the colony are attached to the larger portion or "stern" of the little ship, with the longest tentacles on the outside of the colony. As these trail out they keep the float with its "sail" be-

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Hydroids and jellyfish

1. Portuguese man-of-war
2. Velella
3. Giant jellyfish, North Atlantic
4. Sea bladder, New England
5. A phosphorescent jellyfish, New England
6. Pink-hearted hydroid
7. Berry bush hydroid
8. Sertularia
9. Sertularia, enlarged
10. Corymorpha
11. Clytia
12. Hydroid
13. Strobila (young jellyfishes)

fore the wind, thus serving as numerous rudders. But they may be shortened or lengthened as occasion demands, and if the wind is too strong and the colony is moving too rapidly, the tentacles stretch out until their "drag" reduces the little ship's speed, while if the wind is light they retract until they offer very little resistance to the water.

If the colony decides to alter its course or to "go about," the tentacles change position and size and by adding ballast draw the "stern" down and lift the pointed end or "bow" up to catch more wind. As the tentacles serve to check lateral or side drift in the same way as a keel or a center-board on a real boat, the queer little vessel may be made to sail "on the wind," while it may be "hove to" or "anchored" in mid-ocean by means of the tentacles which extend farther and farther—sometimes as far as forty or fifty feet—from the float, until finally their resistance to the water brings the float to a standstill. Surely there are few creatures in all the realm of Nature that are more wonderful than the Portuguese man-of-war.

Another form of free-swimming hydroid colonies is the *Velella* jellyfish which is very abundant in tropical and semitropical seas and may often be found by thousands washed up on the Florida beaches. Like the Portuguese man-of-war, with which it is often confused, Velella has a bladder-like float, but it is quite distinct from that of the dangerous man-of-war, being long, flattened, and brilliant blue in color. Moreover, it is divided into numerous water-tight

compartments, while the "sail" is triangular and is placed diagonally across the upper surface. Aside from the fact that both species have bladder-like floats, there is little resemblance between them, for Velella's tentacles are all short and threadlike, although like the organisms forming the community of the Portuguese man-of-war, some are feelers or "rudders," others are stinging animals, some are reproductive, while still others are mere eating machines.

Strange as it may seem, scientists know very little about the offspring of Velella, despite the fact that it is such an abundant and wide-spread creature. In fact they have never yet been able to positively identify a young specimen. But where Velella abounds there is another species which lacks a sail and is known as *Porpita*, and in company with these two there is a jellyfish called *Rataria* which is supposed to be the young of either Velella or Porpita. Perhaps some amateur, some chance observer rather than a trained scientist, may learn the secret of Velella's infants and may thus make an epochal discovery.

For that matter, any one may at any time solve many mysteries of jellyfishes, for many of these creatures are very mysterious and puzzling, and scientists know little or nothing of their habits or their origins. Quite frequently some entirely new and hitherto unknown species of jellyfish may appear suddenly and in great numbers in a certain district. For a few days, a few weeks, or even for several months, the creatures

may fairly swarm in the sea and may be washed ashore in vast numbers. Then, as suddenly and mysteriously as they appeared, they will vanish. Sometimes they have never made a second appearance; in other cases they have reappeared after a lapse of several years. Neither are these creatures tiny inconspicuous things which might be overlooked or mistaken for something else. Some of them are huge animals, several feet or more in diameter and so large that a single specimen will fill a wash-tub. Yet whence they come, whither they go, whether they are produced by some unknown gigantic form of hydroids in the depths of the sea or whether they are the offspring of other free-swimming medusæ no one knows.

Many of the jellyfishes are phosphorescent and a large portion of the glowing fire we see in the ocean during the summer and which is so brilliant in tropic seas is caused by young jellyfish. So it is not surprising that many of the attached hydroids should also emit a dull phosphorescent glow. But it is indeed surprising to learn that jellyfishes are edible. Can you imagine dining on a jellyfish? Still, food is largely a matter of taste, and the Japanese consider certain species of jellyfish as a great delicacy. The creatures are cured with salt and alum or are "tanned" between oak leaves. Then, when they are to be served, they are cut into strips, soaked in water, and cooked. It is said that when properly prepared and flavored they are excellent. No doubt they are fully as good as are octopi which are a favorite dish in Mediterranean countries, Latin America, and the

Orient. And think what a fine meal would be supplied by one of the giant jellyfishes of the arctic regions, creatures over seven feet in diameter and with tentacles one hundred and twenty feet in length. Surely, if these giants of the Far North are edible, there should be no excuse for arctic explorers starving to death. But the chances are that they are not fit for human food, for if they were the Eskimos would long ago have discovered their gastronomic possibilities.

Chapter II

LIFE IN A TIDE-POOL

WHEREVER there are rocky shores there are tide-pools, and wherever there are tide-pools there is a wealth of sea creatures dwelling within them.

In fact there are no better spots in which to watch these wonder creatures of the sea, for tide-pools are natural aquaria where the animal life within may be viewed at close quarters. Moreover, the inhabitants of these pools of water, left by the receding tide in hollows and crannies of the rocks, are always changing. Many, to be sure, are permanent dwellers in the pools, but there are many others that come and go, chance visitors who have been left imprisoned as the tide fell, and who will leave the spot when the tide again rises and they are free to go wherever they please.

So let us visit a good-sized tide-pool and see what strange and interesting creatures we can find within it. At first glance it may seem almost devoid of life. Masses of dull olive-brown rockweed cover the rocky sides of the pool. Delicate red and green seaweeds find roothold among the crevices or on dead oyster and clam shells. Clumps of Irish moss gleam with purple and blue iridescence in the shadows. Countless thousands of barnacles cover the rocks and emit

a low hissing sound as we approach and the dull white pyramids of shells close their valves; and of course there will be masses of unattractive mussels growing about the edges of the pool.

But these are everyday uninteresting things. Nothing wonderful about a barnacle or a mussel shell, you say. Are you sure of this? Just because they are so familiar does not prove that *Barnacles* are not interesting and strange. On the contrary, they are truly remarkable creatures, for despite their shell-like appearance they are *Crustaceans*—cousins of the shrimps, crabs, and lobsters. When they are young the barnacles swim about quite as freely as any shrimp, and bear no resemblance to the sharp-edged shelly growths that are so hard on one's bare feet when walking over rocks, and are such a nuisance on the bottoms of boats.

This free and independent life does not last for long, however. After changing their skins several times, the infantile barnacles descend to the bottom of the sea and move slowly about searching for a home-site. Finally they settle down, attach themselves to rocks or other objects, and once more change their skins, as well as their appearance and their habits. With their new garments they acquire snug little houses composed of six or more triangular sections with interlocking edges, and with a hard shell sky-light or trap-door covering the opening at the top.

All these calcareous sections are connected by the creatures' tough skin and may be operated by its muscles, and the first thing the barnacle does when

he is ensconced in his permanent home is to lift his trap-door and push apart his hinged walls. Then, uncurling his jointed feathery legs, he waves them about in the water, for while he has been undergoing his astonishing transformation the little barnacle has fasted, sustaining himself on his own fatty tissues, and now he is very hungry. Being fastened immovably for the duration of his life, he cannot go forth and seek his prey, but that does not prevent him from securing food, for his vibrating legs with their fringes of fine hairs create a current of water which draws countless minute creatures within his reach.

Perhaps, as he dines, a shadow falls across his little house, or some instinct or vibration warns him that danger or an enemy is near. Instantly the fernlike legs vanish within the shell, the trap-door drops back into place, the side walls close together and lock securely, and the barnacle is safe and snug within his armor-plated residence. And when the tide recedes leaving the barnacles high and dry, they do not suffer for want of water. Closing their doors they retain enough water within their homes to keep themselves damp and happy until the tide rises and covers them once again. To the average person all barnacles look alike, but scientists recognize a number of distinct species among the millions of the strange creatures whose domiciles cover rocky shores and almost any object which will afford them a foundation for their homes.

These common shore barnacles have their shelly, conical houses fastened tightly to the object whereon

they dwell, but there are other barnacles who provide their residences with long, flexible, rubber-like stems. These are commonly known as *Goose barnacles* and are usually attached to the under surfaces of floating driftwood, the spiles of wharves, and the bottoms of vessels, although some species attach themselves to rocks. At first glance they appear totally unlike the ordinary everyday barnacles, but if we examine them carefully we will find that the "shell" at the summit of the stalk is very similar to that of the more familiar species, although its form is oval instead of conical or pyramidal. In many species the large white shelly barnacle bears a slight resemblance to an egg, and in days gone by every one believed that they were the eggs of a kind of goose. The most intelligent men, and those who were considered naturalists, believed implicitly in this. They even published pictures of the barnacles growing on limbs of trees, with geese falling from them and swimming about in the water below. The botanist-naturalist, John Gerard, in 1597, stated in his *Generale Historie of Plants* that:

There are founde in the North parts of Scotland and the islands called Orchades, certain trees whereon do growe certaine shell fishes of a white colour, tending to russet, wherein are conteined little living creatures; which shells in time of maturitie do open, and out of them grow those living foules whom we call barnakles, in the North of England brant geise, and in Lancanshire tree geise. But those that do fall upon the land do perish and come to nothing.

Moreover, the credulous author assures the reader that he knows this to be true from personal observation, for he says: "What our eies have seen and our hands have touched we shall so declare."

To us it seems most ridiculous and even amazing that any person with a glimmering of intelligence and common sense should have believed in such a preposterous, impossible fable. But there are countless people to-day who believe in hoop snakes, who are convinced that snakes milk cows, who insist that stones grow and multiply like living things, who fear that dragon-flies will "sew up their ears," and who adhere to countless other beliefs and superstitions just as silly and ridiculous as that of barnacles hatching out geese.

And although we no longer believe in this fabulous transformation we perpetuate our ancestors' credulity by calling the crustaceans "Goose barnacles" and the wild-fowl "Barnacle geese."

Having learned what truly wonderful creatures the barnacles are, let us see what even more remarkable animals dwell in the tide-pool. Upon the masses of rockweed we will find numerous little shells, some so similar to the weed in color that they are almost invisible, others striped, checkered, or merely dull black. But we are not greatly interested in sea-shells, strange as are many of their habits, and we search about for more unusual creatures concealed among the stems and bladders of the weed. And if we have never before gone sea-creature hunting in such

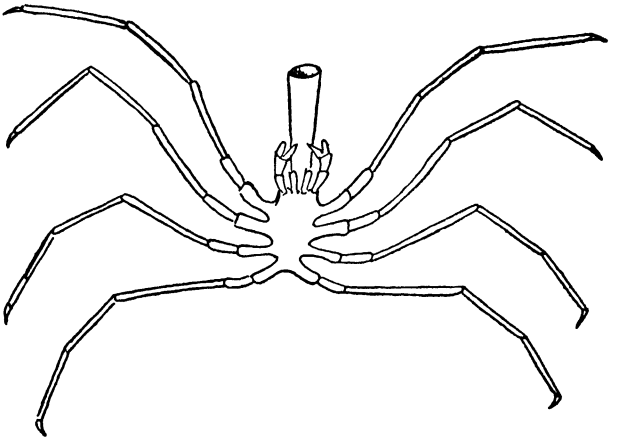
a spot we will be mightily surprised to find what a wealth of queer little beasts make it their home.

Clinging to it in tufts, or zigzagging over it like trailing vines, are hydroids of many kinds. On some of the stems we will see little areas of white, like bits of fine lace or patches of hoar-frost, and if we examine these with the lens we will find them beautiful bryozoans. Queer jelly-like masses adhering to the weed are a species of *Ascidian* or *Sea-squirt*. We may come upon groups of queer urn-shaped, rosy-pink objects which are the egg capsules of the Purpura shells. Scores of tiny *Sand-fleas* or crustaceans will hop and scuttle out of sight as we move damp, cool masses of weeds aside, and we may even discover a *Serpent-starfish* or more probably some common starfishes, concealed beneath the dense growth of weeds.

Within the pool, life is even more abundant. In crevices of the rocks or within the shadowy recesses there will be various species of *Sea-anemones*. Some are olive-green, others flesh-color or orange, others pink or crimson, with their slender undulating tentacles giving them the appearance of lovely flowers. But they are not so innocent as they appear. As we watch them, a tiny shrimp or a little minnow swims by. Instantly minute threads dart forth from the sea-flowers, and touching the creature paralyze it with deadly poison, for these seemingly harmless threads are the stinging lasso-cells with which the anemones capture their prey. As the minnow or shrimp floats helpless and dying, the petal-like tentacles of the anemone reach out and, seizing the hapless victim,

draw it to the center of the voracious "blossom" where, held fast by the tentacles curling over and about it, it quickly vanishes in the mouth of the anemone.

Perhaps, if we are lucky and our tide-pool is on a portion of the coast where conditions are favorable, we may witness a most amazing sequel to this mari-



Sea-spider (Pycnogonid)

time tragedy. Scarcely has the anemone finished its meal when a strange-looking creature appears from some secret lair among the weeds and pebbles. With eight long, slender legs and apparently bodiless, it resembles a daddy-long-legs or some sort of spider. In fact the creature is known as a *Sea-spider*, although it is not a true spider but belongs to an order all its own, for no other creature in the sea or on the earth

is like it. In the first place these *Pycnogonids*, as they are called by scientists, have no means of breathing, for they are devoid of respiratory organs. And although they have no true body yet they have a digestive, circulatory, and nervous system, while the stomach consists of tubes in the creatures' legs, which also contain the egg-sacs, the eggs being laid through openings in the joints. Moreover, these amazing beasts possess four eyes which are situated on the tip of the animal's long proboscis.

The habits of these sea-spiders are as weird and wonderful as are the creatures themselves, as we will discover if we watch the eight-legged freak approaching the sea-anemone who has just dined. Although the anemone darts its stinging threads at any passing creatures which will afford it a meal, yet it seems oblivious of the sea-spider's presence, even when the pycnogonid actually crawls upon the tentacles of the sea-flower. As the sea-spider reaches the center of the anemone it comes to a halt, poised high on its long legs, and then to our utter amazement it bends forward, inserts its long proboscis into the anemone's mouth, and calmly sucks up the contents of the latter's stomach!

It seems incredible that the anemone should submit to being robbed of its sustenance by this long-legged living stomach-pump. But the fact remains that it does, although no one can explain why. Perhaps the uncanny sea-spider possesses a hypnotic power over its victim; perchance it excretes some powerful anesthetic fluid which stupefies the anem-

one and renders it helpless for a time. But on the other hand, perhaps anemones suffer from indigestion and overeating, and welcome the relief afforded by being pumped out by the sea-spiders.

Now that our interest and curiosity have been fully aroused we will search about for more wonder creatures in the tide-pool, and we will not be disappointed. Attached to a delicate weedlike hydroid we will see an elongated queer-looking object which we may mistake for a natural growth. But if we examine it closely we will discover that it is a shrimplike creature, a strange crustacean which holds fast to the hydroid's stem by its rear legs and seizes unsuspecting little creatures that mistake the voracious *Caprella* for a portion of the harmless weedlike growth.

If we turn over some of the pebbles or bits of rocks or empty shells at the bottom of the pool we will see dozens of tiny crabs and other crustaceans scurrying to find new hiding-places. There will certainly be numerous hermit-crabs trundling about in their shell houses. We will doubtless find strange sea-worms, gorgeously beautiful with iridescent colors, and there will be a few sea-urchins looking like curled-up hedgehogs of dull-green, purple, or black. There will be sponges also—very different from our familiar bath sponges; some yellow, others olive, and perhaps a few of brilliant scarlet. And very likely we may even discover a living coral, for while most persons associate corals with tropical seas, there are several species common on our own coasts, while some occur in the arctic seas.

But each of these various groups of wonder creatures deserves a chapter by itself, and as the tide is coming in and our fascinating pool will soon be merely a hollow at the bottom of the sea, we must leave it until the next low tide. In the meantime let us learn something of the lives and strange habits of the creatures who have aroused our interest.

Chapter III

CREATURES THAT DWELL IN TUNNELS

PERHAPS, as we watched the teeming life in the tide-pool, you may have seen some flower-like growths upon the sandy bottom or among the loose pebbles and empty sea-shells. At first glance these might be mistaken for some kind of sea-anemones; but they are very different from these creatures, and are even more flower-like, with feathery "petals" of vivid colors or delicate pastel shades. Moreover, whereas the sea-anemones merely retract their waving tentacles when disturbed and seem to shrink up to form little fleshy mounds, these other sea-flowers vanish completely the instant they are touched or alarmed. If they happen to be among bits of stone or shell, you may search and search without finding a trace of the mysterious creatures, but if they have accomplished their lightning disappearance act on a sandy spot you may find a little hole where, a moment before, there had been a gorgeous living blossom.

And if you should dig into the sand in search of the elusive creature you would find only a *Sea-worm.* To many persons the word "worm" is synonymous with some squirming, repugnant animal, but there are worms *and* worms, and while some species of sea-

worms are as unattractive, as slimy and ugly as any big earthworm or "night crawler," there are others which are gorgeously beautiful creatures with most interesting and remarkable habits. Among these are the lovely but mysterious flower-like objects, for the squirming worm you have excavated from its burrow and the many-hued floral display that attracted your attention are one and the same creature, strange as it may seem.

Yet even in its lowly worm form the creature is beautiful. Instead of being smooth and slimy and dull-colored, it is made up of countless joints or segments, each bearing a tuft of stiff hairs and fine fringes on either side, and from head to tail the body gleams with scintillating metallic colors and opalescent tints. One moment it is shimmering emerald-green, the next instant it is purple and blue; as it moves and the light strikes its body at a different angle it gleams with gold and crimson. How does the creature change color so rapidly? you may wonder. The secret lies in the fact that the worm's body is covered with minute scales, like the feathers on the throat of a humming-bird, and each acts like a tiny prism to break up and reflect the colors of light.

The greatest glory, however, of these marine worms is their crown of gill plumes. Although many species of these *Annelids*, as they are called, do not possess the feathery gills which first attracted your attention, many others have immensely long and most wonderfully colored gill plumes which they extend or expand above the entrances of their tunnels.

These serve as breathing organs but they are also equipped with eyes so sensitive to light that the slightest shadow falling across the outspread floral display causes the worm to withdraw instantly within its tube. Concealed among the feathery multicolored gills you will find slender tentacles with which the worm captures its prey and in many species there will be a long tubular proboscis which in some cases is equipped with sharp cutting teeth like the "head" of a rotary drill.

Although the worm which you dug from its burrow dwelt in sand and was satisfied with lining its hole with a thin coating of mucus to hold the grains of sand together, other worms construct genuine tunnels. On rocks and pebbles and empty sea-shells you will find many small white tubes, varying in size from minute things no larger than hairs to tubes an eighth of an inch in diameter and several inches long. Some are straight, others meander crookedly over the surface of the object, others are curved, while many are neatly coiled spirals. If you should place these in a dish of sea water and watch them carefully, you would be astonished to see most beautiful flowers bud out from these little tunnels. Although they are not large and some are so small they must be viewed through a lens to appreciate their full beauty, they make up in loveliness for what they lack in size. Some resemble miniature Chinese pinks and are known as *Sea dianthus*, others are more like little dahlias, or display a multitude of feathery plumes and a galaxy of colors unequaled by any flower on earth.

Among them you may also find a number of *Sand-builders*, queer little worms who build tiny mounds of grains of sand cemented together to form little craters. When these strange fellows "come up for air," as we might say, they are strikingly different from their tube-building neighbors. Instead of bearing a gorgeous crown of feathery plumes, these sand-builders' heads are covered with clusters of short golden-yellow bristles which resemble the keys of a piano, while at one side there are a number of slender grayish or whitish bristly "whiskers," each coated with a sticky substance which serves like birdlime and catches minute particles of food for the worm's dinner.

If you think these tunnel-makers are too small to be of interest there are plenty of larger ones for you to watch. On sandy areas in shallow water and in tide-pools you will find numerous upjutting tubes resembling the stubble of corn-stalks. At low tide these may be left uncovered and no one would dream that they were the homes of very beautiful creatures known as *Peacock worms*. But when the water again covers the openings to the worms' tunnels they will be hidden under multitudes of long feathery gills arranged in fan shape and with "eyes" of color which give the effect of a peacock's outspread tail. Another worm constructs a long transparent tunnel equipped with a series of doors which may be closed at will. Moreover, he goes all human tunnel-builders one better, for he not only dwells within his tunnel but crawls about dragging his tunnel with him, ready to

pop into it and shut the doors behind him at the first sign of danger. Still other marine worms build big cornucopia-shaped tunnels in which they dwell, while others are sociable fellows and construct a perfect labyrinth of crossing, recrossing, and intertwining tubes, forming a maze of tunnels more confusing than the subways under New York City.

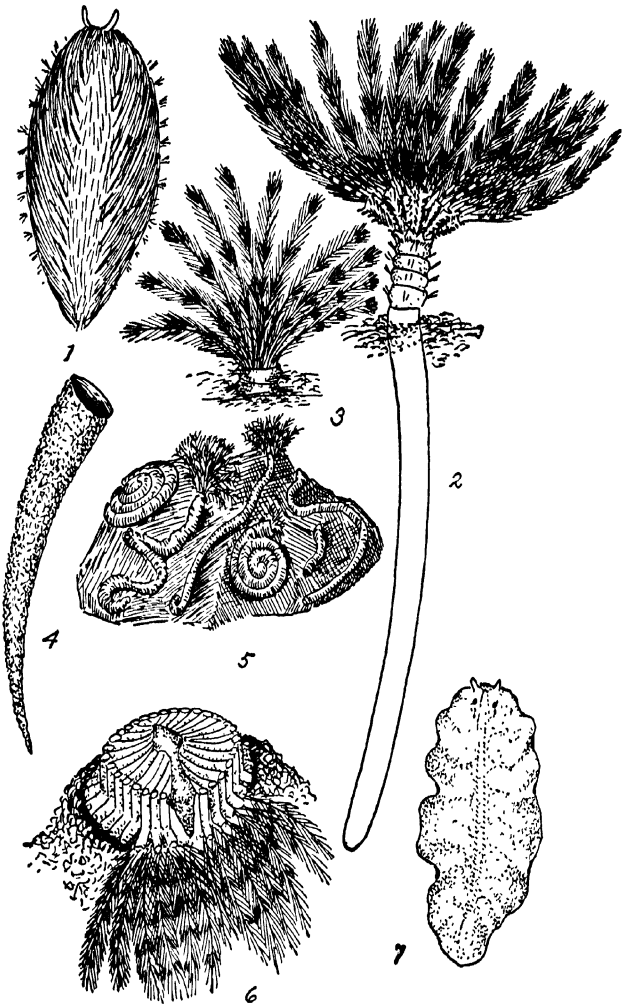
The tunnel-building worms are by no means the most unusual or interesting marine worms, however, for some of their relatives who never build burrows or tubes for their homes have far more wonderful habits. One of these is an inconspicuous white creature striped with chocolate-brown, but unless you knew its habits you would search long and far before you found a specimen. In fact you would never guess where it lives, for it dwells within the house of a species of hermit-crab. Safely ensconced in its tenement far up in the empty shell the crab has chosen for his home, the little worm has no worries. The pugnacious tenant occupying the lower stories of the shell house safeguards the worm from all enemies, and when the worm is hungry he comes downstairs, slips unmolested between the crab's jaws and helps himself to the hermit's dinner. Perhaps the hermit feels that there is plenty and to spare and so does not resent the worm sharing his meal. Perhaps he is hospitable and likes company when he dines. In fact, for all we know, he may even invite the worm to share his repast, perhaps calling to him to "come and get it."

Almost as remarkable as this *Hermit-crab worm*, who is invariably associated with the droll hermits,

is another species which selects a common starfish as his host. Although he is a good-sized worm, fully two inches in length, he makes his home in the grooves on the lower side of the star-shaped creature who never appears to object to being used as a dwelling-place for the worm.

Although all of these creatures I have mentioned are easily recognized as worms, there are others which are so different from our usual idea of worms that one not in the know would never recognize them. Some of these, known as *Planarians*, are broad, flat creatures looking like sections of ribbon or brightly colored autumn leaves. Although they crawl about on rocks, seaweed, or other objects, they are capable of swimming freely and move quite rapidly through the water, progressing by graceful undulations of their ruffled or crinkled edges.

Even more unwormlike are the queer little creatures commonly known as *Sea mice*. Three to six inches in length, short and rather broad and with a rounded back, the sea mouse or *Sea mole* is covered with a dense growth of tiny bristles resembling hair or fur. But here all resemblance to a rodent or a mole ends, for the bristles of the sea mouse gleam and scintillate with iridescent colors. Although it is really a common creature, the sea mouse is rarely seen by the casual observer, for it hides its rainbow-hued body in sand or mud which it shovels up and piles over its back until it appears merely a little mound of sand. Sometimes, after severe storms, large numbers of these sea mice are washed up on the beaches where



Sea-worms

they arouse great wonder in the minds of persons who think them some mysterious sea mammals, never suspecting they are merely lowly worms.

What would you think if you should come upon a worm ninety feet in length? You may find one at any time when you are searching here and there about the shore, hunting for wonder creatures of the sea, for the *Fish-line worm* or *Bootlace worm* is not at all rare and dwells snugly under stones or boulders in shoal water. But you would never suspect what a long fellow he is by his appearance when you turn over a rock and find him, for he looks far more like a mass of reddish-yellow liver than a worm. But just put him in a tank or pail of water, and presto! the mass begins to unfold and uncoil and becomes transformed into a smooth whitish worm seemingly without end and as slender as a fishing-line. That in fact is exactly what he is—a living fish-line, for the amazing creature feeds upon fish which he captures by means of his fish-hook mouth and his fish-line body. Getting a grip on a fish with his sucker-like mouth, the strange worm "plays" its "catch" exactly as does a human angler, his long slender body twisting and

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Sea-worms

1. Sea mouse
2. Dianthus worm, expanded
3. Peacock worm, expanded
4. Tube of a marine worm
5. Serpuline tubes
6. Piano-key worm, expanded
7. A planarian worm

curling as it is dragged hither and thither, until its resistance finally wearies the fish to the point of utter exhaustion, when it is calmly devoured by the living fishing-line.

And speaking of "devouring," can you imagine human beings devouring marine worms and considering them a great delicacy? Yet in the Pacific Islands the natives find a marine worm a most important and highly esteemed article of their diet. The *Palolo worm*, as the creature is called, is not only remarkable for its gastronomic value, but because of its mysterious and amazing ability to keep track of the calendar. Normally, and during the greater part of the year, the worms dwell in holes and crannies of the coral reefs safe from molestation at the hands of human beings. But every year, in October and November, on the day when the moon is on the last quarter and on the day before, the palolo worms suddenly appear by countless thousands. Up from their hidden lairs at the bottom of the sea they come, millions of them, until the surface of the ocean appears to be a solid mass of the creatures. But stranger yet is the fact that only a certain portion of each worm appears. Only the rear part of the worm containing the eggs ever comes to the surface. When the exact day arrives, all the palolo worms in the coral reefs wriggle their egg-filled tails out of their holes and these, breaking off, swim to the surface, leaving the forward portions of the worms with their heads behind them in their burrows.

Strange indeed is the appearance of these count-

less millions of dismembered living segments of the worms, for they are of many colors—deep blue, green, scarlet, purple, and golden-yellow, so that for many square miles the sea resembles a multicolored carpet. But the beauty of the amazing display is lost upon the natives of the islands. To them the appearance of the worms means only one thing—food. Long before the worms have actually arrived, the islanders have prepared for them. They know the exact day and hour when the amazing creatures are due and, filling their canoes with baskets, they put to sea ready to scoop up the worms as soon as they appear. Rapidly the boats are filled and are rushed ashore, for palolo worms spoil quickly once they are taken from the water, and must be eaten as soon as possible after being caught.

Either raw or cooked, they are devoured greedily by the natives who fairly gorge themselves upon this strange harvest of the sea. And although the idea of dining on sea-worms may seem most nauseating and repugnant to us, and we may feel that only savages could eat them, yet white residents of the islands, and of some portions of California as well, find the palolo worms as great a delicacy as do the dusky-skinned Kanakas. Truly there is no accounting for taste. Yet after all, is there any reason why raw sea-worms should not be as good as raw oysters or raw clams?

Chapter IV

MYSTERIOUS TRAILS

ON one occasion, when I was wandering along the seashore in Central America, my attention was attracted to countless strange marks upon the beach of fine sand. Like little roads of all sizes, from half an inch to six or seven inches in width, they extended in every direction. Some ran as straight as an automobile highway across the beach. Others extended in graceful curves; others turned, zigzagged and followed most erratic courses, and here and there they crossed one another. Never had I seen anything like them and I was puzzled as to what had produced the strange trails. They looked as if they had been made by wheelbarrows of many sizes trundled across the beach, but there were no human footprints and no one dwelt within a dozen miles of the spot. Moreover, they began and ended abruptly, exactly as if they had been made by something which had descended from the sky and, after moving across the sand, had sprung into the air.

Presently, as I was studying one of the mysterious little roads, I started. The track was actually lengthening before my eyes! Although no creature was visible the roadlike depression was moving slowly,

almost imperceptibly forward. Here indeed was a mystery, and scraping away the sand at the end of the track I uncovered—a big *Sand-dollar.*

So this was the solution of the mystery. The flat round creatures crawling along just under the surface left the tracks as the fine sand caved into the tunnels behind them.

These particular sand-dollars were members of the "keyhole" sand-dollar group, so called because of a peculiar opening or slit, which is very similar to a keyhole, in their hard flat bodies. On our own coasts most of our sand-dollars lack this opening and are complete discs, although we also have those with the "keyholes," while some species have the discs divided into numerous "spokes" and are known as "sand-wheels" or "wheel-urchins."

It may seem strange to speak of these funny sand-dollars crawling about, for most of those that are found by visitors to the seashore are dead and inert specimens, mere skeletons washed up by the waves. But the sand-dollar in life is capable of moving about as readily as a starfish. In fact the sand-dollars and starfishes, as well as the sea-urchins, are all first cousins, members of one family, and with many peculiarities and characteristics in common.

Perhaps you may think that there is very little resemblance between a flat, disclike sand-dollar, a spiny plump sea-urchin, and a common starfish. But the differences are all superficial, largely a matter of form. There is little similarity between a toy Pekingese dog and a Great Dane, or between a dachshund

and a greyhound, yet if we study their anatomies and their skeletons we find that the differences are all on the outside.

If we examine a sand-dollar carefully we will notice that it is covered with fine spines similar to those on a sea-urchin and that the upper surface bears a star-shaped pattern formed by innumerable tiny openings arranged in symmetrical five-rayed form. If we scrape the spines from a sea-urchin we will find the shell amazingly like that of the sand-dollar with the same five-rayed pattern on the top, and if we are still more scientifically inclined we will find that the mouths, the breathing devices, the "feet," and other anatomical details of the sand-dollar, the sea-urchin, and the starfish are all very similar.

All have ambulatory organs or "feet" with which they crawl or move about, and the openings to the canals which supply water to these organs form the starlike designs on the back of sand-dollars and sea-urchins. In fact sand-dollars and sea-urchins are, non-scientifically speaking, merely starfishes with the arms joined together, or perhaps I might say that starfishes are sand-dollars with the "shell" divided into flexible sections.

But we are far more interested in the strange ways and habits of these creatures than in their scientific status and anatomies, and some of them are very strange and interesting creatures indeed.

Aside from the mysterious trails he leaves in his wake, the sand-dollar is a rather dull chap. He lives a calm and uneventful life, his only enemies certain

large fishes and his only danger that of being washed up on the beach by some heavy storm or being crushed under the keel of a boat or the feet of some human being. But his first cousins, the *Sea-urchins*, are quite remarkable fellows with many strange habits, and some of them perform most amazing feats, as mystifying as any sleight-of-hand trick of a human magician.

If we should watch a live sea-urchin in an aquarium we would be surprised to find that the stiff spines covering his body are all movable, each being provided with a ball-and-socket joint so that the urchin can turn it in any and every direction. Imagine what a wonderful assortment of muscles the little chap must possess in order to control such a vast array of spines. But that is not all that the urchin's muscles and nerves handle. Compared to the multitude of independent appendages, organs, and utensils which the sea-urchin manages expertly, a telephone-exchange switchboard or a train-despatcher's control system is a simple affair. In addition to the innumerable spines and the hundreds of tube feet, the creature possesses thousands of appendages or "tools," each of which may be pushed out through a tiny aperture in the hard shell or may be withdrawn at will. And very useful and essential these implements are. Many resemble slender three-bladed pincers or forceps at the end of long flexible stalks. Others are broad-headed, viselike affairs on mobile stems. Finally there are great numbers of flexible organs tipped with triple jaws provided with needle-sharp teeth. Each of these

three types of appendages is designed by Nature for a special purpose, and a living sea-urchin in action is a more amazing and wonderful example of highly synchronized mechanical perfection than a man-made harvester machine.

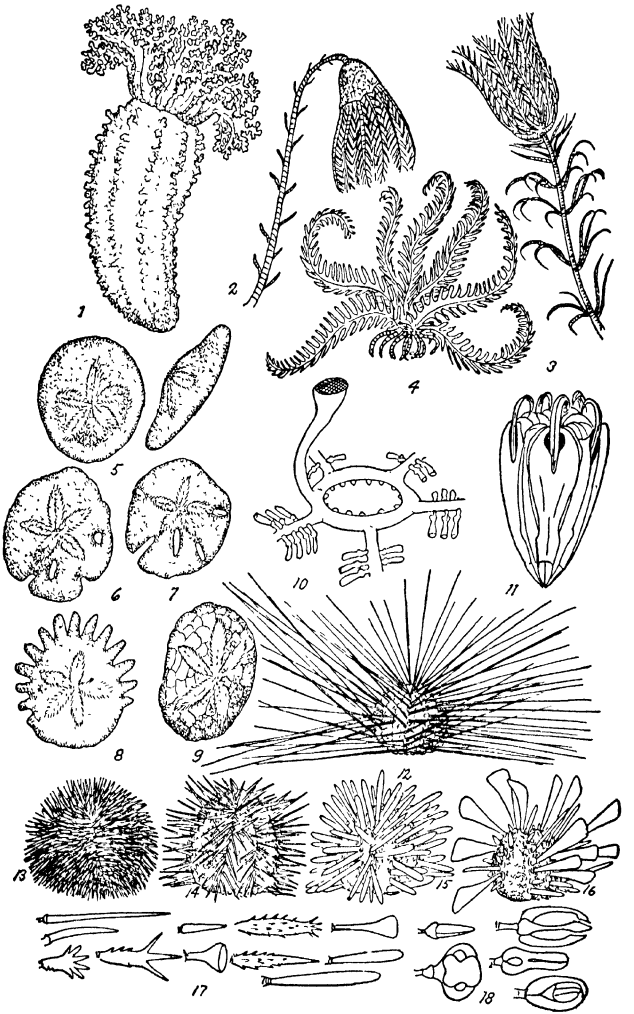
The long stiff spines move slowly this way and that, instantly swinging together and forming an impenetrable barrier of bayonets if an enemy approaches, or spreading wide apart to permit some little animal to come within reach of the multitude of pincers covering the spaces between the bases of the spines. Constantly the forcep-like appendages are busy picking up bits of dirt or other objects which lodge upon the skin of the urchin and casting the offending particles aside. The blunt-headed pincers, equipped with poison glands, move deliberately back and forth searching for chance prey to capture or enemies to destroy. The snake-like organs with their sharp-toothed jaws seize any tiny object that will serve as the urchin's food, while finally, the hundreds of tubular feet rise and fall, reach out and are drawn in, as the remarkable animal moves slowly about, traversing horizontal or vertical surfaces with equal ease.

If we drop a morsel of food upon the surface of the urchin we will witness a truly wonderful sight. Instantly a dozen pincers seize it in their jaws; quickly it is passed from one to another across the surface of the urchin, until finally it reaches the creature's mouth on its under side. But here the object must undergo a test to make certain it is edible, for the

pincer-like grasping organs possess no sense of taste or smell and leave the matter of the edibility of their capture to another set of organs whose sole duty is to taste or sample everything that is passed to them.

These are situated close to the urchin's mouth, and having tasted the morsel and bestowed approval upon it, they pop it into the jaws where five powerful teeth crunch and grind it into pulp. Even these jaws and teeth are remarkable, for they are the tip of a complicated structure consisting of forty distinct parts, neatly joined and interlocked and fitted with toggles and connecting-rods so that they may be opened and closed with perfect mechanical precision and with enormous crushing power, considering their size. This wonderful and intricate device is known as "Aristotle's lantern" and is well named, for when removed from the sea-urchin it greatly resembles an ancient form of lamp.

Now that you have learned how the sea-urchin secures its meals and dines, you may wonder how it manages to crawl so readily over the smoothest surfaces in any and all directions. The secret lies in the structure of the feet, each of the hundreds of feet being operated by hydraulic power and connected by means of slender tubes with a marvelous water system as well controlled as any designed by human beings. Upon the outer surface of the urchin is a special porous plate known as the "madreporic plate," through which water is strained and drawn into a conduit known as the "stone canal." This main aqueduct extends completely through the creature's body and



Echinoderms

empties into a second water-main which encircles the urchin's mouth. From this "ring canal" numerous smaller pipes extend in various directions, each leading to smaller tubes which in turn open into each of the many feet. By expanding or contracting specially designed muscles, the water is pumped into or drawn from the urchin's feet. When the feet are distended with the water they move outward and are pressed against the surface over which the urchin is crawling. Then the water is pumped from the feet, a vacuum is formed and the feet adhere like suckers to the surface. Then by contracting its muscles the urchin draws itself forward by means of its firmly anchored feet, which are released by the simple means of pumping water into them as another group are pumped out and attached to the surface farther on. You might suppose that this alternate filling and emptying of the water-operated feet would result in the animal moving by jerks or hitches, but as the

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Echinoderms

1. Sea-cucumber
2. Crinoid
3. Sea-lily
4. Free crinoid (feather-star)
5. Common sand-dollar
6. Sand heart
7. Keyhole sand-dollar
8. Sand-wheel
9. Sea biscuit
10. The hydraulic system of an echinoderm
11. Aristotle's lantern
12. Poisonous sea-urchin
13. Common sea-urchin
14. Spiny sea-urchin
15. Club-spined sea-urchin
16. Paddle-spined sea-urchin
17. Various types of sea-urchin spines
18. Various forms of pedicellaria

urchin has hundreds of feet and they are operated in regular succession, they adhere and let go one after another and drag the urchin onward with a steady gliding motion.

Although our common sea-urchins have short, rather blunt spines and are quite harmless unless one steps upon them with bare feet and the spines break off in one's flesh, there are numerous tropical sea-urchins with enormously long, slender needle-like spines which are highly poisonous and inflict most painful and even dangerous wounds. The spines on these fellows may be a foot or more in length and as slender as knitting needles, while other sea-urchins, found in our northern seas, have blunt-ended club-like spines two or three inches long and nearly half an inch in diameter. Some species have strange oar- or paddle-shaped spines, some have spines with many-branched tips, while others have spines covered with short, stubby smaller spines.

Some of these spines are purple or reddish and are so soft that they may be used as crayons. It is said that in the early days of the missionaries in the Pacific Islands, the spines of sea-urchins were used in place of pencils by the native pupils at the mission schools.

Perhaps, however, the most remarkable of all the sea-urchins are those which drill deep holes into solid rock. Just how they manage to perform such an astonishing feat has never been satisfactorily explained. One theory is that the urchins bore the rock by means of their teeth. But, strong and powerful

as are the teeth of the sea-urchins, they are soft and friable by comparison with the hard flinty rock which the creatures riddle with their smooth, astonishingly circular tunnels. And it is difficult indeed to understand how the urchin could chew its way into stone when young and small. Yet we often find these tunnels with the outer portions barely three-fourths of an inch in diameter, but widened out within to accommodate a big urchin several inches in diameter.

Another theory maintains that the creatures excrete some substance which either softens the rock so it may easily be cut away or dissolves it. But this would appear impossible, for the urchins' tunnels are not restricted to any one kind of stone. They are very numerous in the limestone shores and reefs of the Bermuda Islands and the Bahamas, but they are equally common in the far harder volcanic rocks of the Antilles, or even in granite, diorite, or other formations. Even if some powerful solvent produced by the creatures were capable of softening or dissolving limestone, it would not affect igneous rocks of a totally different composition.

Obviously, too, these tunnel-boring sea-urchins find it an easy matter to drill homes for themselves in hard stone and accomplish the feat quite rapidly, for in many places the rocky shores are riddled with holes of all sizes and varying in depth from a few inches to two feet or more. If the creatures found boring into the solid stone was as slow and tedious a job as we might suppose it would be, or if they gnawed their way in by means of their jaws, grind-

ing away an infinitesimal bit of rock at a time, it would require years for them to penetrate to any depth. I do not know how long a sea-urchin lives, but these animals must survive for a much greater space of time than the majority of creatures if they bore their holes by means of their teeth or by the steady abrasion of their spines, for otherwise they would die of old age long before they had excavated a cavity large enough to contain them.

Moreover, the occupants of the tunnels are not all old-timers. Many are small, young individuals who cannot be more than a year or two old at the most, and quite frequently these youngsters have bored deeper holes than those of their elders. So we can only assume that these amazing creatures possess some mysterious, inexplicable, undiscovered means of tunneling into the rock readily and quickly. What a wonderful thing it would be if our engineers could learn the secret of the urchins and apply it to drilling our great tunnels. Perhaps, one of these days, we may solve the puzzle and burrow under rivers and through mountains without the aid of all our vast, ponderous, complicated machinery of steel, steam, and compressed air.

Every visitor to the seashore knows the *Starfish*, for not only are these creatures common nearly everywhere, but they are such conspicuous things, so unusual and symmetrical in form, that they invariably attract attention.

As the majority of starfishes found on most parts of our Atlantic coasts are five-rayed species, a person

who comes upon a starfish with six, seven, or more "arms" usually feels that he or she has found a great rarity. But on the Pacific coast many-armed species are very abundant, while there are a number of species with numerous rays found on the Atlantic coast. Moreover, all starfishes possess the ability to bud out new "arms" if one is injured or lost. Quite often the creature seems to feel that, while it is about it, it is just as easy to be on the safe side and grows two arms to replace one. At times, too, some slight injury results in a superfluous arm, the starfish perhaps being unable to recognize the difference between a cut in its body and the loss of one of its rays. If the injury occurs near the tip of one of the rays a new arm may bud out from the first, or two or more new arms may appear when there are several injuries, with the result that the "arm" has the appearance of a deer's antler.

In fact the recuperative power of the starfish is one of the most wonderful features of these creatures. Even when all of the arms are amputated, leaving only the central disc intact, the crippled animal will refuse to give up the ghost and will at once begin producing a new set of rays. Some badly injured individuals do succumb, it is true, but many recover completely and it is not at all unusual to find a starfish with only one fully grown arm and with the other four—in the case of five-rayed species—tiny buds just sprouting from the edge of the disc. Moreover, a single arm when detached will develop a new disc and arms and will become a complete new starfish.

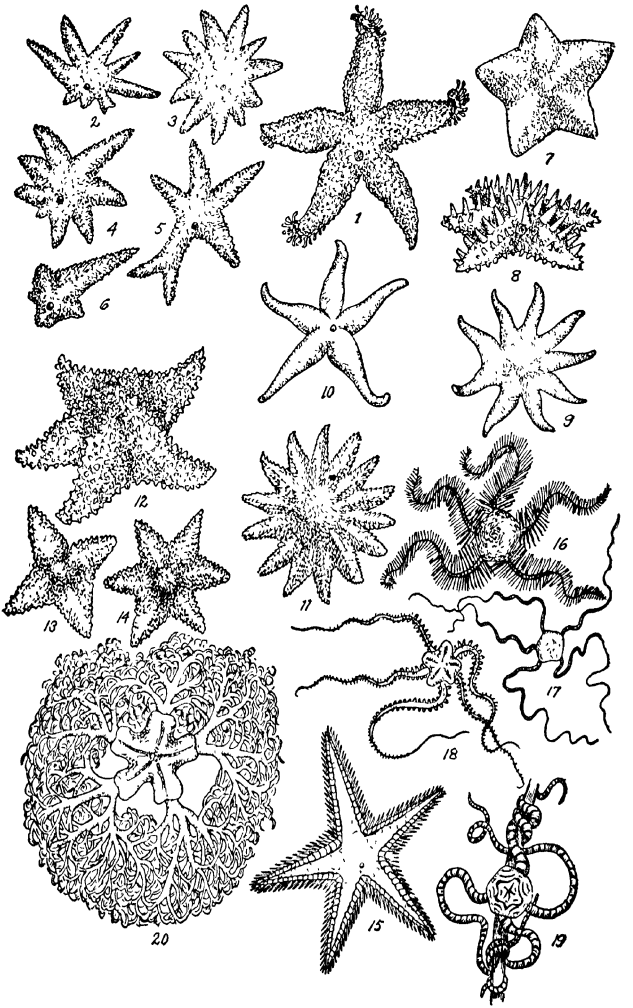
This ability to replace any portion that is lost is most useful to the starfish. It enables him to escape from many a tight place and to survive many an injury, for these strange creatures not only grow new portions that may be lost by accident but can voluntarily break off an arm when it is seized by an enemy or caught under some rock or other object. Our commoner starfishes seldom voluntarily amputate an arm when captured, but there are many starfishes, one of which is quite common on our coast, who break themselves into a number of pieces when taken from the water.

But quite aside from the fact that the starfish has many more lives than the proverbial cat, it is an interesting and in some ways a most wonderful creature. As I have already mentioned, starfishes are very similar to sea-urchins in their anatomical structure. They move about by means of hydraulic-operated sucker-like feet in the same manner as the urchins; but the strainer or madreporic plate which serves as a sluice-gate for the creatures' hydraulic machinery is plainly visible in the starfish, appearing as a brightly colored, usually red or orange, plate on the upper surface between two of the arms. Like the sea-urchins, too, the starfish has spines or tubercles attached to the bony framework of the body, as well as the active pincer- or tweezer-like organs; but in addition the starfish has eyes. These appear as small red spots, one at the tip of each arm, where there is also a large specially formed "foot" which serves as the creature's nose and also as a sort of finger or feeler.

Unlike the sand-dollars and sea-urchins who are mainly vegetarians, the starfishes are carnivorous, voracious animals and kill and devour other creatures often much larger than themselves.

Although they move readily about, they travel slowly and cannot chase and capture active prey, although occasionally some careless fish may come within reach of their sucker-feet and be instantly seized and drawn to the starfish's mouth. But the principal food of starfishes consists of shellfish, and it is especially fond of oysters. As it is always hungry and seems never able to satisfy its appetite, and as it believes that oysters are good to eat regardless of whether or not the month has an "R" in it, the starfish is most destructive to oyster-beds. In fact starfishes are the oyster-growers' worst enemies and a constant warfare is waged against them.

It may seem strange that these creatures, which appear so harmless and are seldom seen in great numbers along our shores, should prove a menace to the oyster industry. But wherever there is an oyster-bed the starfishes swarm by countless thousands. The supply seems endless and although the oystermen labor day in and day out at destroying these pests, there are always more ready to take the places of those that have been captured. Formerly the oystermen were in the habit of cutting up the captured starfishes and throwing the fragments into the sea, but in time they discovered that by so doing they were merely adding to the numbers of their foes, for each fragment, each arm, which was tossed back into



Starfishes

the water developed into a complete starfish in a short time. Nowadays all the starfishes taken on the oyster-beds are carried ashore and dumped onto dry land, and hundreds of tons of the creatures are thus eliminated every day during the greater portion of the year.

Vast as are the numbers of starfishes captured and destroyed, yet many more remain to dine upon the succulent bivalves, for the only effective method so far devised for catching starfish is by dragging "tangles" over the oyster-beds. These consist of iron bars to which are attached numerous chains covered with frayed-out rope. The ropes catch upon the rough spines of the starfishes as the device is dragged slowly across the oyster-beds, and when drawn to the surface it is often completely covered with the creatures. Yet for every starfish dragged from the oyster-beds

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Starfishes

1. Common starfish
2–6. Variations of common starfish
7. Bird's-foot starfish
8. Spiny starfish
9. Purple sun starfish, New England
10. Smooth starfish, New England
11. Sun-burst starfish, California
12. West Indian starfish
13–14. West Indian starfish: variations
15. Sand star, Florida
16. Spiny serpent starfish
17. Brittle serpent starfish
18. Serpent starfish
19. Deep-sea serpent starfish
20. Basket starfish

in this way, dozens escape, for it is impossible to cover every square foot of the beds; there are countless holes, crevices and crannies which the tangles never reach and, as the starfishes move about, an area that has been "tangled" and cleaned of the pests may be covered with them a few moments later. In a way, tangling an oyster-bed for starfishes may be compared to an airship dragging a huge net across the surface of the earth to capture human beings and other forms of life.

No doubt you wonder how a starfish can injure and eat an oyster securely locked within its shell. It does seem as if it would be an impossible feat for the apparently weak creature to open an oyster, but the starfish manages it very easily. What it lacks in muscular strength, it makes up for in tenacity of purpose, and it has learned that a "long pull" and steady pressure will accomplish as much or more than a sudden exertion of strength. Wrapping its arms about the oyster the starfish secures a viselike grip with its sucker-feet and pulls steadily upon the two halves of the shell. Presently the constant, relentless pressure begins to tell; the oyster's muscles commence to tire and the edges of its shell open for a fraction of an inch. Instantly the starfish ejects some of the digestive fluid of its stomach into the opening while continuing its steady pull. Little by little the doomed oyster opens and, as the aperture widens, the starfish does a most amazing thing—the creature turns its stomach inside out, encloses the oyster within it and calmly digests the bivalve within its

shell. Then when the oyster has been completely disposed of, the stomach is drawn back within the starfish's body and he moves slowly and deliberately to the next victim.

It is indeed fortunate for the oyster-growers that only a very, very small proportion of starfish eggs ever hatch out, and that only a very small percentage of the young starfish ever survive to reach maturity. A single starfish produces over two hundred million eggs in a year, and if even one in a thousand hatched, and the young developed into starfishes, there would soon be no oysters remaining in the sea.

But on the other hand think what would result if all the eggs of the oysters survived and developed into oysters. So prolific are these mollusks that if there were no mortalities among their offspring a single bivalve would have so many great-great-grandchildren that in order to indicate their numbers on paper it would be necessary to use the figure 66, followed by thirty-two zeros. Try to translate that sum into billions and millions if you can. But perhaps a more vivid illustration of what the oysters' unchecked increase would be, is the fact that in four generations the shells of the descendants of a single oyster would form a pile eight times the size of the earth. If oysters should increase at that rate, the two hundred million annual increase of the starfish population would scarcely be able to keep the bivalves within bounds.

Our common starfishes are seldom more than six to seven inches in diameter, but there are deep-water

species which are real giants, great many-rayed creatures several feet across their numerous arms; sea sun-bursts rather than stars, and gorgeously colored with crimson, scarlet, yellow, or purple. Imagine what would happen should hordes of these huge fellows invade the oyster-beds. Fortunately, however, they do not dwell in the shoal water where oysters are grown and the larger species of shallow-water starfishes are seldom sufficiently numerous to cause any great damage.

Although our common starfishes have very small blunt spines, some species have long sharp spines, others have knobby tubercles, while others have big blunt-ended conical spines. Some are quite soft and flexible but there are others so hard and stiff that we marvel at their ability to move their arms and crawl about. Such is the big West Indian starfish which is a favorite curio of returning tourists. The dried specimens are unattractive, dull-brownish or grayish things, but in life these creatures are deep crimson, purple, burnt orange, or rich golden-yellow in color, and present a very beautiful effect where hundreds of them dot the pure white coral sand beneath the crystal-clear turquoise water of the Bahamas and the Florida Keys.

As far as I know, starfishes are never used as food by any race, but sea-urchins are esteemed a great delicacy in the West Indian Islands and along the shores of the Mediterranean Sea. They are gathered when filled with roe or eggs, which is the part one eats, and are known as "sea eggs." Personally I do

not see why any one should rave over them, for to me they taste like sand and fish-oil more than anything else. But they are a national dish of Barbados and tens of thousands of the urchins are gathered and consumed annually.

Although the sand-dollars, sea-urchins and starfishes are the most familiar members of their funny family, they have numerous cousins, some of whom are fully as strange and interesting as are these well-known sea creatures.

Sometimes, as we turn over stones on the shore or search among seaweeds for odd sea animals, we may come upon a queer creature with a round disclike body somewhat resembling a sand-dollar, and with long, slender, wormlike arms extending from the edges. If we touch one of these chaps or try to pick it up, one or more of the long arms will usually drop off instantly, for this creature is the *Brittle starfish* or *Serpent starfish.*

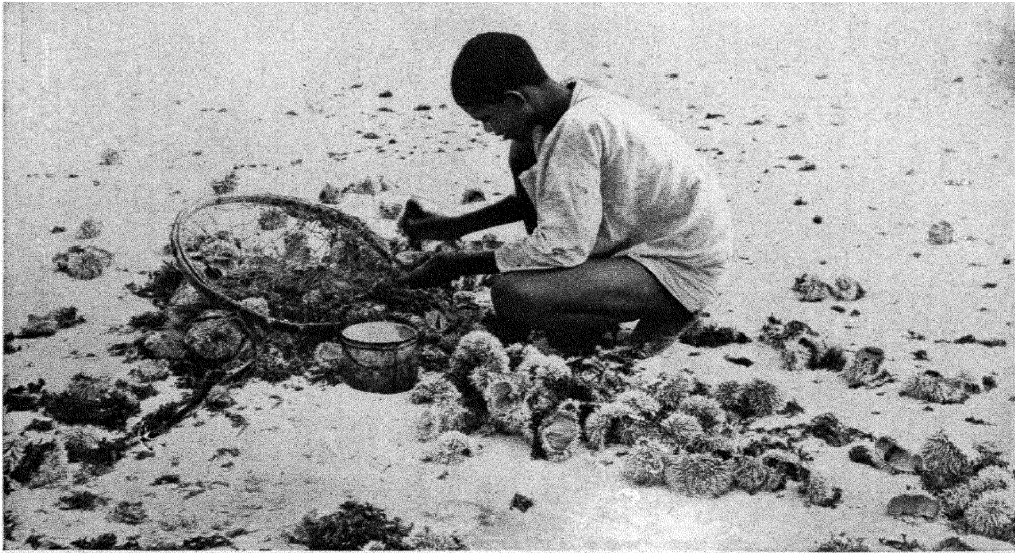
Like the common starfishes, these animals possess the ability to repair damages and replace lost portions of their anatomy in a most remarkable manner. In order to escape from their enemies the serpent starfishes voluntarily drop their slender arms, exactly as a lizard or a "glass snake" breaks off its own tail when seized by that appendage. But as is the case with the lizards, the loss is only temporary and very soon a new arm buds out and takes the place of the missing member. Even if all of its arms are lost, the serpent starfish recovers and grows a new set of arms. But unlike the true starfishes, the dismembered arms

of the serpent starfishes cannot reproduce new bodies.

In many other respects these animals differ greatly from the ordinary starfishes. Their long arms are bare and are not provided with sucker-feet like those of the ordinary starfish. But that fact does not prevent the creatures from moving about freely. In fact they are far more active than true starfishes and can move quite swiftly and climb about on seaweeds or other growths by twining their arms about them like so many serpents. When traveling on a horizontal surface these funny fellows wriggle along by means of their arms and give the effect of a number of snakes wiggling backward and dragging a disclike object in their jaws.

Many of these serpent starfishes have smooth round arms, but other species have the arms covered with long slender spines or fringed with spines which give them a fernlike appearance. Some are black, others gray or brownish; some are almost pure white, others are olive or green, while many are beautifully mottled, spotted, or striped with contrasting colors.

In size they vary as greatly as they do in hues. Those found on our beaches and in our tide-pools are tiny delicate creatures only an inch or two in diameter, while in the deep waters off our coasts there are giant serpent starfishes spreading several feet across their outstretched arms. These are rarely seen except when drawn to the surface by the trawls and lines of the Banks fishermen. Quite often these cod and halibut lines drag very strange and new specimens from



Opening sea-urchins, Barbados, West Indies

the depths and many of the most prized rarities of our museum collections were obtained in this way.

Among the other queer creatures which become entangled in the lines and are drawn to the surface by the fishermen are the animals known as *Basket starfish*. Wonder creatures they are indeed, and most appropriately named, for they much resemble baskets in general appearance. Their disc-shaped bodies are much like those of the serpent starfishes, but here all similarity ends, for the five arms of these queer animals divide and subdivide to form innumerable branches like small trees sprouting from the pentagonal body. In life all of these thousands of fine branchlets are flexible and active and may be curled up tightly or extended straight outwards. When the basket starfish decides to move about, he goes tiptoeing along on these branching arms in a most ludicrous manner. But they serve a far more remarkable purpose also. By raising itself on its arms and standing motionless, the strange creature forms a living fish-trap, for a fish swimming between the branching arms, which the fish perhaps mistakes for seaweeds, is instantly seized by the slender tentacles and is borne to the basket star's mouth and devoured.

Sometimes the fishermen's trawls bring up even stranger-looking creatures. In fact you would probably think these some remarkable plant or flower, for they resemble graceful lilies far more than animals and near relatives of the starfishes at that. Indeed so lily-like are these creatures that they are commonly known as *Sea-lilies* although scientists

know them as *Crinoids.* But if you should examine one carefully you would find that it has many of the characteristics of the serpent-starfishes. There is the same flattened disc or body with the mouth in the center, and extending from the edge of the body are five arms, each of which divides a short distance from the base to form ten rays or tentacles, each edged with flexible feathery spines.

But the mouth is on the upper surface, for the sea-lily lives upside down at the summit of a tall slender stalk growing from the middle of its back. Along this stalk, like the leaves on a lily plant, are numerous flexible arms or tentacles, while at the base it is provided with a strong fibrous root which anchors the whole to some convenient rock or other stationary object. Like the starfishes, the sea-lilies are carnivorous, but as they cannot move about to capture their prey they secure food by means of long slender hairs occupying grooves along the arms. These hairs are kept constantly in motion, thus creating a current of water which flows towards the mouth and sucks in minute animals upon which the creature feeds.

But the strangest feature of the crinoids is that some species do not remain rooted immovably throughout their lives. As if becoming tired of growing like plants in one spot, the "flower" breaks from the stem and goes swimming off quite freely and independently, using its feathery arms to propel itself hither and thither. But it isn't compelled to remain forever on the move, wandering aimlessly through

the sea. Little finger-like appendages sprout from the surface of the body where once the stem was attached, and when the creature wishes to rest it settles down, grasps some object firmly with these jointed grapples, and remains firmly fixed until it feels like going on another journey.

These free-swimming crinoids are commonly known as *Feather-stars* and resemble lovely ferns more than lilies. But instead of being green they are beautifully tinted with rose, pink, or mauve. Most of them dwell in fairly deep water, but one species is quite common on the southern shores of England where it is known as the "rosy feather-star," the entire animal being a delicate blush-rose color, or sometimes cerise. When fully grown these crinoids are about four or five inches in diameter and when, as they often do, they collect in large numbers in a certain spot the effect is particularly beautiful.

But perhaps the most interesting thing about the sea-lilies and the feather-stars is that they are among the most ancient forms of ocean life and are the ancestors of all the sand-dollar, sea-urchin, starfish group. Millions of years ago they were exceedingly numerous and grew to gigantic size with stalks fifteen or twenty feet in height and feathery arms as long as the fronds of a good-sized palm tree. Imagine what a marvelous sight a vast forest of such creatures must have presented as their bright-colored feathery tentacles swayed back and forth, curled and uncurled, and moved about clutching at passing fish

and other animals with which to feed their foot-wide hungry mouths.

Very probably, if you have spent much time at the seashore, you may have found a curious object resembling a soft, rather decayed-looking cucumber washed up by the tide or buried in the mud and sand where you dug for long or "soft" clams.

Perhaps you merely tossed it aside without stopping to surmise what it might be, or possibly you were a bit puzzled by the queer thing and wondered what it was, for although obviously an animal of some sort, it had neither feet, arms, tentacles, nor other visible organs or appendages, but seemed only an oblong bag of skin covered with little tubercles or warts. As I have already said, the object resembled a cucumber and was a creature known as a *Sea-cucumber* or, to use the scientists' name, a *Holothurian.*

If a sea-cucumber is placed in water and is undisturbed, a strange transformation will take place. Slowly one end expands and from an opening little, handlike, delicately colored tentacles appear. Larger and larger they become until the creature is crowned with a mass of finely divided branching tentacles extending for several inches from the body. Meanwhile, countless little sucker-feet have appeared from the surface of the skin and, lo and behold! before we realize it, the seemingly helpless creature actually is crawling along like a starfish. This really is not so very remarkable, for the sea-cucumber is another cousin of the sand-dollar, sea-urchin, starfish, sea-

lily family known as *Echinoderms*. But no one but a scientist would ever guess that they were even distant relatives. In fact scientists themselves have sometimes mistaken sea-cucumbers for something else, and for a great many years some species were classed with an entirely different group of sea creatures known as ascidians or "sea-squirts."

Although the commonest sea-cucumbers found along our eastern coast are rather dull-colored purplish or blackish creatures, there is one species about three inches in length which is brilliant scarlet, and when its tentacles are fully expanded it is one of the most gorgeous and beautiful of the sea creatures of New England waters. Our largest native species is common on the coast of Maine and when fully grown and extended is twelve to fifteen inches in length; but like all of the sea-cucumbers this creature is constantly altering its size and shape. One moment it may be short, stout, and almost spherical. The next minute it may be long, slender, and cylindrical, or it may change quite suddenly to an hour-glass or dumb-bell form.

Still another species of sea-cucumber or holothurian, which dwells in burrows in the sands of the Atlantic coast from Cape Cod to Florida, is long, slender, and so transparent that its internal organs are clearly visible. When the creature has gone foodless for a time its body is white and glasslike with the digestive organs winding in a sort of spiral through the center. But after the strange creature has dined the body appears grayish and filled with

sand, pebbles, and sea-shells which can be seen through the surface of the body. This astonishing creature is eighteen or twenty inches in length when fully grown, but has the remarkable habit of constantly breaking off pieces of its rear end. Any disturbance or irritation causes it thus to mutilate itself, and when kept in an aquarium or other container it quickly breaks itself into pieces and in a short time only numerous fragments of the animal remain. Another strange sea-cucumber found in rather deep water is known as the *Cotton spinner*. This is a large species, brown in color, and when disturbed or excited it throws out countless white sticky threads so tough and strong that they will entangle and hold a good-sized lobster or crab.

In the arctic seas, the sea-cucumbers reach gigantic size, some species being three or four feet in length when fully extended, and in the tropics there are other large species. They abound in the West Indies and occur by millions on the Great Barrier Reef of Australia. In fact coral reefs are their favorite haunt, for despite their soft, weak, helpless appearance, these truly wonderful sea creatures devour coral. Even large pieces of the corals are swallowed, and after the animal matter has been digested the waste material is ejected in the form of finely pulverized limestone.

For a starfish to be capable of voluntarily breaking off its arms in order to escape from an enemy, and then replace them, is truly remarkable, but what would you think of a creature who voluntarily sacri-

fices its own internal organs and afterwards replaces its viscera with a new set? Yet that is what the sea-cucumber does when attacked. Moreover, these amazing creatures actually can turn themselves inside out. If you doubt this just place a common everyday sea-cucumber in a dish of stale sea water and watch the results. Almost immediately the animal will appear to be nauseated, and after writhing and twisting, its "innards" will slowly emerge from its mouth until the leathery body is completely emptied. It assuredly is a most astonishing and novel manner of "casing" its stomach. Perhaps the person who first coined the expression "my stomach felt as if turned inside out" had the sea-cucumber in mind.

Although sea-cucumbers are not considered of any commercial value on our coasts and are never used as food, yet in the Orient vast numbers are gathered, cured, and sold in the markets, for the Orientals, and particularly the Chinese, consider the "bêche-de-mer" or "trepang" a very great delicacy. It is said that even our own native sea-cucumbers, or at least the large species common on the coast of Maine, are excellent and taste so much like lobster that a person cannot tell the difference if he shuts his eyes. Perhaps, if we could induce our people to try these creatures, a great demand for them might result and sea-cucumber fishing would become as important an industry as lobstering.

In the East the animals are dried in the sun and then smoked for twenty-four hours. During this process they shrink from two feet or more to a few

inches in length and resemble black sausages. They are cooked by boiling until they swell to huge size and resemble great masses of glue or gelatine. Personally I have never sampled one of these tidbits, but friends who have done so state that they taste not unlike smoked herring mixed with fish glue. That certainly does not sound like a very delectable meal, but no doubt the gluelike character of the bêche-de-mer is what appeals to John Chinaman, who is particularly partial to gelatinous food such as sharks' fins and edible bird's-nests.

Chapter V

SKELETONS THAT KEEP US CLEAN

I HAVE often wondered who first discovered the use of a sponge for bathing. Probably it was some savage islander who happened to come upon a dead and fairly pliable sponge cast up on the beach. In fact the first users of these sea-growths must have relied upon dead and weathered sponges washed up by the waves, for a sponge in its natural state would be a most unpleasant and ineffectual object with which to wash one's body.

Even the finest quality of bath sponges when alive or when first taken from the water are rough, hard, slimy things. As they are usually covered with bits of broken shells and fragments of coral and are filled with sand, they would scratch and cut one's skin like coarse sandpaper. Doubtless the earliest users of sponges found the supply of dead specimens, partially cleaned by wind, waves, and sun, inadequate for their needs, and, reasoning that what Nature did could be done by human means, they gathered live sponges and "cured" them. Even so it must have required considerable time and experience before these primitive people secured sponges that were reasonably soft and free from abrasive material. But

savages' skins are fairly tough and perhaps they rather enjoyed the scouring and scratching that resulted from the use of their crudely prepared sponges.

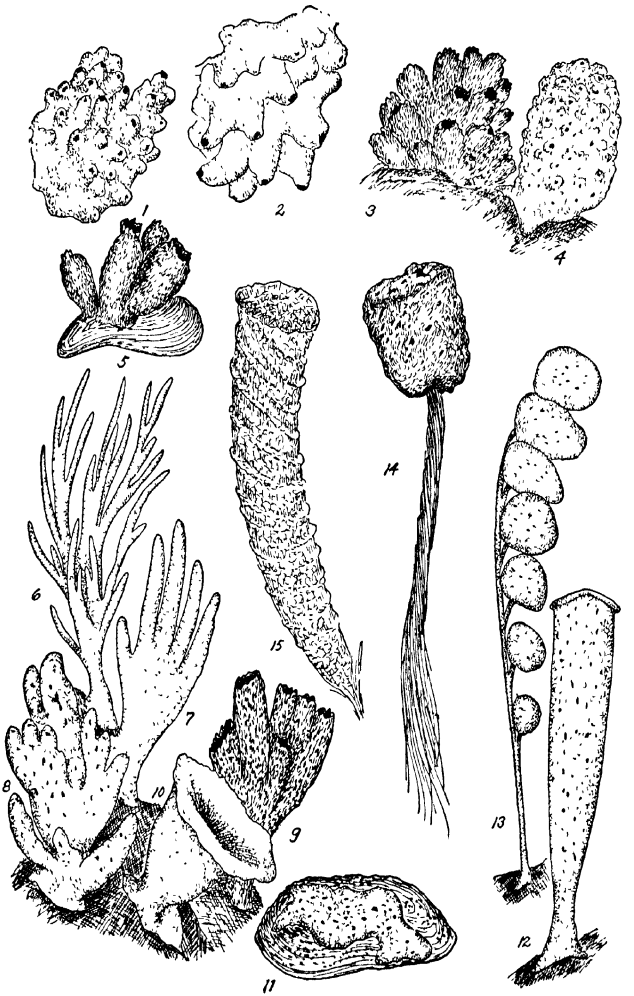
Be that as it may, we know that sponges were widely used for cleansing human bodies in the very remote past, and that thousands of years ago the sponge fisheries of the East were a very important industry. Ancient sculptures show boats and divers gathering sponges, and among the specimens of pre-Incan pottery taken from the ancient graves of Peru there are some which depict sponging (as well as pearling), so we know that centuries before Columbus voyaged to America, sponges were used in widely separated parts of the world by various races. But only those races who dwelt in tropical or semi-tropical lands enjoyed the luxury of bathing-sponges in these distant times, for the varieties of sponges adapted to such purposes occur only in the warmer portions of the oceans, although sponges of various species abound in all seas and on all shores, even on our own coasts and in the arctic and antarctic regions, while some species of sponges are found in fresh water.

As is the case with corals, most persons always associate sponges with tropical seas and shores and are quite unaware that many strange and interesting sponges are common in the shoal waters along our own northern coasts. Practically every tide-pool contains living sponges. If you examine the spiles of old wharves or bridges at low tide you will be almost

certain to find numerous sponges among the masses of mussels, seaweeds, sea-anemones, and other sea creatures which find the sodden spiles such an ideal home. And if you stroll along the beaches and examine the eel-grass, seaweeds, and other flotsam and jetsam cast up by the waves and tides, you will be certain to find many sponges.

Some of these are quite similar in appearance to small bath sponges, but others are so different in form or in texture that you would never recognize them as sponges. One of the commonest of our shallow-water sponges is known as *Mermaids' gloves* or *Dead men's fingers* which are very appropriate names, for these sponges form long, tapering, cylindrical branches very similar to human fingers. The very next sponge you find may be a hard, woody mass somewhat resembling one of those common fungi that grow on dead trees and logs in our woods. Another may be a soft gelatinous mass, while still another may be a rather shapeless growth of vivid scarlet or crimson. On seaweeds or other objects you may find specimens of the beautiful *Flask sponges*, bottle-shaped growths sometimes several inches in length.

In fact the forms and colors of the commoner shoal-water sponges are almost limitless, and if you search the shores of fresh water lakes, or the lock-gates or docks of canals, you will find masses of vivid green sponges which you have doubtless mistaken for some fresh-water algæ. Regardless of the shape or color or texture of sponges you can always identify them



Sponges

as such, for all sponges are filled with countless canals and chambers which connect with little openings or pores on the outer surfaces of the animals. In some species these pores are very minute and the sponge appears at first glance to be perfectly smooth, while other species, such as our familiar bath sponges, have very large openings.

The chambers and canals of all sponges are filled with minute hairs like tiny whips, and when the sponge is alive these continuously vibrate, thus causing currents of water to flow throughout the interior of the sponge. It is in this way that the creatures secure their food, the currents of water bringing in minute particles of food which are eaten by the sponge animals, while the indigestible residue is carried away by the outflowing water. A sponge, however, is not one single animal but is a colony or

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Sponges

1. Pink-eyed sponge, New England
2. Crumb-of-bread sponge, New England
3. Common red sponge, New England
4. Sulphur sponge, New England
5. Urn sponges, Atlantic coast
6. Dead men's fingers, Atlantic coast
7. Mermaid's glove, Atlantic coast
8. Rock sponge, Atlantic coast
9. Tubular sponge, Atlantic coast
10. Petunia sponge, Europe
11. Boring sponge, Atlantic coast
12. Vase sponge
13. Mushroom sponge, Celebes
14. Glass-rope sponge, Japan
15. Venus's flower-basket, East Indies

community of a great number of separate creatures, each occupying its own snug little cell, and all bound together by the skeleton which we know as a "sponge." In some species of sponges this skeleton is composed of spicules of hard, flinty, glasslike silica, and hence sponges of this group are known as *siliceous* sponges. Others have the skeleton made up of a hornlike material known as *chitin*. This may be very coarse, dense, and hard, or it may be as soft and fine as silk. All bath sponges belong in this group, for the siliceous sponges are hard and stiff, often resembling solid stone when dead and dried. But whether siliceous or horny sponges, all grow or increase in size by budding or, rather, by cell division, each of the individual animals constantly splitting or dividing and forming new cells. It is a case of arithmetical progression and in a comparatively short time a single sponge animal may increase to several hundred thousand animals, and the minute sponge, scarcely visible to the naked eye, may become an immense mass.

Moreover, separate colonies of sponge animals of the same species will quickly unite if placed side by side, while if a single sponge is divided or cut into fragments, each will continue to grow and increase. Although sponges may spread from place to place in this manner, they also produce eggs which develop into free-swimming larvæ. These wander about for a few days and then, settling down upon some convenient object, they start a new colony.

It may seem very strange that such seemingly harmless and inoffensive creatures should be capable

of causing enormous damage to man. Yet a little sponge abundant in our northern waters is one of man's worst marine enemies. Incredible as it may appear, these sponges bore holes in solid rock and sometimes completely destroy sea-walls and other structures. They are also one of the worst enemies of the oysters and cause immense damage to the oyster-beds by boring countless holes in the shells. In many places it is almost impossible to find an oyster shell that does not bear the marks of the sponge's presence, and quite frequently they appear as if they had been riddled with small shot. If the holes are merely superficial and do not penetrate the shells, they may not cause serious damage, but in addition to boring into the shells these sponges form immense masses over the oyster-beds and smother the bivalves. In a way, the sponge is a worse foe than the starfish. A large proportion of the starfishes may be captured by means of tangles, but only a very few of the boring sponges can be eliminated in this way. Being attached almost immovably to the shells, the tangles pass over them, breaking off fragments here and there, but leaving the principal masses of sponge unharmed. In Europe many of the oyster-growers raise the shells in big wire frames which from time to time are drawn to the surface and exposed to rain or are sprayed with fresh water. The fresh-water bath does not injure the oysters but kills the sponges which decay and drop off when again lowered into the sea. But it would be an impossible task to bathe our immense oyster-beds in fresh water and as it is, the

oystermen lose thousands of dollars annually through the depredations of the boring sponges.

Although the sponges of our coasts and shallow waters are mainly fairly small, many of the deep-water sponges, as well as sponges inhabiting tropical seas, grow to immense size and have strange forms. Among the coral reefs of tropical and semitropical seas the giant *Cup sponges* are very abundant. In fact they might better be called "tub sponges," for they are frequently five or six feet in height and four or five feet in diameter across the open upper end. Other sponges are most beautiful things and some of these have skeletons which when cleansed of the fleshy material resemble spun glass. Among these are the indescribably beautiful *Venus's flower-basket sponges* and the *Glass-rope sponges* of Japan. In the case of these glass-rope sponges, it is the roots and not the skeleton of the sponge itself which are so lovely. The sponge proper is small and far from attractive, but it is anchored to the muddy bottom of the sea by means of immensely long spicules forming countless slender threads as flexible as silk and producing a yard-long tassel that appears made of spun glass.

Very different indeed are the soft, often velvety, bath sponges which are the most important members of the entire group of these strange sea creatures. Although species of sponges suitable for toilet and other commercial purposes occur in all warm oceans, those most often used and marketed are natives of the Mediterranean, the Caribbean Sea and the Gulf of Mexico, the principal sponge industries being at

Nassau in the Bahama Islands, at Tarpon Springs near Tampa in Florida, in North Africa, and the Ægean Sea.

Formerly sponging was one of the most important of maritime industries. Millions of sponges were taken annually from the sea and millions of dollars worth of sponges were marketed. But with the invention of sponge-rubber and the ever-increasing use of wash-cloths, the demand for bath sponges decreased, until to-day the sponge fisheries, extensive as they are, are comparatively small. Moreover, the sponge beds became depleted and the fishers were compelled to go farther and farther for their supply and to seek new beds in deeper waters. Where once naked divers went down to gather sponges, or the animals were fished up by means of hooks attached to long poles, the spongers nowadays employ diving suits and gather sponges growing at depths far too great for "skin divers," as they are called. In some localities, as in the Bahama Islands, the natural sponge beds have been saved from utter extermination by laws which "close" certain areas for several years, thus allowing the sponges to increase and grow to marketable size, when these beds are "opened" and the other beds are closed. But large numbers of sponges are also grown artificially or are "cultivated."

When growing naturally, the sponges adhere to any and every object, such as coral, sea-shells, or rocks, and as a result they are irregular in form and size. But when propagated or cultivated they are

uniform in size and shape, and hence bring a better price and have far less waste material to be removed.

In establishing these artificial sponge beds, slabs of concrete are "planted" with bits of living sponges and are then placed at the bottom of the sea in fairly shallow water suitable for sponge growth. When the crop has reached marketable size the sponges are sliced off by means of a sharp knife, leaving a small portion adhering to the slab and from this a new sponge sprouts and grows.

But gathering the sponges is only the first step in the industry. When taken from the sea they are slimy, black, unattractive objects having little or no resemblance to the soft yellow or brownish sponges we see in the stores or use in our baths. The sponges having been gathered, they are placed in corrals or fenced-in areas in shallow water where the animal matter is rotted and roughly washed out. Next they are thoroughly rinsed and cleansed, washed and beaten, and finally are dried in the sun. If during the drying process the sponges become wet with rain they may be badly injured and rendered almost worthless, for at this stage of their preparation fresh water rots the horny skeleton and ruins it. Such sponges are easily recognized by their vivid yellow or orange color or by orange or rust-colored spots upon them. No experienced sponge buyer would accept such sponges, but the gullible tourists purchase them eagerly, attracted by their bright color. Thus the wily spongers, who have been unfortunate in having some of their catch injured by rain, usually

Clipping sponges, Nassau

obtain a higher price for their worthless goods than for their finest sponges sold in the markets.

When the "crude" sponges are finally cleaned and dried they are taken to the "clippers," usually Negro women and girls, armed with big shears, who quickly and skilfully clip off all the rough, coarse edges and irregularities of the sponges, leaving them smooth and rounded and ready to be graded, assorted, and displayed in the sponge market where they are auctioned off to the buyers.

To-day Tarpon Springs, Florida, is the world's largest sponge market and the headquarters of the largest sponge fishery. It is not at all unusual for a day's sale of sponges to amount to more than fifty thousand dollars, while sponges worth a million dollars are frequently brought in and marketed during a single year. Practically all of the Tarpon Springs spongers are Greeks and, unlike the Bahaman and other West Indian sponge-fishers, they have organized their business and conduct it in an up-to-date manner, maintaining coöperative warehouses where the sponges are displayed and sold.

An experienced sponge dealer can judge the quality and value of the stock at a glance, but to the average person it seems hopeless to attempt to distinguish one kind of sponge or one grade from another except for size. Yet there is a vast difference in the quality and kinds of these sponges. As a rule there are four varieties recognized and sold. The coarsest and cheapest is known as the "wire" sponge

and is used mainly for washing automobiles and other vehicles. The next in the scale is the "grass" sponge which is one of the cheaper grades of bath sponges and is also used for many commercial purposes. A still better variety is the "yellow" sponge, while the finest of all is the "wool" sponge. But the market value of these depends very largely upon the demand for a certain grade, the size of the stock, its texture, and the care that has been taken in curing and clipping the sponges.

To most persons a sponge is a sponge, and its use is confined to the bathroom and the automobile garages. But sponges have manifold uses and only a small proportion of those taken and sold each year are used for washing human bodies or the bodies of motor-cars. Many of the finer grades are used by surgeons. Chemists and others use great numbers of sponges. The cheaper grades and the larger clippings are ground up and are used in manufacturing linoleum and sound-proof materials for broadcasting studios and offices. Many more are used in padding clothing, for stuffing furniture and mattresses and similar purposes. Quantities are used by cleaners of garments and for washing windows. But by far the greatest number of sponges are sold to glass-works, for sponge is the only known material which may be used for wiping or cleansing hot glass. All fabrics, other than asbestos, burn or char the moment they come in contact with the hot glass, and asbestos is not suitable for the purpose. Leather, chamois, rub-

ber—all are injured or destroyed by the intense heat. But sponge is fireproof, heat does not alter it, and to manufacturers of glass these skeletons of tiny sea creatures are of paramount importance.

Chapter VI

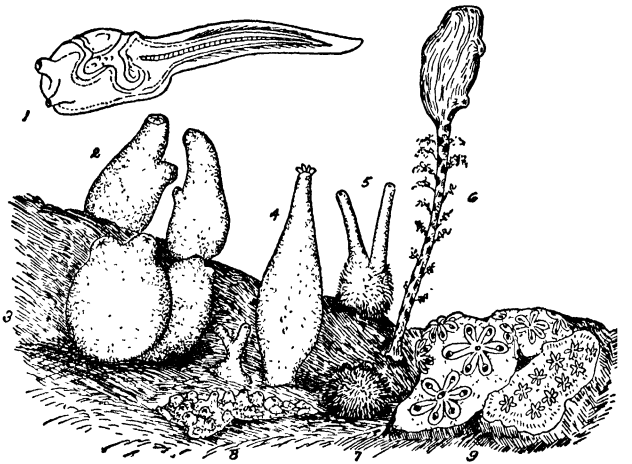
OUR DEGENERATE ANCESTORS

WHEN you are searching about among the clusters of marine growths on rocks, in tide-pools, upon old timbers or spiles, or when you turn over stones or even dig in the sand of the seashore, you will always find some form of the strange creatures known as *Sea-squirts* or *Ascidians*. But until you become somewhat familiar with these remarkable animals you will find difficulty in recognizing many of them, for the members of this group vary tremendously. Many are jelly-like and cover rocks, shells, seaweeds, or other objects with a coating that resembles soft glue. Sometimes this is dull-brownish, again it may be olive, or it may be purple, yellow, green, red, or milky-white, according to the species. When Victor Hugo, in *Toilers of the Sea*, wrote: "The walls are splashed with crimson stain as if giants had been fighting there," he referred to the patches of blood-colored ascidians that often cover large areas of the rocks, especially in caves or grottoes of the seashore.

Regardless, however, of whether the growths resemble blood, glue, or water-soaked leather, they are readily identified as ascidians by the little starlike dots which cover the entire surface. Sometimes these

are arranged in quite regular rows or they may be in clusters or groups. These are the true animals or *Zoöids*, and very frequently they are brilliantly colored. One species, known as the *Golden star*, has *zoöids* that are as bright and shining as if made of pure gold and are set in a jade-green mass, while others may be white on a green ground, others purple on orange or yellow, or white on scarlet. Very often these gelatinous masses form large lumps, often hemispherical and six inches or more in height. Other species form irregular tubercles or may have soft branches or lobes, while some are even provided with short stalks. These gelatinous creatures are known as "compound ascidians," for they consist of permanent fixed colonies of countless individuals all embedded in a mass of jelly-like material.

Although the majority of these compound ascidians adhere to other objects where they remain throughout their lives, there are others which are mobile and swim about. These are known as *Salpas* and are most remarkable creatures, for they occur in two wholly distinct forms, which alternate with each generation. In one of these forms the salpas are individual solitary animals about an inch in length and with two long processes at the posterior end. These little animals soon begin to produce buds which increase in number and develop into complete animals arranged in double rows forming a transparent almost cylindrical strip of tissue which may be several feet in length and may contain hundreds of separate ascidians. In this stage the salpas swim about in the



Ascidians

1. Larva of an ascidian
2. A simple ascidian
3. Sea-peach
4. Sea vase
5. Sea-squirt
6. Sea potato
7. Spiny ascidian
8. Compound ascidian
9. Compound ascidian

sea by wavy serpentine motions. They are very beautiful objects, their cellophane-like masses being tinged with pink and marked with pale blue banded with white, and frequently they are mistaken for the "Venus's girdles" (*See* Chapter VII). But their most peculiar and remarkable feature is that these free-swimming colonies of countless animals do not increase or produce more of their kind by budding or subdivision as we might expect. On the contrary, each member of the mobile colony lays a single egg which

develops into a solitary animal which in turn buds and produces a chain of its fellows.

Quite distinct in appearance from the various compound ascidians are the simple ascidians or true sea-squirts. They are fully as common as their compound relatives and abound everywhere from the edge of the sea to the most abysmal depths of the ocean. There are countless species and no two are alike. Some are globular, membranous creatures so similar in appearance to sponges that they may easily be mistaken for those animals. Others grow in slender tubelike forms, others are branched. Many resemble the cocoons of big moths, while many are borne on the tips of tall slender stems or stalks with little twiglike branches.

Certain species are translucent or even transparent, and appear as if made of cellophane with the internal organs visible within the animal. There are many which are hard and almost stony, others are leathery, still others are like rubber, while one species common on our coasts is known as the *Sea-peach* because of its globular form, its soft velvety surface, and its delicate pink and yellowish shading on a whitish ground. There are species so dark and wrinkled that they appear like dried prunes, while others are soft, gelatinous, and repulsive in appearance. In size these animals vary from tiny spheres or delicate tubes to massive affairs several inches or, in tropical seas, a foot in diameter.

In colors the sea-squirts vary as greatly as they do in form. A great many are dull-colored—brownish, gray, ocherous, whitish, or even black. But others

may be most brightly colored. A species commonly found on the spiles of wharves and on shell sand in shoal water along our coasts has an oblong body marked with triangular patches of purple and white. Another common ascidian is low, flat with thin margins and is flesh-colored. Numerous species are brilliant yellow or orange, others are vivid green and some are purple, lavender, or gleaming red; while many cover themselves with bits of seaweeds or grains of sand.

All sea-squirts, however, are alike in certain features. All have sack- or bottle-like bodies and when touched or disturbed eject jets of water, a habit which has given them their very appropriate common name of "sea-squirts." And if we examine these strange creatures we will find that every individual is provided with two apertures or openings; one of these serves as the intake, the other the exhaust. Water is constantly drawn into one tube and after passing through the animal and having been relieved of its organic contents and its oxygen it is forced out through the other aperture. If we should dissect one of these curious creatures we would find that the inner walls of the body are pierced by thousands of tiny openings to form a most perfect sieve. As the indrawn sea water passes through this, the minute organisms it contains are captured by the living strainer and serve as food for the ascidian.

But there is much more to the creature's internal anatomy than this cleverly designed strainer. Simple and seemingly as lowly as they are, almost plant-

like in appearance and mode of growth, yet these sea-squirts have a far more complete internal structure than most other sea creatures aside from the fishes. Not only do they possess a well-defined heart and a complete blood-vascular system, but their hearts actually beat and pump blood through the veins. But the heart of the sea-squirts beats in a very different manner from the hearts of the higher animals, for instead of throbbing steadily and thus causing an even pulsation of the blood-stream through arteries and veins, the heart of the ascidian pumps the blood in one direction for a time and then stops, goes into reverse and pumps the blood in the other direction. Many, I might say most, of the lower orders of marine animals have mere sacs to serve as digestive apparatus, but the sea-squirts are provided with a stomach, an intestine, and a liver. In fact these strange creatures have many points in common with the far higher classes of animal life and are of intense interest to scientists as they form a sort of connecting link between the vertebrates and the invertebrates.

But the most remarkable thing about these animals, perhaps the most amazing of all the amazing features of the lives of sea creatures, is the fact that the young or larval form of the sea-squirts is a tadpole-like animal with a rudimentary backbone or notochord very similar to that of the embryos of the vertebrate animals, including man. Moreover, these young ascidians possess well-defined eyes, brains, ears, and mouths, as well as a digestive tract, a com-

plex nervous system, and a heart. In fact they are complete highly developed, free-swimming creatures, while, most astonishing of all, they are far more advanced on the road of evolution than are the adult sea-squirts.

Why or how it happened that creatures who were well started on the upward way towards higher things should suddenly have halted by the wayside and then gone backward is a mystery, a puzzle which even the most astute and greatest of scientists cannot solve. But the fact remains that this must have happened, for the highly organized baby ascidian with its rudimentary backbone swims about for a time, propelling itself by means of its tadpole-like tail, much as though it were an embryonic fish. But at last it abandons its active life and, finding some suitable object, attaches itself and undergoes a most astonishing transformation. Its notochord disappears, its tail vanishes, its nervous system completely changes, it loses its eyes, brain, ears, and mouth, and the few vital organs that remain—the stomach, digestive apparatus, and circulatory system—become so greatly altered that they bear no resemblance to those of the free-swimming larvæ. In short, the tadpole-like animal undergoes as great a transformation as does the caterpillar of a butterfly, but instead of emerging as a more highly advanced and more mobile imago, the larva of the ascidian becomes a much lower, much more primitive adult, a mere sea-squirt incapable of independent action.

But the instinct to survive as a free and mobile

creature, to advance rather than to retrograde, is still strong within the tiny brains of certain species of ascidian larvæ. Although his fellows settle down and develop into fixed sea-squirts whose eggs will hatch into other tadpoles, the *Oikopleura*, as it is called, refuses to stay put. Nature has doomed him to develop into an ascidian, but he is far too fond of the foot-loose life to become a fixture in any one spot. So, clinging to his larval tail with which to propel himself hither and yon, the creature evades the fate of his relatives and satisfies the law of Nature by producing masses of gelatinous ascidians far larger than himself and completely covering his body. As the masses become so large that they prove a serious handicap they are discarded and new ones are formed. Most fittingly, this wonderful little creature has been called the *Housebuilder*.

If we are to have faith in the theory of evolution, then the strange ascidians are our remote ancestors. It is a simple matter to trace back the genealogical relationships of the higher vertebrates. No one who has really examined into the matter can deny that there is a regular and complete chain of evolution or gradation from the mammals to the fishes, and then we come to that other strange sea creature, the *Lancelet* or *Amphioxus*. Fishlike in form, the lancelet swims feebly and prefers to hide its interesting personality in the sand of shallow waters. Possessing simple gills for respiration, with a mouth, a digestive tract, and a rudimentary spine or notochord, the little animal has been deemed a living example of

the creatures which in the dim and distant past bridged the gap between the invertebrate and vertebrate animals.

However, in many ways the larva of the ascidian is much farther advanced than the lancelet, for it boasts of eyes, ears, a heart, and a brain, all of which are lacking in the lancelet's make-up. So even if the creature does lose out and become a backboneless, brainless, blind and deaf ascidian in the end, it may be a nearer ancestor of the human race than the amphioxus. Perhaps we should not feel particularly proud at the thought of being descendants of sea-squirts, no matter how inconceivably remote the relationship may be. But after all is it any worse than having the lancelet for an ancestor? Moreover, there is one great advantage in tracing our lineage back to sea-squirts, for it does away with all snobbishness and "family superiority." Even if our ancestral ascidians were purple or scarlet, green or gold, gelatinous or leathery, one was as good as another. There are no "first families" among these creatures.

And perhaps we speak more truly than we think when we refer to some bumptious youth as a "young squirt."

Chapter VII

COUSINS OF THE CORALS

IF you have taken even a cursory interest in sea life or if you are at all observant, you must have noticed the sea-anemones that abound on our rocky shores and in almost every tide-pool. Those of our own coasts, such as I have described in Chapter II, are rather small, with slender simple tentacles, and are often dull-colored, inconspicuous creatures, although some are yellow, orange, or even brilliant red.

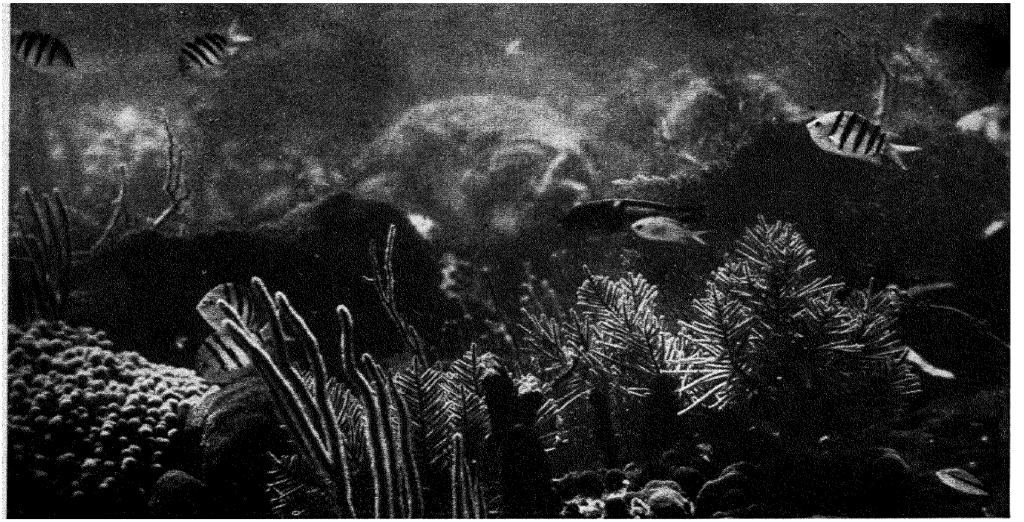
But in deep water, and in tropical seas, there are gigantic sea-anemones, many with tentacles two feet in length, and of many forms. Some, like our own shallow water species, have slender, tapering, simple tentacles like the petals of a "single" flower, others have numerous rows of small tentacles forming a thick fringe about the central disc, others have broad flattened tentacles growing in masses which almost conceal the disc and remind one of lovely "double" flowers, while still others have the edges of the disc crinkled or convulated and edged with thousands of tiny tentacles.

In colors these creatures vary as greatly as they do in size and form, and in tropical waters they

fairly blaze with gorgeous tints. One species, abundant in the West Indies and Bermuda, is vivid scarlet, ornamented by a band of eyelike spots of intense azure blue. Another common species which grows to huge size has an olive-green body and foot-long pale green tentacles tipped with gorgeous cerise. Still another is ivory white with innumerable exceedingly long and slender tentacles, each of which is ringed with deep maroon. No flower garden on earth ever equaled the galaxy of colors and beauties of form of these animal flowers of tropic seas, yet theirs is a fatal beauty. Like the little sea-anemones of our tide-pools and our rock-bound shores they possess deadly poisonous stinging organs and "lasso-cells" with which they stun and capture their prey or drive off enemies.

And don't delude yourself with the idea that these are puny or insignificant weapons. Our little northern sea-anemone can stun or even kill a good-sized shrimp or a small minnow by means of its threadlike stings, so you can imagine how much more powerful are the lasso-cells of these giant species of the coral reefs. Some will inflict very painful and serious stings on human beings and the collector who handles these handsome creatures will rue his carelessness if he fails to don rubber gloves.

Although we usually think of the sea-anemones as firmly rooted to the spots where we find them, the majority are by no means permanently attached, but can change their location and move slowly about at will. Yet if we attempt to dislodge them we will find they



Courtesy Submarine Film Corp.

Corals, sponges, gorgonias and coral fishes photographed at home, at the bottom of the sea

are so firmly anchored that it is often impossible to detach them without tearing them apart. Like the proverbial limpet, the sea-anemones adhere to an object by suction, the base of the body or column of the animal forming the sucker, or perhaps better, a vacuum-cup. There are also species of sea-anemones which bury themselves in sand or mud with only the disc and waving tentacles protruding, while others swim about freely and quite rapidly. Some of these swim by means of the tentacles and are supported by an enlargement of the body which serves as a float, while others move about by alternately drawing in and ejecting water, each jet serving like the discharge of powder in a sky-rocket and driving the animals along in a series of rapid jerks.

There are also sea-anemones that are immovably anchored. Strictly and scientifically speaking these are not true sea-anemones but are known as *Zoanthus*. But they are so closely related to the true sea-anemones and are so similar in appearance that no one not a naturalist could distinguish any real differences. Some occur singly, but the majority form large colonies all connected near the bases of the bodies and often covering several square yards. Many have good-sized discs an inch or more in diameter while others have countless small discs packed closely together. In color they vary from dull browns and olives to vivid orange, brilliant yellow, bright green, and dull red. Some grow upon rocks, others prefer coral reefs, still others may be found on sand, and some even thrive in slimy mud. Certain kinds have a curious

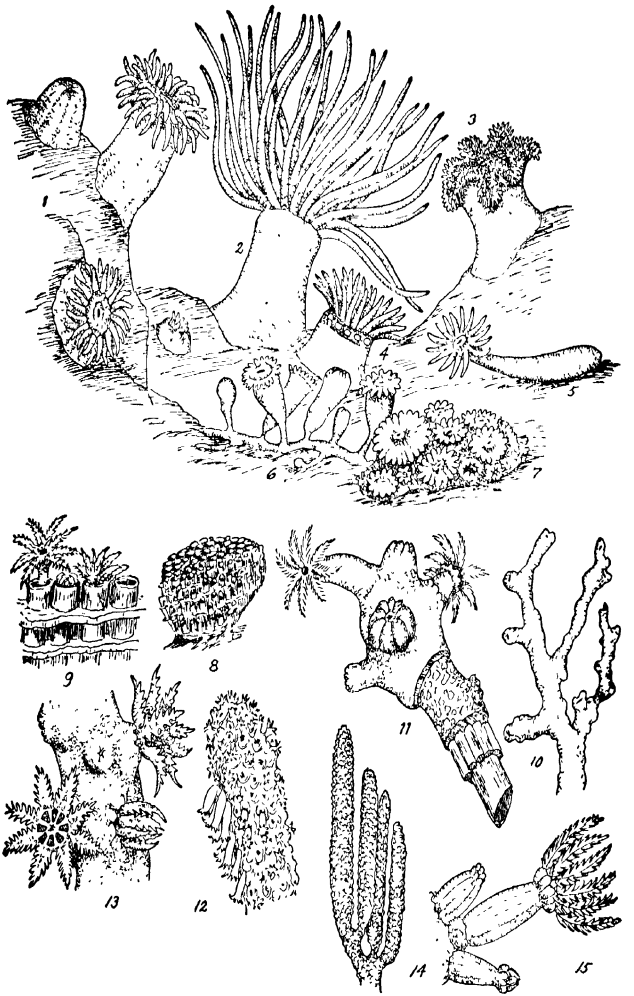
habit of covering themselves with grains of sand or fragments of shells and corals, thus concealing all but their mouths and tentacles. When thus camouflaged these Zoanthus colonies might easily and excusably be mistaken for living corals. This is not surprising as they form a sort of connecting link between the sea-anemones and the corals, for sea-anemones are very near relatives of the sea creatures whose lime skeletons are known as coral. Indeed some scientists regard the sea-anemones as coral animals who do not form lime residences in which they dwell.

But there are many other sea animals that are in a way intermediate between the true sea-anemones and the true corals. These are known to scientists as the *Alcyonaria* or more commonly as *Gorgonias*. To this group belong the *sea-fans*, *sea-rods*, *sea-plumes*, *sea-whips*, and *sea-pens*. At first sight there seems little resemblance between a lacelike flexible purple or yellow sea-fan and a sea-anemone, and just as little between a sea-fan and a hard calcareous coral. But if we should examine a sea-fan when alive we would find its surface covered with little polyps, each with a central mouth in a circular disc surrounded by delicate tentacles like those of the sea-anemones. We would find similar animals expanding their tentacles from countless apertures in the stems and branches of a sea-rod, a sea-whip, or a sea-plume, and the strange sea-pens, which are often hauled up on deep sea fishermen's lines, consist of a flexible stem surmounted by a number of branches each covered with the same type of animals.

The sea-fans, sea-rods, and the other Gorgonias of this type are very flexible when alive and sway and wave and bend to the ocean currents, for they consist of a tough, horny, central stem or core covered with a skin or epidermis composed of innumerable tiny lime spicules embedded in animal matter. Very frequently you will find sea-fans or sea-whips washed up on the beach and very different in appearance from the specimens sold in curio stores or by the native boatmen and peddlers of tropical countries. Instead of being yellow or purple with velvety-looking branches, these wave-washed Gorgonias have black or deep-brown branches which appear as if made of wire or hard rubber. Quite frequently also, portions of the surface of a specimen of a sea-fan may have this same peculiar appearance. And if a sea-fan or a sea-whip or sea-plume is kept in a very dry room, it may soon become transformed to a mere shiny black skeleton, as the outer skin and spicules drop away from the horny stalks.

But there are also species of the group which are almost as hard and rigid as true corals. One of these is known as the *Organ-pipe coral*, owing to the countless tubes of which it is composed, each tube being separated from the others by open spaces, but connected by little horizontal platforms. In life this creature is very beautiful, the "coral" itself being brilliant red while the anemone-like animals, each of which dwells in a tube, are vivid green with long feathery tentacles.

Another of these semi-corals is the red coral or so-



Cousins of the corals

called *Precious coral* used in making jewelry, for necklaces, et cetera. In the Orient it is regarded as a potent medicine. In life the precious coral is very different from the pink or red fragments of commerce. Its surface is quite rough and its many branches are covered with snow-white flower-like animals, the precious coral as we know it being only the central stalk or stem of the Gorgonia, corresponding to the horny interior of the sea-fans and sea-rods. Formerly nearly all the red coral was obtained from the Mediterranean Sea, especially from the waters about Italy and the Grecian Archipelago, but to-day the chief sources of supply are the Japanese waters.

Although I have said that these Gorgonias and spicular corals are intermediate between the sea-anemones and the true or stony corals, scientists consider that the true corals and the sea-anemones are

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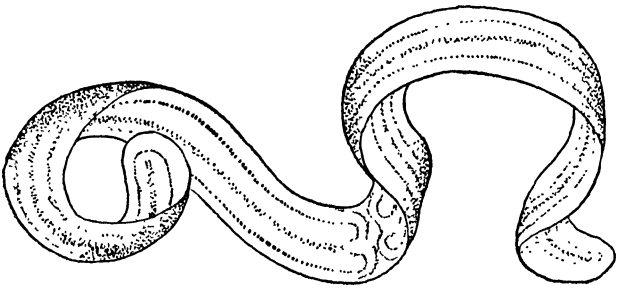
Cousins of the corals

1. Common sea-anemone
2. Giant sea-anemone, Florida
3. Ruffled sea-anemone, Bermuda
4. Blue-eyed sea-anemone, Bermuda
5. Free sea-anemone, Florida
6. Trailing zoanthus, Florida
7. Carpet zoanthus, Florida
8. Organ-pipe coral
9. Organ-pipe coral, animals
10. Precious coral
11. Precious coral, animals
12. Gorgonia
13. Gorgonia, animals
14. Sea-rod
15. Sea-rod, animals

more nearly related than are the anemones and Alcyonarians. Undoubtedly the scientific gentlemen are right, but they base their classification on the anatomical structure of the creatures, while the average person is more concerned with their outward appearances and habits.

Perhaps, if you have ever voyaged over tropic seas, especially if you have sailed on the Mediterranean, you may have seen a strange and very beauti-



Venus's girdle

ful object like a ribbon of shimmering iridescent silk. Or if you have watched the water on some warm tropic night, admiring the play of firelike phosphorescence, you may have seen a brilliantly illuminated object moving slowly by graceful curves and convolutions through the sea. If so, you have seen a very strange and interesting creature known as the *Venus's Girdle* or *Cestus* as the scientific sharps call it. It is one of the real wonder creatures of the sea, a member of a small group of animals midway between the worms and sea-anemones in the zoölogical tree. Flat and

ribbon-like in form, the Venus's girdle is often five or six feet in length and only a few inches wide and is as transparent as glass. Midway of its body is an "eye" or sensitory organ and opposite this is the creature's mouth, with a single short tentacle on either side. The strange animal is also provided with eight comblike swimming plates along the edges of the body, but it swims mainly by graceful serpentine movements and by rolling and unrolling its ends, rather than by means of the swimming organs Nature has given it. In life it is tinted with delicate pink, violet, and blue, and has all the shimmering opalescent beauty of a soap bubble or iridescent glassware. But it is a very delicate thing and it is almost impossible to capture it without serious injury and mutilation. Moreover, when preserved, it loses its wonderful colors and appears merely an unattractive semi-transparent strip of animal matter, not fit for a girdle of an everyday mermaid, although Venus herself might well be proud to wear a girdle of such delicacy and beauty as the living Cestus.

Chapter VIII

THE CREATURES WHO BUILD ISLANDS

IT may surprise many persons to learn that corals are found on our own coasts and in our northern waters. But there are a number of species of true corals which inhabit the oceans of the temperate zone and even the arctic regions. To be sure, these northern corals do not build reefs nor grow to huge dimensions as do the corals of tropical seas. They are rather small and inconspicuous and usually may be found in the larger tide-pools and in crevices of rocky shores, while quite frequently their dead and bleached skeletons are washed up on the beaches. But do not expect to find beautiful branching corals, massive brain corals, or similar forms thriving in our tide-pools, for the native corals are mainly of the "cup coral" type and when symmetrical in growth are often very pretty things.

Another fact about corals which will come as a surprise to many people is that the reef-building corals are shallow-water creatures. They must have light in order to thrive. They cannot withstand cold water and many species require air and grow to best advantage when they are left uncovered by the tides for several hours daily. As sunlight cannot penetrate

the sea water to any great depth, even in the crystal clear waters of the West Indies and other portions of the tropics, and as the ocean's temperature is barely above the freezing point in really deep water, irrespective of latitude or longitude, the reef-building or massive corals are restricted to depths where the temperature is not less than 68° F., while the great majority occur within six or eight fathoms of the surface. Also, while various species of these corals may be found from the bottom to the top of a reef, certain corals are confined to certain depths, so that there is always a more or less regular stratification of the species, although this is more apparent in the upraised fossil reefs than in those composed of living corals.

Strictly speaking, none of the corals actually "build" the reefs which are formed by the gradual accumulation of hard lime skeletons of the corals, the fragments broken off by waves or storms, dead seashells, sand which lodges in the innumerable crevices, and all sorts of foreign matter which accumulates among the coral growths.

How do the polyps produce the limestone coral? you want to know. Where do they obtain the lime? Why are coral reefs restricted to warm seas?

Perhaps it is best to answer the last question first, by propounding another query: Why are certain birds, insects, fishes, or members of the various other forms of animal life found only in tropical lands, while others closely related are restricted to temperate zones, with still others inhabiting the frigid areas of

our earth? No one knows the real answer, and it is the same with corals. To-day corals thrive best and construct their massive reefs in tropical waters mainly because these warmer seas contain far more lime in solution than do northern waters. But this superabundance of soluble lime in the sea water results from the gradual dissolving of coral reefs and of æolian limestone, and these were formed directly or indirectly by coral animals.

In other words, one of the principal if not *the* principal reason why coral reefs occur only in tropical seas is because other corals built other reefs there ages ago. The lime, dissolving in the sea water or carried into the sea by rains from upraised coral reefs or limestone rocks with a coral basis, is used by the little animals to form new coral reefs which in time will be decomposed and dissolved, when the lime will be used over again to produce more coral in a never-ending circle. To attempt to find the beginning or end of a circle is of course a hopeless task, and it is just as hopeless to attempt to find the beginning of the coral cycle. Had Nature seen fit to make reef-building corals natives of temperate or cold seas we might have coral reefs along our shores. But as far as known reef-building corals have always been denizens of the warmer portions of the oceans and the upraised fossil coral reefs which form large areas of limestone deposits in various localities, as in western New York State, were all formed when this portion of our earth was blessed with a tropical climate.

Even if we cannot definitely state just *why* corals

are mainly restricted to the warm waters of the ocean we do know exactly how the little animals build the hard skeletons which gradually accumulate until they become huge reefs and large islands. As the animals grow, they throw off quantities of carbon dioxide and ammonia, and these chemicals set up a reaction in the water close to the polyps, which causes the lime in solution to be precipitated in the form of calcium carbonate or limestone. This precipitate or, rather, crystalline formation, is produced most rapidly about the bases of the animals where the greatest quantities of ammonia and carbon dioxide are excreted. As a result, the little polyps are being constantly encrusted with the hard limestone which forms casts, much as would plaster of Paris, conforming to the animals' structure. In order to avoid being completely covered by the ever-forming lime crust and becoming encased within living tombs of their own making, the animals grow steadily upward or outward, while, just as steadily, the limestone forms behind and about them.

It may seem as if the minute quantities of carbon dioxide and ammonia thrown off by a tiny creature the size of a coral polyp would be so insignificant in the enormous mass of sea water that it would be completely disseminated without causing any chemical reaction to take place. But we must remember that there are countless millions of the animals packed closely together, and the aggregate amount of the chemicals they produce is very large indeed. In fact there is such a superabundance of these that lime

held in solution by the sea water for a considerable distance from the corals is deposited and forms a calcareous coating on various other objects. Seaweeds and plants, dead shells, stones, metal or even wooden objects are often so coated with limestone that they appear true fossils or lose all resemblance to their original forms.

Old wrecks that have found a resting-place among coral reefs are frequently so encrusted with this product of the polyps' chemical laboratory that they appear to be embedded in solid concrete. On one of my expeditions to salvage treasure from an ancient galleon wrecked on a coral reef in the West Indies, we found the hulk completely encased in solid limestone fourteen to eighteen inches in thickness, which had been formed during the three hundred years the wrecked vessel had been resting on the bottom between the reefs. Many of the old cannon were covered with a coating of limestone several inches thick, and would never have been recognized as metal guns until the encrustation was chipped off, while bits of wood wrenched from the old hulk were as heavy as solid stone and were so impregnated with the lime that any one would have thought them fragments of petrified wood, millions of years old.

Moreover, the corals do not begin to grow upon a level space and gradually climb upward to form a reef or an island. Only a few species can thrive on sand, and wherever we find a coral reef we may be sure that the corals are merely a superficial growth with a foundation or core of solid rock. But the rock upon which

the corals grow may be far beneath the surface of the sea and the encrustation of coral may be many feet in thickness. Their individual growth may be quite rapid, but as they near the surface or reach the point where they are exposed during periods of low water they are constantly broken and smashed by heavy seas so that the reef itself rises very slowly, about half an inch in ten years under favorable conditions.

Owing to the fact that corals grow upon natural rocks they conform more or less closely to the contour of the foundation, and hence we find coral reefs of many shapes. Very often they cover the summits of upjutting spires or peaks of submerged mountains. They may form long, straight, narrow reefs where they grow along the verges of undersea cliffs. If they grow about the rim of some submerged crater they will form the circular reefs known as *atolls;* and where the ocean is filled with masses of broken-down mountains, great boulders, and water-eroded rocks, there may be hundreds, even thousands of coral reefs of every size and shape and filled with deep caves, fissures, and grottoes.

There is still another element that has a very great influence upon the formation and the shape of coral reefs. Corals thrive best where the water is constantly agitated and in motion, and as a result the corals grow larger, faster, and more abundantly on one side of a reef than on the other, while the waves breaking across the reef, smash off bits of coral which accumulate on the leeward side. Consequently the reef builds up more rapidly on the sheltered side,

and the more it builds up, the more sheltered it becomes and the more débris accumulates upon it. In time the reef may be gradually extended in this manner until it forms a good-sized island with living corals growing only on one side, for once the flotsam and jetsam, the broken corals, and the other débris is piled up, until it reaches the surface of the sea, an island forms rapidly. Seeds, carried by the waves and wind, find lodgment upon the new-made speck of land and quickly sprout and grow. There will be sea-beans and the seeds of sea-grape trees; wiry grass and sedges will appear, and floating coconuts encased in their buoyant water-tight husks will be washed ashore. In a surprisingly short time palm trees will wave their fronds above the little islet, tough vines and beach grass will form a miniature jungle, and as the roots of the plants bind and hold the bits of sand, broken coral, and other materials together and prevent them from being washed away, the island's growth will be even more rapid than before.

Many of the so-called "coral islands" of tropic seas have been formed in this way and one may search the waters about their shores for true coral reefs in vain. Here and there among the rocks and sea growths there may be a few corals, but there is no sign of vast numbers, nothing to show that corals had a hand in building the island. Such islands may be sandy with the original coral reef buried many feet beneath the surface of the land, or then again they may be composed of solid rock. But if we examine the rock carefully, we will find that it is com-

posed entirely of wave-ground, wind-drifted sand consisting of minute fragments of broken corals and sea-shells. Ages ago a submerged ridge or mountain top rose to within a hundred feet of the surface of the sea where the island now lies. Corals grew and thrived upon it. Débris, carried by waves and wind, found lodgment among the branches and masses of the coral. Then finely pulverized bits of shell and coral accumulated until a sandy island rose above the sea. But the very material which the corals had formed spelled their doom. The sand, washed by rains down the sides of the new island, smothered the corals; beaches came into existence, covering their dead skeletons with many feet of sand. And the rain, percolating through the finely ground remains of shells and corals, dissolved a certain amount of the lime and redeposited it, cementing the grains together to form solid rock. To geologists this form of rock, of which the Bermudas, the Bahamas, and many other islands are composed, is known as "Æolian limestone"; in other words, limestone formed by the wind.

In many cases these islands formed of solidified wind-drifted sand are low, with their highest points only a few yards above the surrounding sea. Others may rise in dunes and wind-formed hillocks for many feet, while a great number have been gradually elevated until to-day the original surface, once barely exposed above the sea, may be hundreds of feet in air. In such elevated islands one may find the original coral reefs high above the sea-level, forming an integral portion of the limestone rocks and cliffs. An-

cient as they are, many of these fossil corals are identical with those living to-day. And very often the entire story of the formation of the island may be read by a study of these elevated fossil coral reefs.

In other localities, especially in Bermuda, we often find land shells, of the same species as those inhabiting the island to-day, embedded in the limestone or hidden away in "pockets" filled with loose sand which has never solidified. If we search about we may find the semifossil trunks of trees and the queer circular holes where trees once grew in the sand which is now rock.

These islands of Æolian limestone are usually rich in caves and grottoes, some of which are of immense size and are very beautiful, with a wealth of gleaming stalactites and stalagmites depending from the ceiling and rising from the floor. In some cases these caverns may have existed in the original reef, but the majority have been formed by the gradual erosion and dissolution of softer areas of rock, or by huge sand pockets, the contents of which have been washed out.

Although I have mentioned that corals growing upon the rim of a submerged volcanic crater will produce a circular or semicircular reef or atoll, these atolls are sometimes formed by breaking waves wearing away the center of a reef, combined with the more rapid growth of the corals around the outer edges. About the shores of the Bermudas and also in some of the Bahamas, there are numerous miniature atolls formed in this way. These are known as "boilers,"

and although composed mainly of worm tubes, corallines, and small corals, they are perfect atolls and afford a splendid demonstration of the way in which many large atolls are formed.

In addition to the various types of coral reefs I have described, there are the barrier reefs. These are usually extensive reefs situated at a considerable distance from the land and separated from it by deep wide channels. Such barrier reefs may be short, surrounding some small island or stretching along some section of a coast, or they may be of enormous length and size. Such is the famous Great Barrier Reef of Australia, which extends for a distance of 1,315 miles and stretches from New Guinea southward along the entire coast line of Queensland.

To naturalists, and to every one at all interested in the wonders of the sea and the marvels of Nature, a coral reef is a veritable wonderland. Even those who care nothing for ocean life or strange sea creatures are invariably amazed and impressed when they view a coral reef and marvel at its beauty and its wonders, for coral reefs are not only wonderful spots but they are astonishingly beautiful as well. No description however vivid can begin to convey any true idea of the appearance of a coral reef; no words can picture the galaxy of colors, the ever-changing effects of light and shade, the weird, fantastic forms of marine growths, or the fascination of a coral reef. Only by visiting one, by gazing downward through the transparent water of the tropic seas, can one ob-

tain a true idea of what it is like, for there is nothing like it, nothing to equal it on earth or in the sea, it is the greatest wonder of all the wonders of ocean life and beauty.

Chapter IX

A VISIT TO A CORAL REEF

IF we cannot visit a coral reef in person, the next best thing is to visit a reef in imagination. So let us imagine ourselves sailing across the impossibly blue sea of the Bahamas, headed for one of the countless coral reefs that abound in these waters.

Overhead, the long-tailed tropic birds circle about, their snowy plumage tinted with palest aquamarine from the reflected light of the marvelous azure sea. A mass of cumulus clouds upon the horizon is strangely tinged with turquoise, and our boatman tells us the color marks a distant islet, the brilliant sunlight reflected from the white coral sand of the shallows passing through the water and painting the clouds with color, although no trace of the island itself can be seen.

Often, as our little craft speeds onward, we pass Portuguese men-of-war and Velellas, their shimmering rainbow-hued floats bobbing upon the tiny waves.

Flying-fish skitter across the sea from beneath the boats' bows; now and then a big amber jack or a kingfish leaps from the sea, flashing like burnished metal in the sunlight, and a flock of heavily flapping, clumsy, brown pelicans wing their way to some feed-

ing-ground, flying close to the surface of the water and rising and falling in perfect unison with the swell.

Long before we reach our objective we can detect its location, marked by a deep purple patch in the clear blue expanse, and presently our sails come rattling down, the ebon-skinned skipper heaves his anchor overboard and we have arrived.

As the ripples of our wake smooth out and we peer over the boat's rails we almost gasp with wonder and amazement. Gone is the cobalt sea over which we have been sailing. Our craft is floating in air, suspended by some invisible means above a landscape of transcendent beauty and color. It is as if we had been transported through space to some other planet, and from our rocket-ship were gazing downward at the surface of another world.

So marvelously clear is the water that objects forty feet beneath us appear almost within reach of our outstretched hands. We can see the anchor resting upon a patch of sand, one fluke buried deeply, with the rusty chain sagging in a long curve among masses of waving sea growths. All about it swarm scores of fish attracted by the tiny creatures dislodged by the anchor as it dug into the bottom. And what fish! Golden grunts with stripes of cobalt blue. Hinds spotted with scarlet and white. Turquoise-blue parrot-fish with fins and tails edged with orange. Angelfish of opalescent tints with silken ribbons of vivid yellow streaming from tails and fins, as well as dozens of smaller fishes of every imaginable color and com-

bination of colors. But we scarcely notice these rainbow-hued finny inhabitants of the tropic sea, for beneath our eyes is the gorgeously fascinating and wonderful panorama of the coral reef.

Close to the surface, seemingly in the open air, are masses of jagged multibranched growths of pinkish fawn color. Like the stubble, jagged stumps, and lopped-off branches of a newly cleared forest, they litter the highest portions of the reef. These are the *Maredpores*, the common *Stag-horn* or *Tree-corals*, and just beneath them other members of the colony jut outward in great palmate branches like the horns of moose, while others appear like stunted and twisted trees upon a mountain top. Among them, waving gently or bending to one side to some ocean current, are clumps of deep-purple sea-plumes, carmine sea-feathers, black sea-rods, and glaring yellow and pale lavender sea-fans. Like outstretched hands with clutching fingers these uppermost corals seem reaching for our boat, and as the craft rises and falls to an invisible ground-swell they seem to writhe and move, and we have the strange and somewhat terrifying sensation of being drawn downward by some uncanny force. But the depths hold far too many marvels to permit us to give thought to this, and we stare into the transparent water uttering involuntary ejaculations of admiration, surprise, and delight as our eyes become more accustomed to the maze of colors and forms spread beneath us.

Everywhere the reef glows with color, with every hue and tint known to man. Everywhere are myriads

of weird, strange, fantastic forms. Here and there mysterious blue chasms yawn or vast grottoes loom, black and forbidding, in the jagged reef. Far down and veiled with misty blue we can glimpse patches of bare white sand and areas of what might well be ocean forests. Great rounded hemispherical objects like gigantic oranges show here and there, patches of scarlet and crimson gleam like living flames, and as our boat swings to the wind and tide, or as clouds drift past the sun, the colors and forms shift and change as though we were looking through a giant's kaleidoscope.

But marvelous as is the reef when viewed from the surface, if we are to see it at its best, if we are to appreciate its full beauty and study the life it holds, we must descend to the bottom of the sea. So let's "go down," as divers express it. In shoal water or near shore it is a simple and easy matter to dive in "a hat," as the divers call the metal helmet used without a suit or other equipment, and in many places, such as Bermuda and the Bahamas, "hat" diving has become one of the attractions added to the program of sight-seeing arranged for tourists. Equipped with one of these contrivances and clad in a bathing-suit, the visitor descends to the "sea gardens," as the spots are called, and obtains a glimpse of seaweeds, a few Gorgonias and sea-fans, a modest display of the commoner corals, and some of the finny denizens of the tropical sea. But such brief excursions into Neptune's realm afford only a vague and inadequate idea of the wonders and beauties of coral reefs and sea creatures.

For safety's sake as well as for convenience, the sites selected for the entertainment of transients and tourists are close to settlements, towns, or harbors. Clear as the water may be, yet it is hot, stagnant, and is more or less contaminated with sewerage, trash, and other impurities, and is so shallow that the most timid and inexperienced woman may descend in perfect safety and ease. Compared to the big outlying reefs washed by the purest of sea water, beaten and lashed by heavy seas during tropical storms and hurricanes, where the water is six to ten fathoms in depth, the "sea gardens" are like mere patches of wayside woodland compared to the dense untrodden jungles of tropic lands.

But one must be an old hand at the game, an experienced diver, cool, clear-headed, and familiar with conditions, in order to descend to the depths of the sea in such spots wearing a "hat" only. Even then it is a most unsatisfactory method of visiting the reefs. A few fathoms beneath the surface the water is quite cold, and the warm air pumped into the helmet makes it feel all the colder by comparison. One's head and shoulders are dry and warm, but the rest of one's person is wet and cold and in a few minutes one becomes chilled through and is compelled to come up. Moreover, a bathing-suit affords no protection against the jagged coral, the needle-sharp spines of sea-urchins, or other unpleasant contacts. Finally, when wearing only a "hat" one cannot bend over to any great extent. The water-level is at one's chin and the instant one bends or stoops, the air rushes out from beneath

the higher edge of the helmet and water rushes in the other side and may fill one's mouth and nostrils. But when wearing a full diving-suit it is a very different matter. Thus clad one may remain down for hours if desired. The rubber suit is inflated with warm air which keeps one's entire person at a comfortable temperature. One remains dry, and it is possible to move in any direction, to bend, stoop, even to stand on one's head if one wishes, with perfect safety and ease.

Of course one cannot expect to put on a "suit" and go down to any considerable depth and feel at home right off the bat, as we might say. There are tricks to the trade, or rather to the profession, of diving, and long practice and experience are needed before a diver becomes a master or an expert. But any one with common sense and steady nerves and self-possession can go down in a full suit, and after a short time will become so accustomed to the novel sensations and conditions that he will feel quite at home at the bottom of the sea.

The most uncomfortable part of diving is being "dressed." First of all comes a warm woolen garment much like a heavy union suit. Then the stiff cumbersome diving-suits of heavy rubberized canvas are donned, and to protect these from the jagged coral and sharp rocks there are the canvas overalls known as "John Barleycorn." Belts filled with lead weights are strapped about our waists, the "tenders" lace great lead-soled boots on our feet, and feeling like animated junk piles we are led to the ladder hanging over the boat's side.

Slowly and carefully we step backwards down the ladder until only our heads and shoulders are above water and level with the vessel's rail. The copper helmets are slipped over our heads and firmly secured in position with thumb-screws and a bayonet lock, the air-hose and life-lines are tested and adjusted, the tender knocks on the helmets to indicate all is ready, the air-pump or compressor throbs and we feel a current of warm air rushing into our helmets. Before being imprisoned in the helmets we have been given chewing-gum and now, as we prepare to drop into the sea, we must begin chewing, for by so doing we will prevent the pressure of the air from affecting our ears or injuring the delicate tubes and membranes within them. There are two other essentials to diving. One is soap, the other vinegar, for there is nothing like soap to prevent the tightly fitting rubber wrist-bands from sticking and chafing, while the vinegar rubbed on the inner surface of the helmet eliminates the odor and effects of the minute quantity of oil that enters with the compressed air.

When all is ready we step farther down the ladder, the tender pays out rope and line, and releasing our hold we drop slowly, lightly, downward through pale blue-green space. We seem to have no weight, we turn and gyrate, we may even turn upside down, but there is no sensation of falling. Rather it is a dreamy sensation as if we were drifting through feathers. Then, before we realize we have reached the bottom, our feet or some portion of our anatomy come to rest against solid matter. The chances are we will find

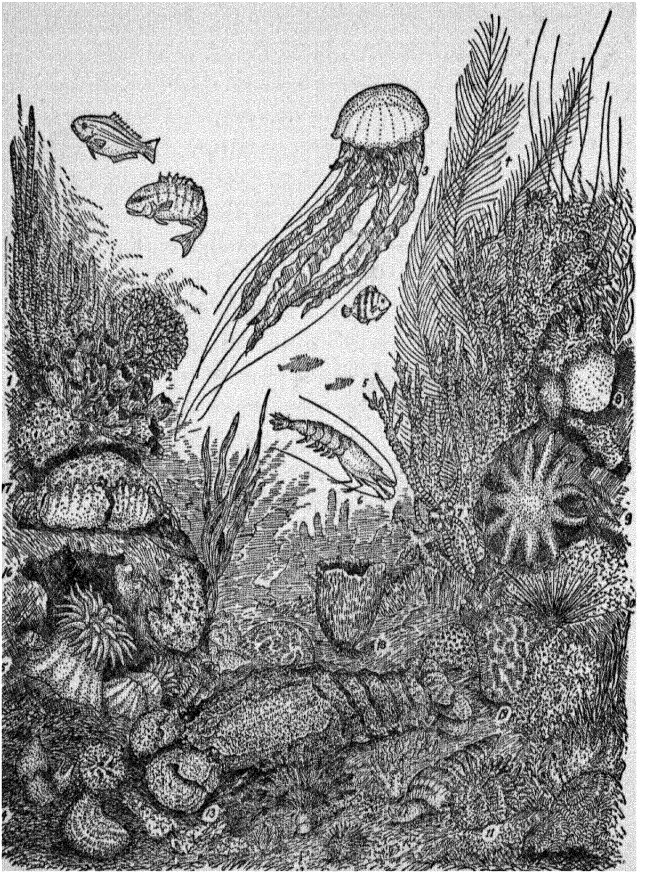
ourselves lying on our backs and gazing upward through the glass windows in our helmets at a mysterious, most astonishing ceiling of quicksilver that moves and undulates and gleams far above our heads. Then we notice the bottom of the boat projecting from the roof of liquid metal, and realize it is the surface of the sea with the sunlight striking upon it. If we try to regain our feet the chances are that, being beginners, we will go sprawling or will float upward, for despite our heavy load of lead weights, metal helmets, and lead-soled shoes we weigh only a few pounds, and we must move slowly, cautiously, and be careful not to make sudden movements. Also, we will discover that we cannot stand upright or walk erect but must lean far forward, almost lying on our stomachs in fact, and must scuffle and drag ourselves about. Perhaps as we descended we forgot to adjust our air-valves to the increasing pressure of the water and air. If so, we may be most uncomfortable, for one of the most essential details of diving is to keep one's head and adjust the inlet and outlet valves so as to maintain as nearly a normal pressure as possible. However, in moderate depths such as we are now exploring, the pressure will not be great, and having arranged the matter of air, and having learned how to keep right side up and to move about, we begin to look around us and to investigate our strange and awe-inspiring surroundings.

Perchance a dark shadow may pass across us, and glancing upward we will see the phantasmal ghost-like outline of a huge shark. But do not be terrified.

Sharks have never been known to molest a diver in a suit, and as a rule they dash off as fast as they can swim the instant a diver descends. It is often said that the sharks are frightened at the air bubbles rushing upward from the helmet escape-valve. But this is not the case. The sharks, as well as many other fish, are frightened by the vibrations of the air-compressor or pump, which are far louder and more noticeable beneath the water than in the open air. Again and again I have seen sharks swimming about without the least fear when great streams of bubbles were rising from an air-hose connected to a tank of compressed air, yet the instant the pump began to clank and vibrate they would turn tail and dash off out of sight.

Relieved of all fear of possible man-eaters, we turn our attentions to more interesting matters. We are standing or, rather, half-reclining upon a floor of white sand strangely mottled with patches of greenish-golden light where sunshine strikes downward through the rippling waves of the surface of the sea. But the sandy area is by no means bare. Huge sand-dollars as large as saucers are scattered about. Half a dozen enormous red or purple starfish move slowly across the surface, and an immense conch trundles its way through the sand, swaying from side to side like an elephant, and raising a cloud of white impalpably fine sand behind him as he digs his powerful clawlike foot into the sea bottom and drags himself forward.

At one side of the open space we see a dense jungle



Denizens of a coral reef

of interlaced, many-branched trees. Strange trees they are, fawn-colored and leafless, for the "jungle" is a forest of slender stag-horn corals. It is as impenetrable as any jungle of thorny acacia trees, however, for every branch of the corals is covered with countless needle-sharp calicles of hard limestone. Filled with the living animals as they now are, they appear soft and velvety, very similar in fact to a deer's antlers when "in the velvet," for the thousands of polyps conceal the lime calicles with their outspread tentacles. But the instant they are disturbed they vanish like magic within their cells and leave the jagged openings of their homes exposed and ready to rip and tear the toughest canvas of our overalls.

Denizens of a coral reef

1. Sponges
2. Sea-fan
3. Jellyfish
4. Sea-plumes and sea-whips
5. Stag-horn coral
6. Shrimp
7. Brittle starfish
8. Chrysanthemum sea-anemone
9. Sun starfish
10. Poisonous sea-urchin
11. Paddle-spined sea-urchin
12. Dianthus sea-worm
13. Flat lobster or sea-cockroach
14. Sea-cucumber and sea-squirts
15. Sea-anemones
16. Ascidians
17. Bashful crab
18. Neptune's cup sponge
19. Brain coral

Near this coral jungle we see a mass of dome-shaped objects. Some are orange, others vivid green, others fawn-colored, and not until we approach and touch them do we realize that these are brain and star corals. As we examine them more closely we notice two long, slender, rodlike objects projecting from a cranny of the reef. Approach cautiously and if you have wisely provided yourself with a barb-tipped fish-spear, dart it suddenly into the opening, and the chances are you will draw it forth with a big spiny lobster or sea-crawfish harpooned upon it. Being clawless he cannot bite, but be careful how you handle him, for he is protected by many sharp thorns and spines which will lacerate your flesh. He is a toothsome morsel, so we'll drop him into the canvas bag we have brought along.

From another cranny protrudes a cluster of waving undulating tentacles two feet or more in length and as thick as one's finger. Beautiful they are, too, for they are pale jade-green with mauve or cerise tips and we recognize them as the tentacles of a giant sea-anemone. Everywhere about us are other forms of these flowers of the sea. Painted with every hue: scarlet, purple, emerald-green, orange, lemon-yellow, or pure white; spotted, streaked, mottled with contrasting colors; with tentacles a yard long and scarcely thicker than twine, tentacles short and stubby, thousands of tiny tentacles forming fringes—the sea-anemones grow in riotous profusion.

Countless sponges are there also. Sponges of every possible form and color. Slimy, pulpy-looking, shape-

less black masses of sponges which, if properly cleansed and dried, would be transformed to the finest of bath sponges. Sponges with six-foot fingers rising above our heads in yellow, brown, or purple columns. Vivid crimson and scarlet sponges covering many square feet of dead coral and rock, and we pause with wonder beside an enormous "Neptune's cup" sponge like a Titan's goblet, a yard or more across its rim. Like bright-plumaged birds winging their way through tropical jungles, flocks of rainbow-hued coral fish or "butterfly-fish" dart in and out amid the bewildering growths of seaweeds, sea-rods, enormous crimson sea-plumes, and sea-fans of every size, from tiny specimens that might be used by fairies to giant fans ten or twelve feet across their yellow or lilac latticework surfaces.

Strange bright-colored sea-snails crawl over weeds and other growths. A dull-colored lump of mottled brown and green suddenly comes to life, and magically changing to purple and pink, is transformed into a repulsive octopus who scuttles into some cranny leaving a cloud of smokelike ink behind him. Strange "sea-cats" or "sea-hares" with long ears and undulating fleshy "wings" slide, sluglike, across rocks and corals, or surprise us by flitting off like golden and green bats when we approach too closely.

From its hole among the corals a scarlet squirrel-fish stares at us with immense blue eyes. We chuckle with laughter as we come upon a pair of silvery "grunts" holding a fishy petting-party in the shelter

of a sea-fan, their mouths pressed tightly together in a lingering soulful kiss. Again we may see a big dignified-looking "schoolmaster" clad in rich yellow and white, leading a bevy of smaller fish as if conducting his pupils on a sight-seeing hike. We stare in surprise as we see a huge vivid-blue "macaw" fish calmly biting off chunks of hard coral and gulping them down; or we may beat a hasty retreat as, passing some dark cavern, a veritable sea monster appears from the dismal depths. With its great snakelike head and powerful jaws filled with sharp strong teeth, its thick green body and manelike fin, it might well be the real sea-serpent. But it is merely a green moray, an eel-like fish, but an ugly customer when attacked, so we'll keep at a safe distance from its lair.

As we clamber among the fallen masses of dead coral or pick our way between great "mushroom corals," like gigantic toadstools, we must be careful that our hands do not come into contact with the poisonous black spines of big sea-urchins that project like ebony knitting needles from cracks, crevices, and crannies everywhere.

We have visited the reef to observe and study corals, although we have seen so many strange and surprising sea creatures that we have almost forgotten the purpose of our invasion of this wonderland. But now we pause to rest and gaze upward at the cliffs, pinnacles, ridges, and precipices that tower far above our heads on every side. It is as if we were standing in a valley or a cañon with mountains hemming us in. But never did such mountains exist on

earth. Overhanging ledges are ablaze with color. Cliffs are covered with huge shelves of vivid yellow, like enormous fungi. In place of trees sprouting from crevices in the walls, there are leafless branched growths of purple, blue, crimson, or snow-white. Where rough débris would cover the talus slopes of a mountain on earth, the bases of these undersea precipices are hidden beneath a vast accumulation of orange, buff, green, blue, lavender, crimson, brown, and mauve spheres, hemispheres, irregular lumps, slablike formations, and countless knobs, cones, and columns. We are in a world apart, in a silent world where the only sound is the steady vibrant throbbing of the air-pump in our boat upon the surface of the sea; a world where weird forms, fantastic shapes, and limitless colors rule.

Suddenly, we realize for the first time that there is something else that is strange about this undersea world. It is a world of two dimensions. There is a peculiar puzzling flatness about it, and distance is entirely lacking. We cannot be certain whether an object is two or twenty feet from us. Until we stand beside it we cannot feel sure whether some growth is five or fifteen feet in height. At first we are puzzled by this weird dreamy state of affairs. Then it dawns upon us that there are no real shadows; that the underside of an outjutting mass of coral is as clearly visible, as well illuminated as the upper surface. Our own bodies cast shadows upon the ocean floor, passing fish cast flitting shadows as they swim overhead or nose about close to the sandy bottom, yet the lower

parts of the fish are not in shadow and they appear more as if cut from cardboard than like rounded bodies. The caverns and grottoes loom dark mysteriously blue, but they appear no darker ten feet within the openings than at the portals. The effect is as if the entire area within the reefs were illuminated by scores of hidden lights casting their glow from every side and from the bottom as well as from overhead.

In a way that is exactly how the place *is* illuminated. The sunlight, shining through the clear blue water, is filtered and loses all its golden glow. Striking the white coral sand, it is reflected as if by a mirror and illuminates the under surfaces of every object. Yet the light being strongest from above, a solid object like our own bodies or a fish will cast a thin ghostly shadow made misty and nebulous by the reflected light from beneath it.

Having mentally solved this puzzle we look upon the wealth of growths and the strange animals in a new light, both literally as well as figuratively speaking. And having become somewhat accustomed to the bewildering array of colors and forms—although one never becomes blasé no matter how often one may go down—we begin to distinguish details and to take note of smaller things. We study the living corals and admire their multitudinous, flower-like animals, each occupying its own tiny cell in the limestone foundation it has helped to create. We also notice that each coral has animals of distinctive forms and colors. Those of the dome-shaped *Brain corals* occupy the convolutions or furrows of the limestone,

forming a continuous row of little mouths in the fleshy mass, and with the tentacles in a fringe on either side. Although the coral as a whole may appear orange or brownish, we discover that when examined closely the animals are multicolored, and that it is the blending of various dots and splashes of many tints that gives the effect of a solid color.

We find that the polyps of a lovely *Mushroom coral* are delicate translucent things with plump, short tentacles of palest green, with a second row of threadlike tentacles of silvery white tipped with gold. A slender glass-brittle *Oculina* is covered with animals like miniature chrysanthemums, the closely set tentacles alternating rose-pink and jade-green, and surrounding a mouth with lips as vividly red as though the coral had been using a lip-stick. A massive, irregularly rounded *Star coral* is dull fawn-brown studded with white flower-like animals, with pale crimson lines forming a corona about the lilac-tinted mouth. And we will find that the abundant *Rose corals* which cluster everywhere may vary from gray to emerald-green, from purple to pale pink, from almost black to snowy white.

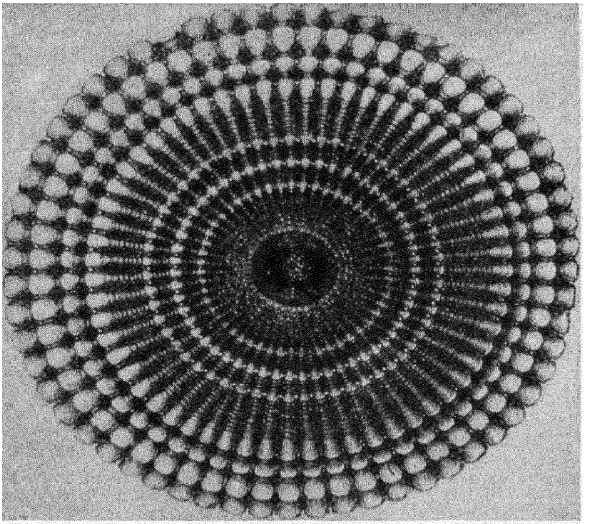
Why, we wonder, should these animals vary so greatly in color? Why are the brain corals where we stand deep green in color, while above our heads the great hemispherical growths of the same species are yellow or orange, and those near the surface appear dark lilac-brown? Why should the stag-horn corals we saw at the top of the reef be rich tan color whereas those forming a jungle at the base of the reef are

pale, dull yellow? And why should some rose corals be one color and some a totally different color?

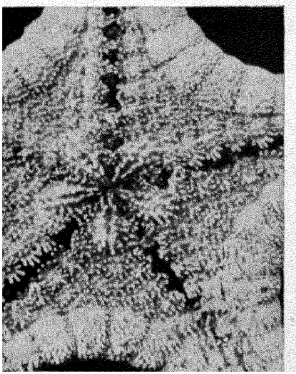
Like everything else in Nature there is a reason for this, and fortunately in this case we know that reason, and a very interesting one it is.

Brilliant and endless as are the hues of the corals, only a portion of their colors are natural, the result of pigmentation in the animals' tissues, while the other tints are caused by minute plants or algæ. Some of these grow upon the lifeless limestone formation, while others infest the translucent flesh of the living polyps. Although the individual cells of these plants are microscopic in size, yet they occur by millions in the tissues of the coral animals. They are not parasites, but on the contrary are most beneficial, I might even say vital, to the health and life of the polyps. Being plants, they of course require carbon dioxide and this they obtain from the excretions of the animals who in their turn secure a supply of oxygen from the gas given off by the plants.

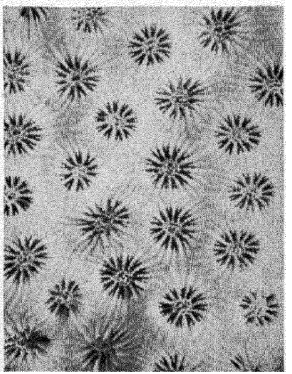
These microscopic algæ thrive best where there is sunlight and increase to such incalculable numbers that their own golden-yellow tint colors the animals in which they live. As a result, the corals near the surface, where there is the most sunlight, have the greatest amount of the yellow algæ color which may totally obscure the natural hues of the corals. Those lower down on the reefs, where there is less sunshine, have fewer algæ in their tissues and the result is a blending or combination of their own natural colors and the yellow of their plant partners, while those



Section of a spine of a sea-urchin



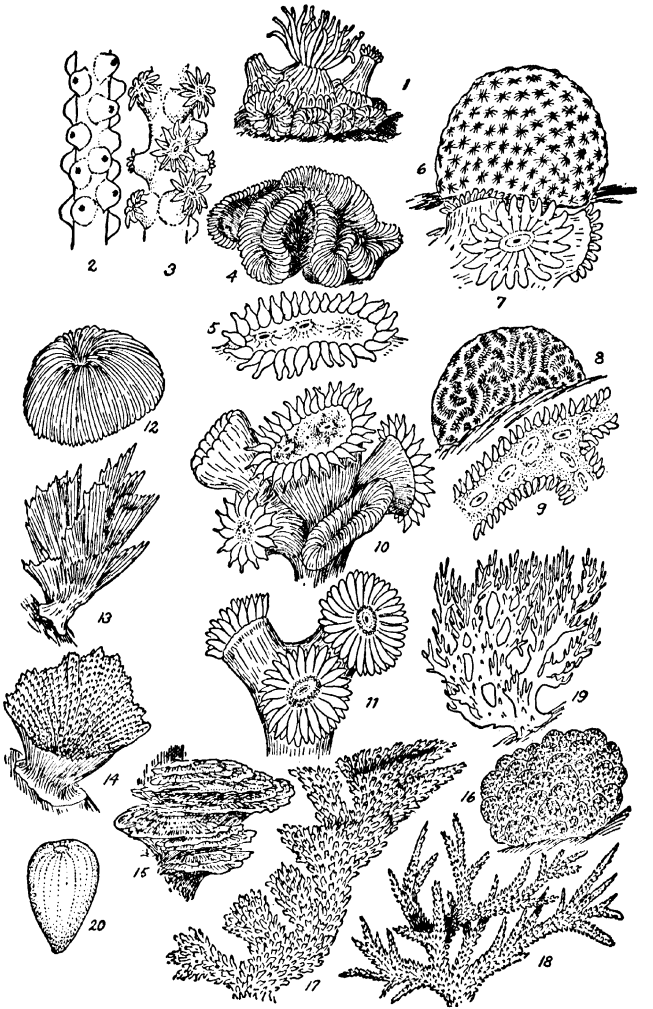
Jaws of a starfish



Surface of coral showing the homes of the coral animals

deepest down have so few algæ that their own colors predominate. Moreover, corals which happen to grow on the underside of the projections of the reef or where they are in shadow, lack enough algæ to effect their own colors, whereas corals of the same species growing where bright sunlight shines upon them through the clear water, will have a totally different color owing to the vast number of minute plant cells within them. Once we understand how coral animals depend upon these plants for their health, we realize why corals do not grow in deep water beyond reach of sunlight, and will not thrive in turgid, muddy water where sunlight cannot penetrate.

Algæ, however, play another very important rôle in the life of the coral animals, for they provide the polyps with a large part of their sustenance. Certain species of algæ actually grow within the stomachs of the little coral-builders and are digested by the animals. Of course, if the polyps fed on nothing else, they would soon exhaust the vegetables in their internal larders and their cupboards would be as bare as that of Old Mother Hubbard in a very short time. Moreover, coral animals, like the sea-anemones, are naturally meat eaters, and the majority feed mainly at night. During the darkness they expand, open their mouths and throw out their lasso-cells and stinging threads to capture any small creatures that may venture within reach. Then when day dawns and the tropic sunshine illuminates the depths of the sea, many of the corals withdraw their weapons, retract their tentacles, and shut up as tightly as a barnacle.



Corals

Perhaps they sleep, but if so they eat while they sleep, for as the sunlight stimulates the algæ within them and the plant cells multiply and increase too rapidly for comfort, the dozing polyps keep them within reasonable bounds by digesting the surplus.

Truly a most remarkable, as well as a most convenient arrangement.

Now, having learned why the corals about us wear as many hues as Joseph's famous coat, we are ready to discover more wonders of the reef. A stoutly branched, crimson sea-rod attracts our eyes and we find that the flexible swaying branches are covered with tiny green stars and are fringed with expanded

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Corals

1. Common northern coral, New England
2. Oculina
3. Oculina, animals
4. Rose coral
5. Rose coral, animals
6. Star coral
7. Star coral, animals
8. Brain coral
9. Brain coral, animals
10. Coral animals showing budding
11. Branch coral, animals
12. Mushroom coral
13. Leaf coral
14. Cup coral
15. Fungus coral
16. Porites coral
17. Elk-horn coral
18. Stag-horn coral
19. Millepore coral
20. Young coral

polyps hanging like the blossoms of a blueberry bush from the lower surfaces. How, we ponder, do these marvelously beautiful creatures spread and increase?

If we search among the polyps of the rose corals or mushroom corals, we may find a partial answer to the puzzle. Here and there are double mouths. In other places we will find tiny but perfect animals sprouting from their larger fellows, for the corals increase and grow by budding, each polyp dividing and subdividing, and each newly developed polyp steadily building the lime framework of his home larger and higher to accommodate himself and his ever-increasing offspring.

But, you argue, even if the corals increase in size and the number of animals in this way, they could not spread far and wide by merely dividing and forming new animals in the same mass of coral. Quite true, but coral animals also produce eggs and active free-swimming young. Propelling themselves by means of tiny swimming hairs, the pear-shaped baby corals wander about for a time, and then settling down, attach themselves to some solid stationary object and start a new colony by budding. In fact the life history of a coral is not unlike that of a plant. The seed produced by the flower is carried by winds or other means to a distant spot where it takes root and grows. But the bush or plant which produced the seed may spread and increase in size by sending out suckers or buds until the single plant is the center of a big clump of its kind, all its own offspring as truly as the distant plant that sprouted and grew from the seed.

We might spend hours, days, here beneath the sea among these wonder creatures of the coral reef. But even when clad in full diving-suits, an hour is about all a beginner can stand, and regretfully we signal the watchful tender that we are "coming up"; the lines tighten and the bottom drops from beneath our feet. Back and forth the whole strange scene seems swinging, rotating all about us. We have the sensation of remaining stationary while the coral reefs sink beneath us. Then suddenly we see the lower rungs of the ladder before us. We grasp it and laboriously clamber upward. There is a tap on our helmets and a moment later the metal head-piece is lifted off and our visit to the bottom of the sea is over.

Chapter X

POOR SHRIMP

WHEN we refer to some person as a "poor shrimp," we are really slandering the crustaceans, for while shrimps may be spineless creatures anatomically, they are by no means spineless or lacking in energy by nature. Moreover, they are very courageous creatures, while finally they are most useful and important inhabitants of the sea. Although so small, yet they abound in such numbers that they are very important food animals, and in many lands as well as on our own coasts, the shrimp fishery is one of the most important and valuable industries. In California alone the annual shrimp catch is estimated at more than one hundred thousand dollars. On our Gulf coast, on the eastern coast of Florida, all along our Atlantic seaboard and even in Maine, shrimp are taken by countless thousands. Tons are marketed fresh and many more tons are canned. So even if we may feel sorry for the "poor shrimps" destined to be neatly packed in tins or to be served with rice and curry, we cannot regard them as "poor" in any other sense of the word. And a very interesting and strange family they are, if we include all the smaller long-bodied crustaceans as "shrimps" or "prawns."

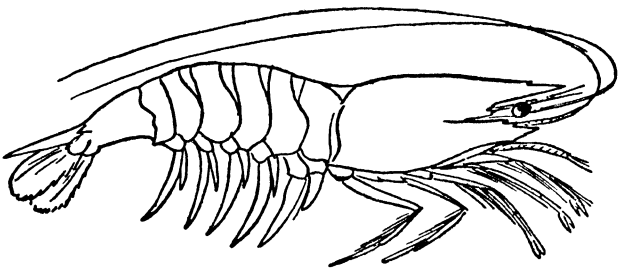
Just where a dividing line may be drawn between the two is a problem, for there are numerous species of shrimp and prawns marketed and eaten, and very often the larger individuals of one species will be classed as *prawns*, while the smaller ones will pass as *shrimp*. In fact whether a crustacean is a shrimp or a prawn depends upon the size rather than the kind, and while there are many species of shrimp which rarely or never reach our tables, yet there is no reason why they should not be eaten. Probably, if these more unusual fellows were as abundant as the more familiar kinds they would be just as popular. In China vast quantities of tiny shrimp are taken and dried and when these are soaked and cooked they are fully as toothsome as our own shrimp.

Most of the canned shrimp sold in our markets are obtained from the Gulf of Mexico, and the Atlantic coast of Florida. Like mackerel and other fish, shrimp have regular "runs" or migrations, and at such times they congregate in vast "schools" of millions of individuals. Then the shrimp fishermen reap their harvest and a rich harvest it is, for the shrimp fisheries of the United States amount to millions of dollars annually.

Until quite recently it was something of a mystery as to whence the shrimp came and whither they went, but we now know that these little crustaceans travel for immense distances and that shrimp migrate from the Gulf of Mexico, around the tip end of Florida, up the Atlantic coast, and back again every year—surely a very long journey for these tiny creatures.

If we examine a shrimp when alive or freshly cap-

tured we will find that it has ten legs and hence is a member of the order known as *Decapods*, or ten-footed crustaceans, which includes all the crabs and lobsters. In general form the common shrimps resemble miniature lobsters, but they lack strong claws on their front legs. Some have tiny pincers, others have cleft feet, while others have the feet broad and flattened. Many have rows of hairs on the legs, while the delicate little fellows known as *Opossum shrimp*,



Shrimp

owing to the fact that they carry their eggs in a pouch, have feathery gills hanging free from the legs and appearing at first glance like a second set of fuzzy feet.

Nearly all of the shrimps are phosphorescent and one deep-water species escapes from its enemies by ejecting a luminous material which serves like a phosphorescent smoke-screen to conceal the creature's movements. Many of the smaller shrimps are as transparent as glass and all their internal organs are plainly visible. Others are sand-color, while many

are brilliantly colored with blue, green, purple, or red.

Important and interesting as are the true shrimps, many of their distant relatives are far stranger and more interesting. To scientists these crustaceans are known as *Copepods*, *Isopods*, and *Amphipods*, but to most persons they are merely *Sand-hoppers* or *Sow-bugs* or *Pill-bugs*. It is bad enough to libel them by referring to them as "bugs," but it is even worse to defame them by calling them "sand-fleas." None of them are "bugs" or insects, and the only similarity between them and fleas is that both creatures jump prodigiously.

Although the majority of these queer little crustaceans live in the sea or inhabit the shores, there are many fresh-water species, while the land-dwelling species are the funny creatures, resembling miniature armadillos, which we find in decaying logs, under stones, and in similar situations in our woods and gardens.

I suppose that many naturalists will criticize me for grouping all these various crustaceans together; but only a scientist can distinguish the real difference between them, and there are certain crustaceans which even have the scientific chaps guessing. This is not surprising, for there are over ten thousand known species and probably far more which never have been described, enough to keep the scientists busy a long time. But most persons are more interested in the strange ways of these little people than in their exact

relationships, so why bother over keeping isopods and amphipods apart?

Broadly speaking, however, the amphipods are hoppers and jumpers, while the isopods and copepods are swimmers and crawlers. For that matter, many of them neither swim nor crawl but are parasites infesting various other creatures. Some are parasites of fish, but many more are parasites of other crustaceans. One of these parasitic fellows dwells in hermit-crabs, others infest shrimps or lobsters, while the *Sacculina* is a terrible parasite of crabs. This creature is as little like an everyday crustacean as is the barnacle, for it is merely a sac-like thing on a stalk; but once it lodges upon some unfortunate crab the victim is doomed to a slow and terrible death. Quickly the root of the parasite divides, each branch divides and subdivides, and the living roots penetrate through the entire body of the crab, even to its legs and claws, and slowly devour him.

Perhaps you may wonder how the vampirish thing can remain upon a crab if the latter "sheds" or molts. Why isn't it left behind with the cast-off shell? The answer is one of the most astonishing features of the whole affair: Although the crab may molt each year or oftener under normal conditions, yet once one of these fearful parasites has attached itself to the doomed crab, the crab never sheds its shell again during the three years he is being devoured. Why, no one knows. Perhaps the presence of the parasite affects some glands or other portions of the crab's

anatomy which control the shedding process. Or it may be a part of Mother Nature's plan, a provision to prevent the parasite from losing out and to give the little rascal a chance to live.

Very different are other parasitic crustaceans which choose the mighty whale as their victim. These repulsive-looking things are very louselike in appearance and are provided with strong hooked feet to enable them to cling tightly to the slippery skin of the whale. They are quite large for members of their group—often nearly an inch in length, yet most minute pests as compared to the size of their hosts. Unlike the parasites of the crabs, these creatures cause no serious injury to the whales. Possibly the huge mammal may feel "itchy" when hundreds of the "lice" crawl over his body and hang onto his eyelids and lips and snuggle back of his flippers. In fact whales must sometimes itch, for they not infrequently scratch themselves against floating driftwood or other objects, although it would seem that animals encased from head to tail in a thick blanket of blubber would scarcely be sensitive to vermin.

And speaking of whales, we must not forget the tiny crustaceans known to fishermen as *Brit*, which form a large portion of the whale's diet. These swarm by countless millions in many portions of the sea, but despite the fact that whales devour them, that vast numbers are destroyed by sea birds, by fishes and by other marine animals, their numbers never decrease.

This is not so surprising when we stop to consider that a single individual of the crustaceans known as

Cyclops will produce four billion, five hundred million offspring in a single year—that is, if the tiny creature lives a year, and by some phenomenal streak of luck escapes the hordes of foes that constantly menace the Cyclop's existence. Some idea of the truly inconceivable numbers of these minute crustaceans may be obtained from the fact that although they are transparent and almost jelly-like, yet there are so many of them that they frequently impart a reddish color to many square miles of the surface of the sea. But perhaps the most interesting thing about these insignificant creatures is that they are of the utmost importance to thousands upon thousands of human beings.

Of all fisheries the herring industry is one of the most valuable and important. Not only are great fleets of vessels and thousands of men employed in taking the herrings, but in addition, armies of men and women depend for their living upon salting, drying, smoking, and otherwise preparing herrings, and thousands of people in all parts of the world consume herrings in one form or another. Yet the entire industry depends upon the minute crustaceans known as "brit," for these form the food of the herrings. When the brit abounds there is a large "run" of herrings, but if the crustaceans do not appear in vast numbers herrings are scarce. And if there were no brit, there would be no herrings and tens of thousands of people would be out of work and penniless, and thousands more would be compelled to do without their "kippers" and their "red herring."

Some species of crustaceans may be found in nearly every portion of the ocean, others can live only in fresh water, while there are certain kinds who are real "old salts" and who survive only when swimming about in brine so dense with salt that it is scarcely liquid. In the West Indies where sea water is evaporated by the sun in great enclosures or "pans," these little crustaceans fairly swarm in the thick brine. Even when the water has almost disappeared and the salt crystals are forming the little creatures seem perfectly happy and content. Very often they prove a great nuisance to the salt "harvesters" and are raked up in windrows by the workmen. But they are welcomed by other two-legged natives of the islands who find the salty, wriggling, big-eyed crustaceans exactly to their taste. Sea-gulls and terns, ducks and other wild fowl, flock to the salt-pans to gorge themselves on the teeming creatures, while hundreds of gorgeous pink and scarlet flamingoes stalk about on their long, slender, crimson legs, constantly scooping up the water in their funny bills and swallowing the tiny crustaceans it contains.

A great many crustaceans are luminous or phosphorescent and one species is the most brilliant of all known light-producers of the sea. So bright is the light produced by this mite of a creature that it is visible even in the daytime. In the deeper portions of the ocean, animals of many kinds gleam with light of various colors. Most of these never leave the impenetrable blackness of their cold deep-sea homes. But many of the crustaceans come regularly to the

surface of the sea at night and swim merrily about, flashing their phosphorescent lanterns as if delighting in such revelry, until just before sunrise they once more descend to the bottom of the sea.

Strange indeed are some of these nocturnal visitors to the surface of the ocean, especially in the tropics. On one occasion when I was aboard a vessel anchored many miles from shore in the Bahamas, the sea fairly scintillated with flashing lights, streaks of fire and luminous phosphorescent glows. Even the sailors became interested in the display and were filled with curiosity as to what sort of creatures caused the light. In order to see the animals that were darting hither and thither like marine fireflies, we lowered a powerful flood-light over the side. And what a fascinating, amazing wealth of life was revealed! The rays of the light penetrated for several fathoms into the clear water and everywhere within the illuminated area, from the surface to as deep as could be seen, the sea fairly swarmed with creatures of innumerable forms, sizes, and colors. Some moved slowly, deliberately. Others raced madly at breakneck speed. Others progressed by a series of jerks. Some gyrated like animated tops, while others seemed to be skating on the surface.

Dave, my head diver, became quite excited, which was most remarkable for he had never before seemed in the least interested in the many unusual creatures dwelling in the sea. But now he was as interested as any amateur scientist.

"By glory, I never knew the ocean was so full of

bugs," he exclaimed. "Hey, look at that fellow! See him? Looks like a golf-ball. And what the devil is that long streak of green light?"

The object he indicated appeared like a luminous green serpent ten or twelve feet in length and as thick as a man's wrist.

"I'm sure I don't know what it is," I told him. "I haven't the least idea what a tenth of those creatures are. Let's catch some of them and see."

Straddling the ship's rail, the diver plunged a fine-meshed, long-handled net into the illuminated area of water and hauling it in dumped it into a pail of sea water. Scores of small creatures filled the pail. Scores of points of light gleamed as they rushed back and forth, around and around. But there was no trace of the big, green, snakelike thing.

"Say, where did that green light go to?" Dave wanted to know. "I'm dead sure I got it, but it ain't here."

He glanced over the side of the vessel. " 'Tain't out there either," he declared.

"Must have got away," I told him. "Probably it turned off its light and dove. It— Hello, what's this in your net?"

Clinging to the wet net and moving sluggishly was what appeared to be a slender whitish worm no thicker than a piece of twine. Curious to learn what it might be, I immersed the net in a bucket of water and rinsed it back and forth. The next moment I was staring, speechless, and Dave expressed his astonishment by a string of deep-sea oaths. Seeming to fill

the pail to capacity was the big luminous green object we had seen.

"I'll be darned!" ejaculated the skipper who had been an interested onlooker. "Am I drunk or ain't I? Where in thunder did that thing come from?"

"Search me," replied Dave. "It wasn't in that net and now it's in the bucket. Say, we must all be drunk or dreaming."

Reaching into the water I passed my hand beneath a convolution of the serpentine ribbon of light and lifted it from the bucket.

"There's the answer!" I exclaimed as the strange object vanished as if by magic, leaving the string-like, limp and pulpy worm in my hand.

Dave scratched his head and stared. "Beats me," he announced. "What's the answer, chief?"

"Phosphorescence," I told him. "What we saw was the light from the creature, not the thing itself. It's some kind of worm."

"Hey, look who's here!" cried one of the men who had been peering into the first bucket. "Queerest fish ever I see."

"Fish, that ain't a fish," declared the skipper. "That's a damned hop-toad."

"Mouse-fish," I told him. "Sargassum-fish if you prefer. It lives in the gulfweed. See those front fins? They're like feet. And he's colored to match the weed and—"

My words were interrupted by a roar of laughter from the diver. "Gosh, I never seen such doodly-bugs!" he ejaculated.

He was quite right. Even if his classification of the captive animals as "doodly-bugs" was not precisely accurate, yet he was not so very far off, for the creatures which had so amused him were "bugs" beyond all question, true insects resembling the queer "water-boatmen" or "back-swimmers" of our ponds and streams. But there were many other and far stranger creatures in our extemporized aquarium. There were tiny fishes—the young of file-fish, angel-fish, and others whose identities still remain a mystery. There was Dave's "golf-ball" which in the bucket was transformed into a globular jellyfish suffused with a faint bluish-white glow. There were numerous wiggling, threadlike worms, and most numerous of all were dozens of strange crustaceans. Some were shrimp-like, but so transparent that only their internal organs and black eyes betrayed their presence. There were flat blunt-ended chaps gleaming with metallic blue, green, and gold, and with antennae five times the length of their bodies. There were "hoppers" dressed in scarlet and white whose ambition seemed to be to beat all high-jumping records of the sea, and which were constantly springing from the water and adhering to the sides of the bucket six inches or more above the surface. And most amusing and strangest of all were long, slender, golden-yellow crustaceans with such big heads and staring eyes that the poor creatures seemed sadly handicapped or perhaps better, headicapped, and found it impossible to steer a straight course but swam swiftly, frenziedly in circles, never getting anywhere and flashing ex-

traordinarily bright lights emanating from opaque orange spots on their attenuated abdomens.

The interest aroused in the men by these strange creatures of the sea was remarkable, and it was a strange sight to see them crowding about the buckets, laughing and joking and uttering exclamations of surprise and delight as they discovered some new captive or witnessed some new trait of the little animals. Dave was absolutely fascinated and spent the greater portion of the night scooping up myriads of specimens and studying them with all the intense concentration and interest of a true naturalist.

Although the water teemed with life at night, yet when morning came it was almost deserted. A few jellyfish moved lazily about, their milky umbrella-like discs pulsating slowly. Portuguese men-of-war spread gaudy sails to the trade-wind, and a school of long-snouted *Ballahoo* fish breakfasted on invisible food just below the surface. But all attempts to secure more of the strange sea creatures of the night were fruitless. Again and again Dave dipped his net into the water only to bring it up empty. The fantastic revelers of the night had vanished. With the first glimmer of dawn they had returned to their haunts at the bottom of the sea.

If you turn over masses of dead seaweed, bits of driftwood, stones, or almost any objects lying on the shore, you will uncover hordes of tiny crustaceans. Some leap like grasshoppers and vanish in the sand or beneath the nearest shelter. Others scurry off seeking some safe refuge. Others move sidewise by a series

of short jerks and bury themselves under fragments of weeds or pebbles, while many instantly roll themselves into balls like so many pygmy armadillos.

No doubt, were you a scientist you would find a score of different species of amphipods and isopods among the congregation, for both orders are very abundant everywhere along the seashore. All are harmless creatures, despite the popular but erroneous idea that the "sand-hoppers" are a kind of flea and will bite, although many are ferocious creatures for their size and fight savagely with other tiny animals. Nearly all are scavengers, however, and comprise the sanitary squad patroling the shores and render a real service by eliminating decaying animal matter.

It might seem that such small fry as these crustaceans would make little impression and that the part they play in destroying dead animals would be negligible. But numbers rather than size is what counts, and when millions of individuals unite in one project they can accomplish marvels. Even good-sized masses of carrion vanish as if by magic under the myriads of hungry little beach-combers. In some places they are so numerous and so efficient in their cleaning-up activities that naturalists employ them to prepare skeletons. The carcass of the bird or other animal which is to be skeletonized is enclosed in a netting bag or a screen-covered receptacle and is anchored between high and low water marks. When the tide comes in and covers the body the army of tiny crustaceans gets busy, and by the time the tide has again ebbed, not an atom of flesh will be left on the bones.

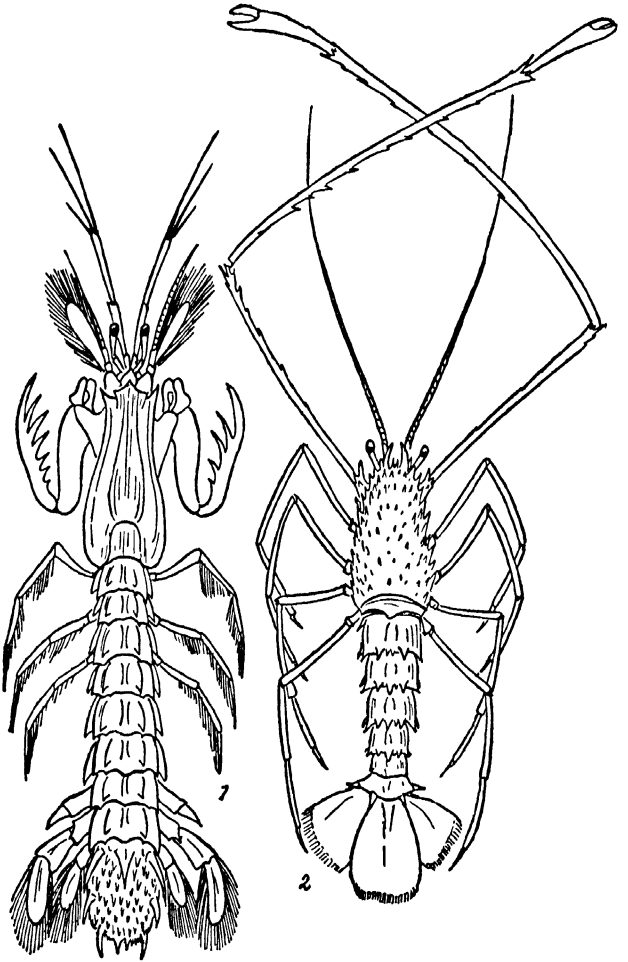
The complete skeleton will be as clean, white, and perfectly prepared as any one could wish. Moreover, the bones will be nicely articulated, for the hungry crustaceans will not devour the tough cartilage unless the specimen is very small.

Many of these little scavengers of our shores and shallow waters take upon themselves the duty of keeping other creatures clean, and act as janitors, as one might say, of sea-urchins and starfishes. Of course this is not an entirely unselfish job, for the fragments of their hosts' food, bits of dirt and other rubbish which accumulate among the spines of the urchins and stars, provide sustenance for the self-appointed house-cleaners. Very frequently a sea-urchin or starfish will fairly swarm with these minute crustaceans, and more than twenty thousand have been taken from a single urchin.

Although the majority of these small crustaceans are scavengers and feed upon dead and decaying animal matter, many are vegetarians, and a number of species devour wood. These are real termites of the sea and will completely destroy large masses of wood in short order. Some species bore deep holes in the timber, honeycombing it with their burrows, and feeding upon it until it is so weakened that it goes to pieces. Others follow a very different but fully as efficient method. These chaps do not gnaw deeply into the wood but riddle it with holes to about half an inch in depth. Then when this perforated area breaks off they burrow in for another half inch. By thus eating away a layer of wood at a time they very

rapidly destroy large pieces of timber and even entire tree trunks. But as they devote themselves principally to devouring wreckage and driftwood they are usually more beneficial than harmful, for by destroying water-logged trees and timbers which would prove a menace to shipping, the tiny crustaceans aid rather than hinder navigation.

Very often when you are collecting seaweeds or hydroids you may be surprised to see a branch or twig come suddenly to life and start crawling off in exactly the same manner as a "measuring" or "inch" worm. The queer creature who poses as a bit of the weed or hydroid is no caterpillar, however, but a remarkable crustacean known as the *Caprella*. Totally different from all other crustaceans in form, the Caprella is long, slender, and much resembles those strange insects known as "walking-sticks." Like these queer creatures, the Caprella poses as a twig or branch and when motionless is so perfectly camouflaged that he is almost invisible. But his method of progression is not at all like that of the insects who make believe they are twigs. When the Caprella decides to move he lifts his hooked hind feet, bends the center of his body into an inverted "U," draws the hind feet forward, secures a fresh grip and then, straightening out his body, extends it as far forward as possible, grasps the object over which he is crawling with his front feet and again draws his rear feet ahead. Naturally he is not a speedy creature, but rapid travel is of no importance to the Caprella, for he never strays far from home and knows that he is



1. *Squilla (mantis shrimp)*
2. *The "Archer"*

much safer from his foes when posing as an inanimate branch of seaweed or hydroid than he would be if he depended upon "stepping on the gas" to escape hungry fishes and other enemies.

Another very strange crustacean which you may find when digging clams or "fishworms," or may even discover under some stone resting on the shore, bears a most amazing resemblance to the weird "praying mantis" insect. Long, slender, and colored green and yellow, this creature appears to have but six legs and is provided with powerful jointed claws exactly like those of the mantis or "Devil's coach horse," as the well-known insect is sometimes called. Moreover, the *Squilla* or "Mantis shrimp," as the creature is named, uses his claws in the same manner as the insect, seizing his prey with them and holding it to his mouth while assuming a most innocent-appearing prayerful attitude. They are exceedingly active chaps, for they depend upon speed and agility for capturing other animals, and as they are quite as fearless as their insect doubles they do not hesitate to put up a stiff fight when caught or cornered. Neither are they all bluff. Their hinged spine-armed claws are far harder and more powerful than those of the true praying mantis, and a good-sized squilla, eight or ten inches in length, can inflict very painful wounds on one's fingers.

Although the squillas are not eaten in this country they are superior to lobsters in flavor and are highly esteemed as food in other lands. Perhaps one reason why they have never become a popular dish in the

United States is because they are retiring in their habits, spending the days in deep holes in the sand or burrowing under rocks on the shore and only coming forth at night to hunt for food. As a result they are seldom seen even by persons who spend much of their lives by the sea, although they are really very common sea creatures. But the natives of southern Europe have solved the problem of taking squillas in large numbers, and lure the mantis shrimps within reach of their nets by means of torches or lanterns. Attracted and apparently blinded or confused by the glare, the usually wary squillas are easily taken.

Practically all of our crustaceans carry their eggs or "roe" clasped in specially formed appendages or "legs" adapted to the purpose. Some shrimps are provided with pouches for carrying the eggs beneath the thorax, but the squilla, being a unique creature, adopts an equally unique method of caring for its eggs until they hatch out. Forming the eggs into a little ball the mantis shrimp pops them into her mouth where they remain, quite safe from harm, for two or three months or until the squilla babies break their egg-shells and leave their strange hatchery.

All things considered, the squillas are true wonder creatures of the sea. In fact they are so strange and differ so greatly from all the other crustaceans that scientists are not quite certain just where they belong on the genealogical tree. So to be on the safe side they have created an order especially for the squillas. It really is a pity that the mantis shrimps do not appreciate the distinction thus rendered them.

Surely if presenting a famous man with an order is considered a great honor, how much greater must be the honor scientists have bestowed upon the squillas by presenting them with an order especially created for them and in which no other living creatures may claim membership.

Chapter XI

LOBSTERS AND THEIR KIN

EVERY one knows the lobster, for it is highly esteemed everywhere and even in districts far from the seacoasts, where no one has ever seen a live lobster (unless in a salt-water aquarium), canned lobsters are available and lobster salad, lobster à la Newburg, and lobster in various other delectable forms are familiar dishes.

That lobsters should be so much in demand and should be considered such fine and highly prized food is rather strange when we come to consider Mr. Lobster's—or Mrs. Lobster's—habits and table manners. It is difficult indeed to persuade people to eat crows, for the black-plumaged birds are always regarded as carrion-eaters and therefore unfit for human consumption, despite the fact that their flesh is well-flavored and, in the case of young crows, tender and dainty. Most persons seem horrified at the mere thought of dining on snakes, yet snakes are among the cleanest of creatures and many species, such as the rattlesnakes, are delicious. And who would ever dream of eating the flesh of a vulture?

Yet the delectable lobster is a scavenger and as inveterate a carrion-consumer as any vulture. Of

course, the material which a creature devours rarely has any bearing upon the edibility of its flesh. Swine are far from cleanly creatures, but most people like pork. Poultry will eat almost anything and everything, including carrion, but no one refuses roast or broiled or fried chicken on that account. Yet for some reason or another we humans have most amazing tastes and prejudices when it comes to the question of what we eat or do not eat. Moreover, no two races, or for that matter, no two persons, agree on the matter of food. The old saying that "what is one man's food is another man's poison" is absolutely true. Grasshoppers, crickets, grubs, caterpillars, are all eaten with gusto by some races, and although few of our people could be induced to so much as taste such viands, yet we eat maggoty cheese and pay fancy prices for it. But the very same persons who like cheese fairly alive with "skippers" would be nauseated at thought of swallowing an apple worm, a corn-borer caterpillar, or eating a wormy chestnut or weevil-infested cereals.

But I do not know of any people anywhere who do not like lobster. It is one kind of food upon which every one seems to agree, which is rather unfortunate for Mr. Lobster and his kindred. In fact lobsters would have been exterminated long ago and would be as extinct as the Dodo to-day, were it not for the fact that they are not readily detected, that many dwell in remote inaccessible areas of the sea, and that those captured form only a small percentage of the entire lobster population of the ocean. Moreover,

lobsters are most prolific creatures. Every female lobster produces thousands upon thousands of eggs, and if one out of a hundred newly hatched lobsters survived to reach maturity there would never be a dearth of lobsters in the sea.

The young lobster lives a precarious and dangerous life. From the moment it emerges from the egg until it has acquired a hard shell and is able to take care of itself, it is constantly threatened with destruction, for fishes, crustaceans, mollusks, and every carnivorous denizen of the sea is just as fond of lobster as are human beings, even though they prefer theirs young and raw.

Beyond question, had the lobsters and their natural enemies been left to work out the problem of life by themselves, Mother Nature would have seen to it that the balance of oceanic life was maintained and the number of lobsters in the sea would have remained approximately the same indefinitely. But when man appeared upon the scene and discovered that lobsters were good to eat and proceeded to eat them on a wholesale scale, he completely upset the balance of Nature, just as he has done in so many other cases.

As a result, the lobster population eventually began to decrease. And once the lobster census commenced to fall off the decline in the population was rapid. Lobsters were being caught and eaten faster than they could breed, and before very long our nation was threatened with a lobster famine. Where only a few years previously lobsters had been almost a drug on the market, no lobsters were available.

A big spiny lobster, Bermuda

Great lobster canneries, established where the crustaceans fairly swarmed, found it impossible to secure lobsters to can.

For example, take the Bay of Fundy. When I was a boy, hundreds of big lobsters could be gathered by hand on the bottom of the bay left bare by the receding tide. It was scarcely possible to turn over a stone or a mass of seaweed without finding one or more lobsters, and very often they were of immense size—weighing ten to twenty pounds. So abundant were they that the natives were in the habit of turning their swine loose between tides so that the porkers could gorge themselves on the lobsters. Then a big cannery was established near-by and to-day one could search every nook and cranny of the shores and bottom between tides and have little chance of ever finding even a "short" lobster.

It was the same story all along the coast. Lobsters were becoming more and more scarce. Where, a few years earlier, lobsters sold for a few cents a pound they now brought as much as a dollar a pound. From a cheap sea-food within reach of every one they became transformed to a high-priced delicacy so expensive that their name became synonymous with the most exclusive restaurants, and a "lobster dinner" was the epitome of extravagance.

Then our Fish Commission stepped into the picture. All along our coast lobster hatcheries were established, the eggs were protected and safeguarded, and the baby lobsters were carefully reared until able to fend for themselves. Millions were released,

yet for some reason the lobster population failed to increase as rapidly as it should.

Then some one made a discovery. The young lobsters reared from the eggs in the hatchery tanks did not know enough to go to the bottom and find safety in hiding-places among the rocks. Instead they swam aimlessly about for some time and fell easy prey to fishes and other creatures who benefited tremendously by the activities of the government's lobster experts. As a result, only a small proportion of the released lobsters survived and reached maturity, and a new problem arose. How do you suppose this problem was solved? By teaching the baby lobsters to dive!

Experiments proved that the young crustaceans possessed a certain degree of intelligence, or perhaps they merely learned by experience. At all events, the lobster sharps discovered that the youthful lobsters could be trained to dive by sliding them down a chute leading to the bottom of the water. After being repeatedly forced to "shoot the chutes" the immature lobsters immediately dove to the bottom as soon as released, much to the relief of their human nurses and doubtless much to the disappointment of the hungry fishes.

The solution of the problem led to the creation of an entirely new profession—that of teaching baby lobsters to dive, and to-day every lobster hatchery has its experts whose sole occupation is to propel young lobsters down chutes until they learn to dive for themselves. Thanks to the artificial propagation of

lobsters and lessons in compulsory diving, the delectable crustaceans have increased and multiplied enormously within the past few years. Strict laws regulating the taking of lobsters are in force, and although it is necessary to maintain the numerous hatcheries and to release millions of trained diving lobsters every year in order to maintain the lobster population of our coast, lobsters are again reasonably abundant and cheap.

Familiar as they may be with lobsters ready to eat, or even alive in markets and restaurants, most persons know very little about the home life of Mr. Lobster and his family. As a rule, even those who dwell near the seacoast or who have seen the lobster-pots in which the crustaceans are trapped, have only a vague and indefinite idea of lobsters' haunts and habits. They may know that lobsters, being crustaceans, shed their skins as do crabs and other members of the family. But it is seldom that a soft-shelled or "shedder" lobster is captured, for unlike the bold and fearless crabs who brave countless dangers by appearing in the open while their new shells are still soft, the lobster after shedding its old skin retires within the seclusion of some cave, crevice, or cranny, where no enemy may enter, and remains there until the new suit of armor has become as hard and protective as the old.

It is also of interest to note that when the lobster outgrows its skin the old shell splits open down the back, whereas crabs' outgrown coverings are provided with a sort of "zipper" seam which opens from

side to side at the rear of the body or *carapace*. Moreover, Mr. Lobster changes his skin much oftener than does Mrs. Lobster. Like other animals, the lobsters grow more rapidly in youth than in later years and are compelled to change clothes eight times the first year, five times the second year, and three times during the third year. But after that, Mrs. Lobster is content with a new dress once every year, while Mr. Lobster casts away his old shell and puts on a new one twice a year for the rest of his life.

Although the majority of the lobsters taken are captured in comparatively shallow water, the creatures are more abundant in really deep water, and during the cold winter months those who dwell in shoal water during the summer retreat to greater depths of the sea. As very few lobsters are trapped in really deep water many individuals attain great age and gigantic size in such localities, for these old-timers, with their thick armor and immense crushing claws, are practically immune to all dangers from other inhabitants of the depths. No one can say how many years a lobster may live nor to what dimensions he may attain, but we do know that there must be incredibly huge individuals, real centenarians, for now and then an enormous specimen is accidentally captured. Lobsters weighing nearly thirty pounds, and with their claws alone weighing more than ten pounds each, have been taken off the New Jersey coast. No doubt if traps designed for these monsters were set for them we would find that they are quite common, for those which have been brought

up had become entangled in the wire netting of the pots as they tried to reach the bait within.

Every one knows that lobsters have claws and can use them most effectively, and doubtless many have noticed that one claw is usually larger and heavier than the other. But do you know whether lobsters are right or left-handed, that is, whether the right or left claw is the larger? As a matter of fact some lobsters are right-handed and some left-handed, while occasionally there is an ambidextrous lobster with both claws the same size and shape.

Sometimes, too, we may find a lobster having freak claws, with one or more additional claws sprouting from the main claw. These may be natural abnormalities like six fingers or six toes on a person's hand or foot, or they may be malformations resulting from injuries. Like all the crustaceans, lobsters may lose a claw or limb, or both claws and numerous legs, and suffer no permanent injury, for with the next change of skin new appendages will appear to take the place of those lost. And sometimes when a claw or other portion of the creature is injured and not lost, the tendency to replace it may result in a superfluous claw or limb appearing where the injury occurred.

Another peculiar feature of lobsters is that they are readily hypnotized. Although many an old lobsterman has never heard of hypnotizing a lobster and is mightily surprised to witness the feat accomplished, yet it is a very simple and easy matter. Select a good lively lobster, stand him on his head,

his claws resting flat upon the surface supporting him; bend his tail slightly inwards, stroke his back a few times, and upon removing your hands the creature will remain motionless, balanced upon his nose and claws, for an indefinite length of time. Of course this isn't actual hypnotism, but is similar to the trick of "hypnotizing" a hen by tucking her head under her wing and whirling her about, or placing her beak against the floor and drawing a chalk line straight away from the tip of her bill. But it puts Mr. Lobster to sleep just as effectually as though he were really mesmerized.

If you have ever seen lobsters in an aquarium you may have seen them swim. Lobsters swim readily and quite rapidly, although we usually think of them as crawlers rather than as swimmers, probably because they have long, mobile, and thoroughly practical and efficient legs and feet, but do not possess fins. But the lobster doesn't require fins. He bears about the same relation to finned swimmers as a propeller-driven vessel bears to a side-wheeler, for the lobster swims entirely by means of his tail. Moreover, he swims backwards, propelling himself swiftly by rapid motions of the broad thin plates at the tip of his abdomen. This is not at all strange when we consider that lobsters are stream-lined from stern to bow, and that it would be a hopeless undertaking to attempt to make any considerable progress with the creature's broad fore-end, his massive claws, his long legs and antennæ all offering tremendous resistance and "skin friction" to the water.

Every one knows that lobsters are red when cooked, for who hasn't heard the expression: "As red as a boiled lobster"? But only those who have seen live lobsters know that they are green or bluish, variously marked with dull orange and yellow. Occasionally, however, creamy-white albino lobsters, or very pale green or blue specimens are caught, while lobsters of vivid green or bright blue are not unknown. But don't laugh at the man or woman who thinks lobsters are bright red when alive. If you do, the laugh may be on you, for there are lobsters which are naturally red.

And very handsome creatures they are, marked with innumerable ivory-white dots and with large eyelike spots of cream-color and black on their tails. These are the *Spiny lobsters* of Florida, the West Indies, and the warmer waters of both the Atlantic and Pacific coasts of America.

They have no large claws, their front legs ending in large hairy feet, and strictly speaking are not true lobsters but *sea-crawfish;* but they are always called lobsters by the English-speaking inhabitants of the localities where they occur, while the Spanish-speaking people call them *Langosta* which means the same thing. In England similar closely related species are invariably called *Crawfish* to distinguish them from the true lobsters, for both animals are found in the same localities in Europe, although on our side of the Atlantic the true lobsters are not found farther south than Virginia, and the most northerly haunts of the spiny lobsters are the Bermuda Islands.

Although they lack the big powerful crushing nippers of our common lobsters, these sea-crawfish manage to survive, and seem to get along just as well as their big-clawed cousins, for they are such spiny fellows, with long sharp horns on their thorax and legs and scattered over their bodies, that they are unpleasant customers to tackle. Moreover, they possess long nimble legs and can move very rapidly, while their enormously long feelers or antennæ warn them of any danger.

If you should watch one of these creatures closely, you might see him rub the joints of his antennæ across the forward end of his shell, and if you have sharp ears and listened carefully you might hear a queer, squeaky, scratching sound. Moreover, if there happened to be another individual somewhere in the vicinity you would see him "prick up his ears," figuratively speaking, waving his antennæ, rising on his toes, lifting up his hairy front feet, turning his head towards the other crawfish, his every action and posture indicating interest and alertness. Then he would rub his antennæ across his forehead while the first chap appeared to be listening, for these remarkable creatures actually communicate, producing various notes or sounds by using their antennæ as bows and their foreheads as fiddles.

These sounds are "picked up" or received by the hairs on the creatures' legs. In other words the spiny lobsters talk through their noses and hear with their feet.

Like our northern lobsters, these fellows live in

crevices and holes in rocks and are particularly fond of the coral reefs with their innumerable cavities. They grow to enormous size, often weighing twenty pounds or more, and as they have no large heavy claws, a twenty-pound spiny lobster is fully twice as big as a twenty-pound northern lobster. In fact they are the real giants of their race and among the largest of crustaceans. Wherever they occur, they are highly prized and extensively fished and in the estimation of many persons are superior to our ordinary lobsters, especially when young, for the flesh of the big fellows is rather tough and stringy.

Although they are abundant almost everywhere about the coasts of Central and South America, the West Indies, and our more southerly states, as well as in California, they appear to be most numerous and to attain greatest size at the island of Juan Fernandez off the coast of Chile. Here at Robinson Crusoe's island, the giant spiny lobsters fairly swarm and practically the only industry of the island is the lobster fishery. Thousands of the big spiny lobsters are shipped alive to the mainland and thousands more are canned. Cruise-ships that stop at the famous island always take on a supply of the lobsters, and thereby hangs a little tale which serves to illustrate how unobservant many people are, even when it comes to most obvious matters.

On one of my trips aboard a steamer plying between New York and Chile, the chief steward was dilating upon the size and superior quality of the Juan Fernandez lobsters, and becoming very enthusi-

astic on the subject he informed his listeners that a single claw of one of the creatures would furnish a full meal for a person. Here indeed was interesting information. Was the steward merely romancing or were there actually lobsters with claws in Chilean waters? If so, they must be some new and unknown species, and instantly I was all attention.

"Are you sure those lobsters have claws?" I asked the steward.

"Sure? Of course I'm sure," he replied a bit indignantly. "I've served hundreds of them to passengers."

"Do you suppose you can get me a specimen—an entire lobster with claws?" I inquired.

He assured me that he could, that when the ship came northward he'd have not one but several of the creatures ready to deliver to me in Panama.

But when, weeks later, the ship docked at Balboa and I hurried aboard, anxious to see the specimens of an undescribed lobster from the South Pacific, the chief steward's face was as red as the proverbial boiled lobster.

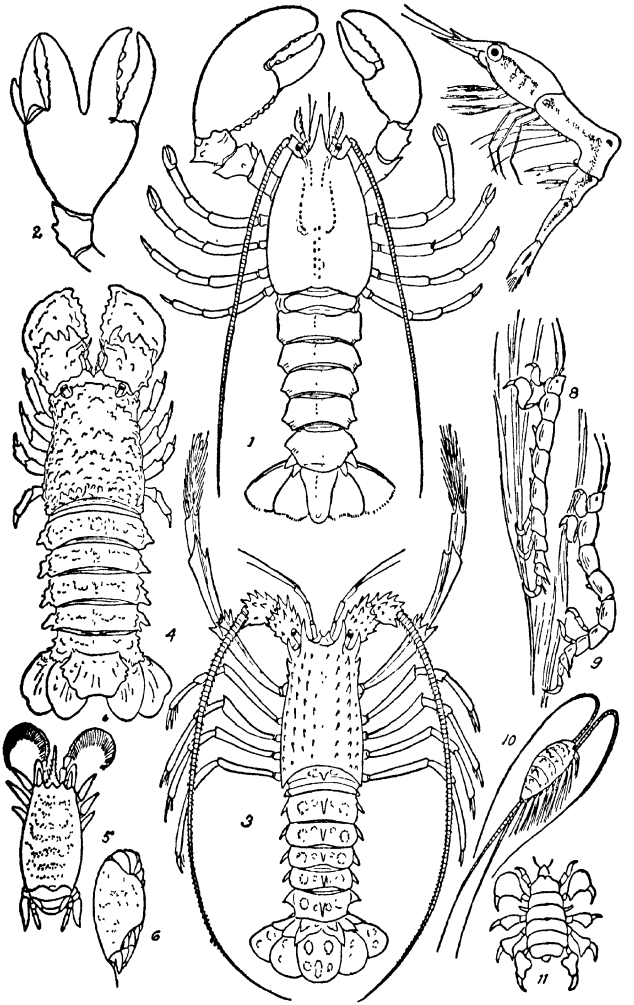
"I guess cigars are on me," he informed me with a shamefaced grin. "I couldn't find a single lobster with claws, and when I asked the chaps at Juan Fernandez to get me one they thought I was crazy—said Chilean lobsters never did have claws. But I could have sworn they do—that I'd served them many a time."

No doubt the steward was perfectly sincere. But

he had become so accustomed to northern lobsters that his mind had come to regard claws as essential and universal to all lobsters, and despite the fact that he had handled and served hundreds of spiny lobsters he had never noticed that they were clawless creatures.

Modern means of rapid transportation, and up-to-date refrigeration have brought many hitherto unknown delicacies of far-off lands to our northern markets. Among these are sea-crawfish tails, which are shipped in large quantities from Florida, the West Indies, from South America, and even from Cape Town, Africa. As practically all the edible flesh of these crustaceans is that of the "tail" or abdomen, this is the only portion exported, either frozen or canned.

Speaking of spiny lobsters' tails reminds me that I must not forget to mention the extraordinary vitality of these creatures. As is the case with all crustaceans, the spiny lobster may lose one or more legs, even one or both of its antennæ and be little the worse off, for with the next change of skin new appendages will take the places of the missing members. But I doubt if any ordinary lobster or crab is capable of surviving the complete loss of the greater portion of its body. Yet these spiny sea-crawfish appear to be little inconvenienced when minus most of their anatomy. In the Bahama Islands and at Key West, Florida, it is customary for the fishermen to break off the bodies of the lobsters for their customers and to toss the



Lobsters and their kin

remaining portions overboard. Any one would suppose that the creatures thus ruthlessly torn apart would give up the ghost in a very few moments, or at the very least would be helplessly crippled, and would die a slow lingering death. The moment they are thrown overboard and reach the bottom they walk about on their long legs, waving their antennæ, and seemingly quite unaware that they have parted with their abdomens and consist only of a thorax, legs, and antennæ. They are so little affected by the amputation of their bodies that they even eat, although minus intestines and a goodly portion of their digestive apparatus.

How long they might survive in this condition I cannot say, for numbers of big green parrot-fish or "pugs" always frequent the vicinity of the wharves and fishing-boats, picking up an easy living on the offal thrown into the sea. They are particularly fond of lobsters, and as a result the de-bodied crawfish seldom go far before being gobbled up by these ever-hungry fishes. Possibly, if they escaped this fate, they might live on indefinitely. For that matter perhaps Nature might provide them with new bodies when next they changed their skins, for almost anything would

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Lobsters and their kin

1. Common lobster
2. Freak claw of lobster
3. Spiny lobster
4. Sea-cockroach
5. Hippa (mole-shrimp)
6. Hippa rolled up
7. Deep-sea shrimp
8. Caprella at rest
9. Caprella crawling
10. A copepod from the deep sea
11. Whale louse

seem possible for creatures so tenacious of life as the spiny lobsters.

Very often when the West Indian fishermen haul up their big fish-pots or traps from deep water they find strange creatures within them. Among these are the amazingly long-legged lobsters known as the *Sagittarius* or *Archer*. This is a really appropriate name, for the creature's front legs are so long and curved that they resemble bows, and in addition, the owner has a habit of crossing one over the other, thus giving the effect of drawing an arrow "to the head."

Although rather small, seldom weighing more than a pound, the archer is considered a great delicacy and has the most delicately flavored flesh of any crustacean I have ever tasted.

Among other cousins of our lobsters are the funny *Alpheus* or *Snapping lobsters* common in tropical and semitropical seas where they may be found under stones and particularly in the holes and cavities in masses of dead or even living corals. These fellows have the appearance of lobsters in miniature, with one claw enormously developed. But the peculiar feature of the Alpheus is the arrangement of the joint of the movable nipper which has a sort of trigger-like device so that when suddenly released it produces a loud snapping sound like a tiny fire-cracker. Very often a fragment of coral will be so filled with these snapping crustaceans that when disturbed there is a continuous volley of sharp reports which would mystify any one not familiar with the habits of the creatures.

Still another strange lobster common in our tropical seas is the so-called *Flat lobster*, as it is known in Europe. In the West Indies the fantastic crustaceans are called *Sea-cockroaches*, which is a most fitting name, for they resemble gigantic cockroaches or "sow-bugs" more than lobsters or other crustaceans. But the similarity is all on the exterior. Instead of claws these creatures have broad, flat, rounded plates with irregular serrated edges. The other legs are short, stubby, and are concealed beneath the wide, flattened, and roughly granulated carapace, and the segments of the abdomen are rough, broad, and have rough, uneven edges.

There is a reason for this unusual form and the warty roughened surface of the animals. Being slow-moving, clawless creatures with no means of self-defense, they depend upon other means for protection, and when disturbed or threatened with danger they tuck their short legs under the body, roll up like a "pill-bug" or an armadillo, cover their soft underparts with their broad, hard, front legs, and become transformed into armor-plated spheres as hard to crack as a coconut. And when in their natural haunts among the coral growths or upon the bottom of the sea among the reefs and stones, their irregular rough bodies, colored with brown, dull-red and orange, blend perfectly with their surroundings and they appear merely fragments of broken coral until they move.

Perhaps because they are so buglike and unusual in form, or perhaps because the natives do not know

better, the sea-cockroaches are not considered edible in many places, such as in the Bermudas and some of the West Indian islands. But in other localities, especially in the Bahamas, they are regarded as superior to the ordinary spiny lobsters. Personally I agree with the Bahamans, for the flesh of the flat lobsters is more delicate, more tender, and finer flavored than that of the sea-crawfish, and it lacks the slightly sweetish taste of the latter which many persons find objectionable. Unfortunately, however, the sea-cockroaches are rather small, rarely weighing more than two or three pounds, although they are "all meat"; and in most localities they are by no means common, some species being so rare that they are considered great "finds" by naturalists.

Strange as it may seem, among the richest fields for rare or undescribed specimens of crustaceans are the stomachs of the big *jewfishes*. No human collector, no matter how experienced and skilled, can ever hope to equal these huge fishes, and as jewfishes do not bother to chew their food but gulp it down entire, the shells, lobsters, crabs, and other livestock they swallow are not crushed or broken. Moreover, these fellows have enormous mouths and a good-sized jewfish, weighing perhaps a hundred or a hundred and fifty pounds or more, can readily swallow an object nearly two feet in diameter. Neither are they at all particular or discriminating. Anything that is alive and not too large or active to be devoured, as well as anything unusual, is edible according to the ideas of the jewfish. Empty bottles, old shoes, bits of metal—even

good-sized stones—all follow the same road to the capacious stomachs of these omnivorous fishes.

As no one knows what a jewfish may have picked up on its wanderings among the reefs, the fishermen always open the stomachs of those they catch. Quite frequently they are well rewarded for their investigations, for coins, jewelry, watches, and other valuables lost overboard, or salvaged from wrecked vessels by the finny junk-gatherers, have been taken from the innards of the fish. And, more often than not, there will be numerous rare sea-shells and an assortment of crabs, lobsters, and other crustaceans. Cruising far and wide, browsing about the coral reefs, searching the bottom of the sea and sunken ships, the jewfish gobble up many a specimen of sea creatures unknown to scientists, and there are species of crustaceans, the only existing specimens of which were obtained from fishes' stomachs.

Chapter XII

SHELLY SOLDIERS

DO you know a crab when you see one? That sounds like a foolish question, for who can fail to recognize a crab? But there are crabs *and* crabs, and some of them differ so greatly from ordinary crabs that few persons, other than scientists, would ever realize they are crabs. For that matter there are certain crustaceans which are really connecting links between the lobsters or shrimps and the true crabs.

Scientists divide all the ten-legged or *decapod* crustaceans into two general groups known as the long-bodied and short-bodied decapods. The shrimps, prawns, lobsters, and their relatives belong in the long-bodied group, while the crabs comprise the short-bodied decapods. But there are some creatures whose bodies are neither long nor short, while others have long bodies yet otherwise have all the distinguishing characteristics of the crabs or short-bodied members of the decapods. So you see, after all, my question was not quite so foolish as it might seem.

Among the commonest of the half-way creatures, as we might call them, are the odd little crustaceans known as *Hippas* or *Mole-shrimps*. Well named they are, too, for even if they are not shrimps they bur-

row in the sand of beaches, and no furry mole can dig and tunnel more expertly and rapidly than these fellows. The speed with which they can dig in is truly amazing, and even with a spade a man has hard work to keep up with them. Like moles, also, they are seldom seen, and although they are very abundant from New England southward, and even on the shores of South America, they are rarely visible, unless washed up dead by the sea, and in places where there are thousands of the little creatures their presence is entirely unsuspected.

Fishes of many kinds are very fond of the Hippas and in many localities great numbers are gathered by fishermen to be used as bait. This is quite a simple matter when we know the habits of the animals. Each time a wave comes rolling in covering the sands where the Hippas have their burrows, the creatures come out of their holes, hurry about gathering food and pop back beneath the sand as the wave recedes. Equipped with special nets, the Hippa-catchers wade into the surf and each time a wave covers the beach they drag their nets along the sand. Very often hundreds of the queer creatures will be taken at a single haul, and on the coast of Peru it is not unusual for a boy or man to gather several bushels of Hippas during a single tide. These, however, are not destined for fish bait, but are used as food, for Hippas are excellent eating and are far more delectable than shrimps.

Men are not the only fishermen who take heavy toll of the Hippa population, for many sea and shore

birds are as familiar with the creatures' habits as are human beings. This is particularly true of the pretty gray noddy terns and flocks of thousands of these birds may be seen industriously capturing the Hippas where they abound on certain beaches in Peru. It is a most interesting and fascinating sight to watch these birds who become so preoccupied capturing the Hippas that they pay no heed to human beings and may be approached within a few feet. Their technique is perfect. As the receding waves leave the sand bare, the entire flock rushes forward, running nimbly and balancing themselves with their wings, and seizing the crustaceans before they can scuttle into their burrows. Then as the next breaker comes thundering in every bird takes wing and, flying to a point just beyond reach of the waves, they stand ready to dash forward the moment the hissing foam-flecked water commences to run back.

In Florida I have seen flocks of the black skimmers or "scissor bills" capturing Hippas by flying close to the surface of the receding waves, their long lower mandibles buried in the water and scooping up the crustaceans.

Quite apart from their importance as food for fish, birds, and men, the mole-shrimps are very interesting creatures. With their olive-shaped bodies, short, strong, digging legs, and long, curved, feathery antennæ, they are wholly unlike any other crustaceans, and when frightened and unable to bury themselves in the sand they tuck in their legs and feelers, bend their heads and tails under their abdomens, and look

far more like water-worn pebbles than animate creatures.

Although the Hippa appears all thorax, it really has a long abdomen which is kept pressed under the body where it reaches almost to the little creature's head. So, according to the scientific grouping, it should belong with the lobsters, crawfish, shrimps, prawns, and other long-tailed crustaceans.

But as it is far more crablike than lobster-like in other respects, scientists consider it a crab, and to be on the safe side they have allotted it a place by itself, as they have another queer little beach-dweller often found associated with the Hippas and having much the same habits. The *Albunæa*, however, is very different from the mole-shrimp, although most fishermen and others never distinguish the two, but call them all "sand-bugs."

Instead of being shaped like an olive, this creature is squarish or rectangular in form, and the back, instead of being smooth and polished like that of Hippa, is marked with deep lines or creases which give the effect of separate plates. The forward edge also differs from that of the mole-shrimp as it has a row of notches or teeth with a prominent spine at each corner. Like the Hippa it carries its long abdomen doubled up beneath its body, but its legs are very different, being large and stout, with pincers on the first pair and with the others ending in sickle-shaped claws which serve as shovels with which the owner burrows quickly into the sand. Moreover, it has crablike eyes on stalks, while, finally, the an-

tennæ are long, slender, and jointed like those of a lobster. So perhaps these funny little inhabitants of our sandy shores are the answer to the question, "When is a crab not a crab?"

Perhaps you still feel sure that you know a crab when you see one. But how about the *Hermit-crabs?*

Of course they are crabs, you'll say. But are they true crabs? Not strictly and scientifically speaking, for the hermit-crabs are much more lobster-like than crablike. As we see them running about carrying their shell houses on their backs, there seems to be no question that they are crabs. But if we draw one of the funny fellows from his snug home—which is a difficult matter, for they hate to be forcibly evicted—we will find that his crablike appearance ends with his claws and feet. Instead of having a broad flat shell or carapace, the hermit's body is far more like that of a lobster. And instead of having a short, flattened, horny tail folded tightly underneath his body, the hermit has a long soft fleshy abdomen unprotected by plates or armor of any kind. With such a vital portion of his anatomy defenseless, it is no wonder he tucks it inside of a sea-shell for protection. You may also notice that the hermit's abdomen is crooked and twisted to one side, and if you should extract a dozen or more hermits from their temporary homes you would discover that no two had abdomens just alike, for the hermits' bodies adjust themselves to the interior forms of the shells they inhabit, even becoming coiled in a spiral when the creatures are accustomed to using spiral shells for their apartments.

If you have ever tried to draw a hermit from its shell, you undoubtedly have wondered how on earth the little fellow managed to keep such a firm grip on his house. Very frequently one of the creatures will permit himself to be torn apart rather than let go, and when you discover what a soft, almost flabby abdomen is concealed within the shell, you will be still more curious to learn how the hermit holds on so persistently.

But you'll find the solution of the problem in the form of two little hooks at the end of the tail. These are the hermit's anchors and by gripping the interior of the shell with them he is almost as firmly fixed as though a portion of the shell itself. In addition to these grappling-hooks, the hermit's fourth and fifth pairs of legs are very short and stout, and terminate in strong hooks especially adapted for holding fast to the shell he occupies.

Nature, in fact, has designed the hermit-crab for the life it leads, and has even provided the little fellow with a door to his shell house. Perhaps you may have noticed that the hermit-crabs have one large and one smaller claw, and if you are particularly observant you may have discovered that these crustaceans are nearly always right-handed. That is, the right-hand claw is the big one, but the chances are that you have not discovered *why* one claw is larger than the other or why they are so peculiarly shaped.

Just examine a hermit who has drawn back into his shell home and you will find that the fellow's claws are his front doors, real folding doors, too, the large

claw filling most of the opening in the shell while the smaller left hand is shaped accurately to fit into the space left by the big right hand and locking it in place. Moreover, the shape of these claw doors vary in different kinds of hermit-crabs, each having claws designed to close the apertures of the particular type of shell the owner inhabits. Some hermits have both claws the same size; in some the left claw is the larger, for these fellows select left-handed shells or those with whorls spiraling from right to left or "anti-clockwise." Other hermits who take possession of the "tusk shells" or Dentalium shells have the right claw perfectly circular to fit snugly into the mouth of the tubular shell, while the left claw is so small it may be tucked inside with the other feet. There are still other species whose claws are provided with stout sharp spines about the edges so that when the door is closed it is protected by a barbed wire fence, as we might say.

As striking examples of adaptation to a certain mode of life the hermit-crabs are really most remarkable. Not only are their bodies designed to fit the internal cavities of the shells they inhabit, while their claws are shaped to fit the mouth of the shell and serve as a door, but in addition, the eye-stalks, walking feet, and other exposed portions of the hermit's body are all adapted to his habits. As all spiral shells are larger and heavier on one side than the other, and necessarily are carried on a cant by the hermits, it would be most awkward and inconvenient for the occupants if they were compelled to twist

their bodies to one side and to constantly exert more strength on one side than the other in order to keep an even keel with the shells on their backs. But Mother Nature has solved this difficulty by providing the hermit-crabs with legs on one side longer than those on the other to counterbalance the load of shell; and to enable the creatures to have a clear and uninterrupted view of the world about them, she has given them eye-stalks of unequal length, so that even with their bodies tipped to one side by their shell houses their two eyes are on the same level. Moreover, even their claws conform to the same system, the large claw being on the "up" side as the crabs walk about, with the smaller claw on the "down" side, thus enabling the hermits to manipulate their powerful crushing claw freely for the purpose of capturing prey or fighting foes.

Like all other crustaceans, the hermit-crabs change their skins frequently as the animals increase in size, and each time they change the coverings given them by Nature they must also change their living-quarters for larger apartments. It is fascinating to watch the droll little creatures when house-hunting. No human beings are more particular in the selection of a temporary home than are the hermits. Scampering about, hurrying hither and thither, scurrying from one empty shell to another the hermit searching for a new house stops to examine each one, feeling it with his long sensitive antennæ, turning it over if the opening happens to be underneath, and inspecting it with his alert eyes atop their long stalks. If

he decides that it is the right size to accommodate his body and answers all other requirements, he will quickly withdraw from his own shell and pop into the new one so swiftly that the shift is scarcely visible. Wriggling his abdomen about, drawing himself into the new house and closing the door with his claws, he will give it a thorough test. If it fulfils all his ideals of what a hermit's apartment should be, he takes possession and occupies it until his next change of skin.

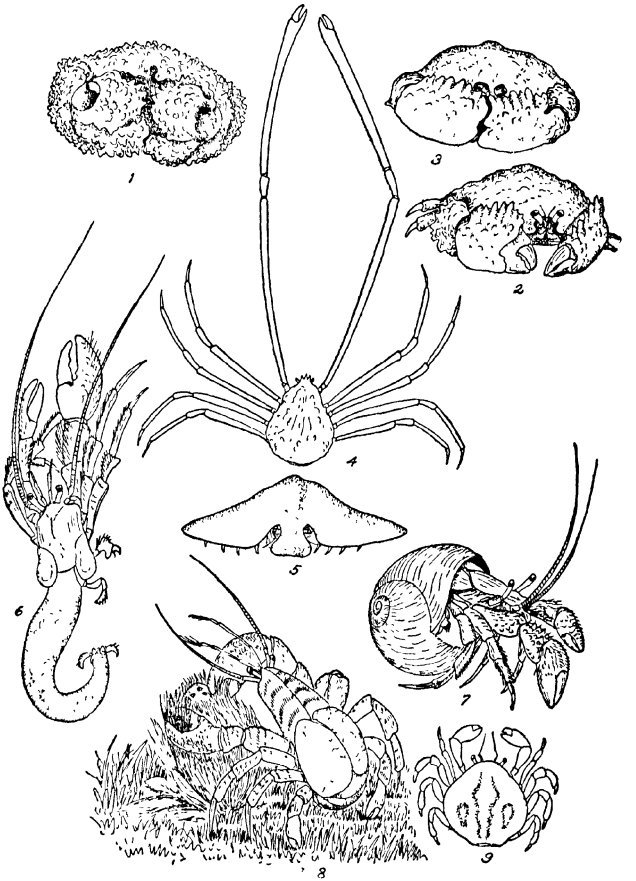
It is seldom, however, that a hermit-crab is satisfied with the first shell he tries out. In order to suit him it must be exactly the right size and weight, and its interior arrangements must conform comfortably to the shape of his body. If possible he will select a shell of the same species as that of the one he is forced to abandon, for his soft abdomen has become accustomed to the curve and twist of the spiral chambers. To be sure, his body will soon adjust itself to slight differences, but until it has done so it will be like wearing a pair of new shoes. Moreover, hermit-crabs have artistic and aesthetic tastes. They prefer certain types of architecture and decorations to others, and it is not unusual for a hermit to discard a newly acquired shell in favor of a handsomer or more perfect specimen of the same size and kind.

Occasionally two or more hermits may all decide upon the same vacant house, whereupon there is a battle royal for ownership. It is a rough-and-tumble fight, a catch-as-catch-can tussle with no holds barred. Even if there are scores of other empty shells lying about, the rival claimants for the par-

ticular tenement will fight savagely until the battle is won, and the victor, usually minus a claw or a leg or two, takes possession of the disputed property.

Most of our northern hermit-crabs are little fellows and dwell in the shells of periwinkles, drills, and Litorina snails. They abound nearly everywhere, on beaches and mud flats, under stones, dead seaweed and driftwood, and especially in tide-pools and damp crevices of rocky shores. The name hermit is really most inappropriate, for these lively creatures are by no means solitary, but are sociable fellows, forever on the go. They seem always in a hurry, as if their lives depended upon getting somewhere within a given space of time, reminding us of the subway crowds in New York City, for like the milling, pushing humans dashing madly to catch a train, their scurrying about seems quite unnecessary. They have no particular objective, they never arrive at a destination and remain there for any length of time, and one marvels that they should waste so much energy and be in such feverish haste and yet gain nothing in the end.

Their actions call to mind the story of the visiting South American and his New York host. Rushing madly through the streets, shoving his way through crowds, risking life and limb by dashing across traffic on the Avenue and diving into a subway station with the bewildered Latin American in tow, the New Yorker caught an express train just as the doors were closing. "Saved five minutes by catch-



Shelly soldiers

1. A crab with ventilating shafts
2. The bashful Calappa
3. Hiding its face
4. Giant crab of Japan
5. The shield-bearer
6. Hermit-crab without shell
7. The hermit-crab
8. Coconut-crab
9. Oyster-crab

ing this train," he informed his companion as they squeezed their way into the tightly packed car.

Gasping for breath, the South American raised his eyebrows. "May I inquire, *amigo*, what you intend to do with those five minutes?" he said.

Aside from the little hermits of tide-pools and beaches, we may sometimes come upon larger ones trundling about with good-sized "moon shells" on their backs, while lobstermen's pots frequently contain numbers of big winkles or conch shells, inhabited by huge hermit-crabs. These larger fellows are not the same as the smaller hermits, however, but are of a different species. There are many kinds of hermit-crabs found on our coasts, even the smaller ones being of several species. In the tropical seas and on tropical shores there are many more, and among these are the strange and interesting *Soldier-crabs.*

In the north the hermits are all inhabitants of the sea or of seashores where they are close to the water, but the soldier-crabs of the West Indies and tropical America are land-dwelling hermits. Even when many miles from the nearest seacoast, high up on mountainsides or on dry plains, one may often find these shelly soldiers. Until one becomes accustomed to their presence it seems very strange to see a sea-shell moving about in the jungle or among the grass far inland, and upon examining it finding it is occupied by a lively crab.

Many of these land hermits are small, others are fair-sized, while many are really big fellows carrying heavy turbo shells or even conch shells on their backs.

In some places they are a great nuisance, for they do not hesitate to enter camps or houses and help themselves to anything edible. Quite frequently they will crawl into one's bed, and it is far from pleasant to stretch out comfortably for a night's sleep only to have a big hermit nip one's toe. And even the soundest sleeper will awaken promptly when a hermit-crab with an exploration complex tiptoes across one's face, and investigates one's nostrils or ears as if considering their possibilities as new quarters. In some localities where the larger soldier-crabs abound, they climb trees and devour young birds or birds' eggs, and they even raid poultry yards and dine on young chicks.

Why, you may wonder, are these land hermit-crabs called "soldier-crabs"?

You would agree that it is a most appropriate name if you should come upon an army of these strange crabs on their annual march to the sea. Although these crabs now live on dry land, their ancestors, ages ago, were sea-dwellers. They have become adapted to existing on land far from water, and through millions of years they have developed specialized respiratory systems; but still the old inherited instincts persist, and once each year they feel the irresistible urge to visit the sea where they lay their eggs in the ocean, change their skins, and secure new shells. Moreover, they are all seized by the same migratory longing at the same time. They appear to be subject to mass mania, and instead of moving seaward singly or in small groups, they make the jour-

ney in vast armies consisting of thousands of individuals.

For some time before the march begins the army mobilizes. From nooks and crannies, from forests and fields, mountains and valleys, the crabs appear, all headed in the same direction, all concentrating at a certain point as if some summons had gone forth calling the scattered units of the crab army from far and near. It is a wonderful sight, these myriads of crabs, each trundling a sea-shell on its back, where a few days earlier only a few scattered individuals would have been seen. But it is nothing compared to the sight of the army on its march to the sea.

As the countless thousands of soldier-crabs move onward along roads, across fields and through jungles, they stop at nothing. No surmountable obstacle turns them aside, nothing short of fire will cause them to turn back and seek another route to their objective. Walls, trees, precipices, are scaled by the swarming creatures. If they meet some insurmountable barrier they will detour, sometimes traveling for miles to get around it, but always, unerringly, undeviatingly maintaining their direction. As if guided by a compass they select the straightest, most direct course toward the sea as surely as a carrier-pigeon wings its way homeward. If they are captured and turned around they unhesitatingly resume their former route when released, and if carried far inland, to a district wholly strange to them, they will immediately head seaward as soon as they are freed.

Tirelessly they march onward, never stopping to

rest, never sleeping, but hurrying seaward day and night. Sometimes, in the silence of the tropic night one may hear the sounds of their marching—the rustle of countless feet, the clattering rattling of thousands of shells clicking together or striking against stones or other objects as the crab soldiers hurry on, driven by instinct toward the ocean whence their ancestors came in the dim and distant past.

The march may cover many miles; days or even weeks may be consumed in the trek of the crabs whose haunts are farthest from the shores. Others may be within a short distance, a few hours' travel of the sea, yet all arrive at almost precisely the same time, those closest to the shore waiting for the vanguard of the army before starting out. Once at the shore the army breaks up, the individuals scatter far and wide, and although the rocks and beaches may be alive with hurrying, scurrying soldiers of all sizes, there is no true army, no concentrated mass. Every crab is foraging for itself, seeking feverishly for a new and larger shell and—like the Hindu pilgrims to the Ganges—crowding into the water and taking advantage of its brief visit to the seaside.

Then, when the female crabs have safely deposited their eggs, when old skins have been cast away and new shell houses have been selected, the crabs turn their backs to the sea and begin the return journey to their accustomed haunts. But not as an army. Singly and in groups they travel. Wandering rather aimlessly, loitering on their way, stopping here and there, until at last they find a spot that suits them

and settle down to a quiet humdrum life of banditry for another twelve months.

Although we always associate hermit-crabs with sea-shells, many of the smaller species find hollow plant-stems or sponges just as satisfactory as the shell houses of their fellows. And there are some species of crabs belonging to the hermit-crab group who never bother with portable houses of shell or other material. These are the *Coconut crabs* or *Robber crabs* of the Pacific islands, the real giants of the hermit-crab clan, the largest species, over a foot in length, being found on Christmas Island. The abdomens of these crabs are protected by tough hard skin and are so similar in shape to the abdomens of ordinary hermit-crabs that the owners have the appearance of huge hermits who have been unable to find shells with which to hide their nakedness. The crabs' abdomens are also enclosed in a thick layer of fat which is highly prized for the fine grade of oil obtained from it, while the flesh of the crabs is excellent eating.

Like the soldier-crabs, these big fellows climb trees readily. But instead of seeking birds'-nests and dining on the eggs and helpless nestlings, they seek coconuts which are their favorite food. Strangely enough, these crabs, when in captivity, will not touch coconuts, but prefer carrion or other offal and are particularly fond of dead rats. It seems incredible that any crab should be capable of stripping off the tough fibrous outer husk of a coconut and cracking the hard-shelled nut it contains. But the crabs ac-

complish the feat with ease, for they possess truly prodigious strength and when placed in an empty kerosene tin they have no trouble in escaping by puncturing the metal and tearing it apart to form an opening large enough for them to pass through.

Not only do these crabs dine upon the coconut meat, but they also line their burrows with fiber stripped from the outer husks, for like the soldier hermits they have taken to a life on dry land, although they are forced to make annual pilgrimages to the ocean to deposit their eggs, as well as daily visits to dampen their gills with salt-water.

Like the soldier-crabs, too, these giant crustaceans are partial to entering houses, and they appear to possess an irresistible desire to steal. They are true crab-kleptomaniacs, for instead of confining their thefts to edible objects, they help themselves to anything and everything that strikes their fancy or arouses their curiosity. Boots, clothing, table cutlery, alarm-clocks—even books and magazines—are all filched by these crabs during the still hours of the night and are carried off. It would not be so bad if the robber crabs abandoned the stolen goods where they could easily be recovered. But the clawed thieves invariably carry their loot to the treetops. It is most annoying to awaken in the morning and find one's trousers, shoes, and other garments waving in the trade-wind from the summit of a lofty palm tree.

Chapter XIII

FIGHTERS AND FIDDLERS

As I have already said, there are crabs *and* crabs. There are tiny crabs, real pygmies so small that the ordinary person would never notice them, and there are huge crabs, true giants, ten feet and more across their outspread legs. There are crabs that burrow, crabs that dwell in holes in rocks or corals, crabs that scuttle about anywhere and everywhere—real hoboes of crabdom—and there are many crabs who swim as readily and rapidly as fishes. There are sea crabs, shore crabs, land crabs, and crabs who spend part of their lives on land and a portion in the sea, while other crabs never set foot ashore but travel for thousands of miles on the surface of the ocean.

Although the majority of crabs are rather dull-colored, nearly all have some bright hues somewhere, reminding us of men who wear the most conservative and inconspicuous clothing but cannot resist a flaming gaudy necktie. But there are many crabs of brilliant colors—some bright scarlet, others yellow, others green, blue or purple, or spotted or marked with several tints.

Regardless of their size, their habits, or their colors, all the members of the crab population are born

fighters. We speak of dour, ill-tempered persons as "crabbed," but the crabs are more than this. They always carry a chip on their shoulders—or, rather, on their shells—and love a scrap regardless of the reason for the quarrel, or if for no reason whatever. Nature has equipped the crabs for fighting, for she has provided them with stout coats of mail and has given them powerful weapons which they wield most effectively. No gladiator of old Roman days, no Crusader, no knight of the Round Table was ever more fitted for a hand-to-hand combat than are the crabs. There is not a streak of "yellow" in their make-up; they do not know the meaning of "fear" and they unhesitatingly show fight no matter what the odds against them may be or how large the foe. Even a human being has no terror for a crab once he is cornered, and it is highly amusing to see some pugnacious little fellow raise his claws threateningly, clash his nippers, rear himself on his legs, and prepare for battle when faced by a person who must appear like a huge mountain to the little scrapper.

But crabs are no fools. Even if they are among the most courageous of all living things and will fight viciously to the end when in a tight place, they know that they cannot hope to be the victors in a struggle against such gigantic foes as men or large fishes, and will dash for cover when threatened with destruction by such formidable enemies. But not through cowardice. Never do they turn their backs to the foe, and even as they scurry off to pop into their burrows or vanish in crevices of rocks they face their enemy,

maintaining a bold front with weapons ready to use at an instant's notice. Like all good warriors, the crabs know that under some circumstances to retreat in good order is much wiser than to court certain destruction in a suicidal battle.

But given anything like an even chance, or when battling with others of his kind, a crab becomes a maniacal fighter. As a rule the crabs' battles are the result of some grievance. It may be over a lady crab; it may follow the attempt of one crab to take possession of another's home or hunting-grounds; it may arise from two or more crabs finding some choice morsel at the same time, or from some other trivial incident. But quite often there will be a battle royal apparently from pure cussedness on the part of one or both of the combatants. Dozens, hundreds of crabs may live side by side, under the same stones, in the same masses of seaweeds or on the same beaches or rocks in perfect amity and peace, and yet suddenly, without any apparent reason, two individuals will rush at each other in a fury and battle madly until one has "had enough" or until both fighters are too badly injured or too exhausted to continue the battle.

Very rarely do these duels result in fatalities. Claws, legs, or other appendages may be mangled or lost in the struggle, but these are mere trivialities. Minus one or both claws or several of his legs, a wounded crab warrior may be unfit for service for a time, and may be forced to keep out of sight and reach of foes, but with his next change of skin he will come forth with his full complement of legs and

brandishing new weapons as good as the claws he lost.

Some crabs are, of course, more pugnacious than others. Certain species have a code of honor and do not quarrel among themselves, and there are many who, bold and heroic enough when necessity arises, believe thoroughly in "safety first" and only fight in defense of their lives, their freedom, or their homes.

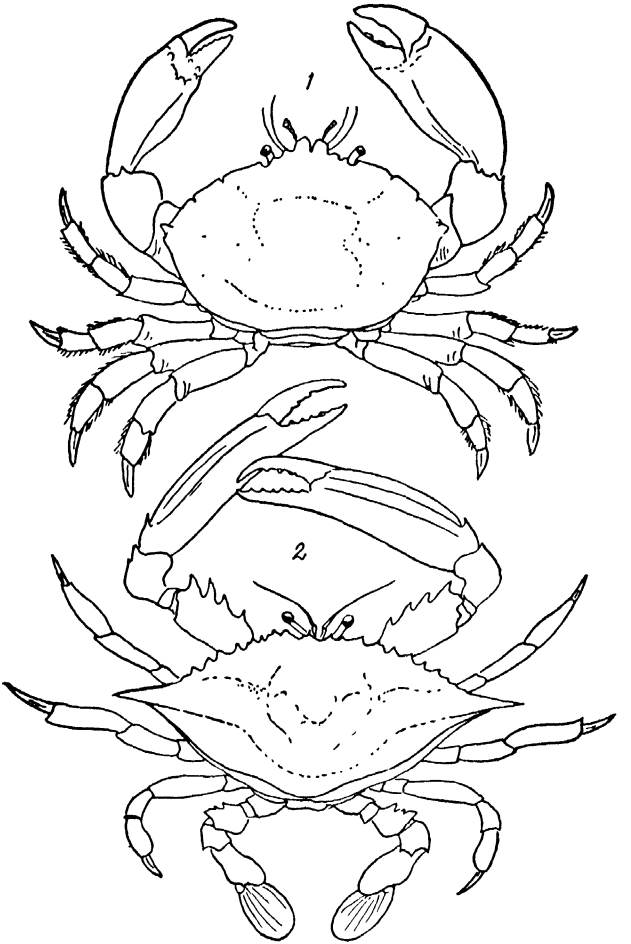
For its size, the common *Green crab* of our shores is probably the most courageous and pugnacious of our crabs. Abundant all along our coast from Delaware Bay to Cape Cod, this crab is found in tide-pools, under stones, and among masses of rockweed. Although barely two inches in width across its green yellow-spotted shell, yet this lively chap does not hesitate to stand at bay and face a human being with threatening snapping claws. Its utterly reckless courage is truly amazing and has been recognized by scientists who have named it *Mænas* or "frenzied," while the French know it as the *Crabe enragé* or "mad crab."

The true crabs are divided into two principal groups known as the "swimming crabs" and the "walking crabs." Although it is easy to recognize some of the swimming crabs on sight, for their rear legs are provided with broad-bladed paddles, others lack these and it is difficult for any one not a scientist to know whether or not a certain crab belongs to one group or the other. This is the case with the ferocious and audacious green crab, for although it lives among rocks and under stones, it belongs among the

swimming crabs and swims readily, using its flattened hind legs as paddles or oars.

Another common member of this group is the handsome *Lady crab* with a white shell covered with countless ring-shaped markings formed of innumerable red and purple dots. This species is abundant on our Atlantic coast from Cape Cod to Florida. Although a swift and powerful swimmer with large palette-shaped swimming feet, the lady crab burrows in the sand below low-water mark, leaving only its eyes and antennæ exposed and ready to snap up any unsuspecting prey that ventures within reach of its strong sharp-pointed claws. At the first sign of danger these crabs "dig in" and vanish beneath the sand, although they are savage, valiant fighters if it comes to the necessity of battle. Owing to their sand-dwelling habits they are not commonly seen alive, but countless numbers of their empty shells litter many of our beaches.

Far more familiar, probably the best known of all our crabs, for that matter, is the big *Blue crab* or *Sea crab* as it is called in the South. This is THE crab, the crab which many persons regard as the only edible species despite the fact that many others are fully as good, while some are much better, both in flavor and quantity of their meat. But so firmly established has the blue swimmer crab become that if a person asks for "crabs" in almost any restaurant or market he will be given blue crabs. They are a popular dish, both in their hard-shelled and soft-shelled or "shedder" state, and of all crustaceans are ex-



1. *A walking crab*
2. *A swimming crab*

ceeded only by the lobster in their commercial value and importance.

Unlike the land crabs who inhabit sandy beaches, the blue crabs prefer muddy shores and are partial to bays and estuaries where there is an abundance of eel-grass. Here they conceal themselves by burying in the mud where they await their prey. Strong, active, swiftly swimming creatures, they are also among the boldest and most pugnacious of all our native crabs. Their front claws or nippers are long, exceedingly sharp and powerful, and easily penetrate the hard shells of other crabs or the skin and flesh of a human being. Although like most crabs they feed largely upon carrion, they also chase and capture fishes.

In England there is a similar closely related species known as the *Fiddler crab*, owing to the shape of the paddles on the hind legs, whereas the "Fiddlers" of our coasts are a very different sort of crab. These edible swimming crabs of the British waters are known to chase and capture good-sized pollock and mackerel, but the most remarkable feature of *Henslow's crab*, as the species is known to scientists, is the amazing scarcity of females. During forty years of crab-fishing out of Plymouth, only two female Henslow's crabs were taken, and the Prince of Monaco reported that not a single female was found among five thousand crabs that he secured on one of his scientific trips.

By far the most abundant crabs on our seacoasts are the numerous species of *Rock crabs*, *Stone crabs*, *Mud crabs* and other members of the walking-crab

group. In most places it is impossible to turn over a rock, lift a mass of dead seaweed, or investigate a tide-pool without coming upon dozens of crabs of this class. In shallow water off shore, big rock and stone crabs abound, and very frequently, I might say usually, a lobsterman finds his pots swarming with big rock crabs. These are usually broken up to serve as bait or are thrown away, yet they are delicious eating and in Europe the rock crabs are considered superior to the swimming crabs.

In some localities, however, our people have discovered the edible qualities of these crabs and at Newport the *Jonah crabs*, as one species is called, are esteemed more highly than the blue crabs. On the coast of California the rock crabs are the most important and valuable edible crabs in the markets, while the stone crab of our southern coasts is considered most desirable. It seems very strange that along our northern coast, especially in New England, our people have never learned to appreciate the edible qualities of the rock crabs which fairly swarm in many localities. Thousands of these big meaty delicately flavored crabs are thrown away or used as lobster bait, while visitors to our shore resorts are paying fancy prices for blue crabs which do not compare with the "worthless" rock crabs. Yet the very same persons who would turn up their noses at the thought of dining on these common crabs rave over the delectable flavor and excellence of the *Morro crabs* served in the restaurants of Havana, not realiz-

ing that this famous Cuban variety is nothing more than a species of stone or rock crab.

Another interesting crab which is common on our sand beaches from Long Island southward to Brazil is the *Sand crab*, known also as the *Ghost crab*—which is a far more appropriate name, for these pale, almost white crabs are so wraithlike, and appear and disappear so mysteriously, that they seem more like disembodied spirits than actual living creatures.

Unlike the majority of crabs, these fellows are very timid and nervous and will dash off to their burrows at the first sign of possible danger. And although when the tide is out they may wander for long distances from their holes they are mighty hard to catch. Not only are they exceedingly swift of foot and able to run as fast as a man across a sandy beach, but they are adepts at playing hide-and-seek and in dodging.

If they find they are losing in a race they flatten themselves in the sand where their color, or rather lack of color, renders them almost invisible. Then if they are discovered they dart off with amazing speed in another direction, running with their bodies held high on their long nimble legs, dodging, twisting, and turning, but constantly moving nearer and nearer to their holes, until just as they seem almost within reach they vanish as if the earth had swallowed them up—which is literally true.

If you wish to study these crabs you must remain motionless on a beach where they abound and keep your eyes fixed upon the nearest holes. If you are

patient you will soon be rewarded by seeing a slight motion at the entrance of one of the burrows, and a moment later two bright eyes at the tips of long slender stalks will be cautiously raised like tiny periscopes. Satisfied that no danger lurks near, the phantasmal creature will do a bit of housework before setting out to find his dinner. Slipping into his hole he will presently emerge carrying a little load of sand held close to his body by his legs and this he will carry for some distance from his door where he dumps it in a neat pile. Then standing on tiptoe he will survey the landscape before again entering his burrow to bring out more sand. Sometimes one of these crabs will labor steadily for hours, bringing out countless tiny loads of sand and dumping it until he has deepened or enlarged his home to suit him.

But if his burrow requires no real work and merely needs a little house-cleaning, he will go hunting almost immediately if he sees nothing to alarm him. Moving by short rapid spurts, halting to raise himself high on his toes, he peers about. Then, as he catches sight of his prey, he instantly changes his tactics. Slowly, cautiously, his sand-colored body held close to the surface of the beach, he steals forward, long-stalked eyes peering intently ahead. Presently he halts, bunches his legs together, and the next instant leaps like a tiger upon the unsuspecting sand-flea or other creature he has been stalking. Rarely does the ghostly hunter miss his prey, whether it is a browsing sluggish isopod, an alert active sand-hopper, a buzzing fly, or even some beetle, wasp, or

other insect. Anything that is alive and which he can capture and devour is "game" to the ghost crab. But like most crabs they are not overfastidious about their food, and while they prefer live creatures they do not hesitate to dine on almost anything that comes their way. I have seen hundreds holding a regular party and feasting upon tidbits left by picnickers upon the beach.

If you visit Florida or other tropical or semi-tropical places where there are mangrove trees, you will undoubtedly see hosts of big crabs climbing about over the stiltlike roots of the trees. They are of all sizes, but all have dark, almost black shells and brilliant orange-red legs and claws. Frequently they are so numerous that as they scuttle in every direction at one's approach, their feet, scraping over the bark and the oysters clustering on the roots, make as much noise as though some large animal were dashing off through the swamp. These are the *Mangrove crabs*, bold, pugnacious fellows who will fight viciously if need be, but much prefer to be on the safe side by hiding among the roots or behind the trunks of the trees, ready to drop into the water at a moment's notice.

In the same countries where the mangrove crabs abound you will see numbers of very different crabs crawling over the rocky shores, on the sea-walls and docks, the spiles of wharves and similar places. They are rather disagreeable, even repulsive-looking creatures with broad flattened bodies and legs, often

brightly colored with orange, red, or purple, and marked with stripes and spots of lighter shades.

As they crawl over perpendicular surfaces, pausing now and then to gaze about, they remind one of gigantic bedbugs. Just why I cannot say, unless it is because of their form and markings, and to me, as to many other persons, they seem loathsome ghoulish things. But they are harmless *Grapsus crabs* and rather timid creatures, for their flat shells are thin and papery; their claws, formidable as they look, are weak and incapable of even pinching one's fingers to any extent, and although they may lift a menacing claw when close pressed or captured, it is all bluff. But wary as they are, ready to dash off and plunge into the water at the slightest alarm, yet they are most inquisitive creatures and filled with overwhelming curiosity. If a person remains motionless where these crabs are numerous, they will approach nearer and nearer, intent on investigating the strange being, and will even crawl over his body and hands and enter his pockets in their desire to find out what it is all about. But there are few people who can remain quiet and motionless as a dozen or more of these crabs crawl over them, and at the least movement, the lifting of a finger, the crabs will become so panic-stricken that they will tumble head over heels in their blind terror and frenzied efforts to get as far away as possible in the shortest space of time.

Practically all crabs have the upper surface of the shell or carapace formed in numerous little hills and hollows or marked with creases or depressions. The

size and arrangement of these differ, no two species being alike, and as each species of crab has its own particular style or design of these inequalities on its shell, they are quite important to scientists and serve as a means of identifying the various species even when they appear almost identical in other respects.

Very often these raised portions of the crabs' shells are so arranged that they give the effect of grotesque or funny human faces, so that the crab appears to be wearing a mask upon its back. Sometimes the facelike effect is not obvious until one's attention is called to it, while in the case of certain crabs it is so apparent that one feels that Nature must have intentionally modeled the fantastic features, for it seems impossible that such lifelike faces could have been produced by chance.

One species of European crab bears such a striking face upon its carapace that it is known as the *Masked crab*, and a very strange and interesting creature it is, quite apart from the realistic "mask" upon its carapace. The masked crab has a rather long, narrow body and the male is provided with enormously long powerful claws. Unlike most crabs who have very short feelers or antennæ, the masked crab has very long antennæ fringed with a double row of stiff hairs. The antennæ are angular, each with a groove on one side, and serve a most remarkable purpose. Indeed they are the key to the crab's existence and habits which differ as greatly as its antennæ from those of other crabs. Instead of being a swimmer, a crawler, or burrower in the sand, the masked crab trans-

forms himself to a living caisson. Digging tail-first into the bottom of the sea, the queer fellow places his antennæ tightly together to form a four-sided tube which extends upwards to the surface, thus serving like the air hose to a caisson and enabling him to breathe while hidden in the sand beneath the water.

The "mask" which this queer crab wears upon its back has a rather solemn, somewhat lugubrious expression. It might well be the face of a slow-witted, not over-intelligent person and is a most amazing likeness of many a fisher lad and country yokel of the British Isles where these crabs are very abundant. No doubt this strange resemblance between the imitation face on the crab's back and the faces of many of his human neighbors is mere chance or coincidence. But it is a rather remarkable and interesting coincidence. Moreover, it is not unique by any means, for many of the "funny face" crabs wear masks that might well be caricatures of the natives of the lands where they occur. Some of our common spider-crabs have most lifelike faces on their shells, and that worn by one species common on our more southerly shores is the perfect likeness of a grinning Negro, while a little crab inhabiting the Florida coast wears a mask that might have been modeled from some Cuban fisherman of Key West.

In California the most abundant of the shore crabs are the *Purple shore crab* and the *Yellow shore crab.* Hundreds of these little fellows are often to be found hidden under a single small stone, and where there

Looking for sponges, Bahama Islands

are sloughs or accumulations of brackish water, myriads of these crabs swarm over the mud flats. Small as they are, barely an inch across the carapace, yet these ten-legged Californians are fearless fellows and even human beings hold no terror for them. The moment a person approaches, up goes every tiny claw, and with threatening puny weapons the entire horde wheels to face the intruder, quite ready to do battle if need be, but at the same time moving slowly to a safer distance.

If we capture some of these bold heroic little crabs and examine their backs we will be certain to chuckle with amusement. Every individual wears the counterfeit face of a fat-jowled, pudgy human being who appears to be striving valiantly to impart a severe and ferocious expression to his good-natured, almost babyish features. Another Californian crab—a rough and spine-covered member of the spider-crab group—bears the face of a stout motherly old Indian squaw or Mexican woman, which is quite appropriate, for these crabs are particularly abundant at Monterey and along the shore near the Mexican border.

Every one is familiar with the scowling, ferocious-looking faces depicted in Chinese art and on Chinese or Japanese masks. With puffy cheeks, crossed eyes, beetling brows, snarling lips, wide mouths, and prominent teeth, these are most demoniacal-looking and are the Celestials' idea of what a real flesh-and-blood devil should be like. But the crabs inhabiting the seas washing the shores of Nippon and China evolved devil faces millions of years before any Oriental

learned to use a brush or to model clay, and wore demon masks millions of years before a human being, Oriental or otherwise, walked upon the earth.

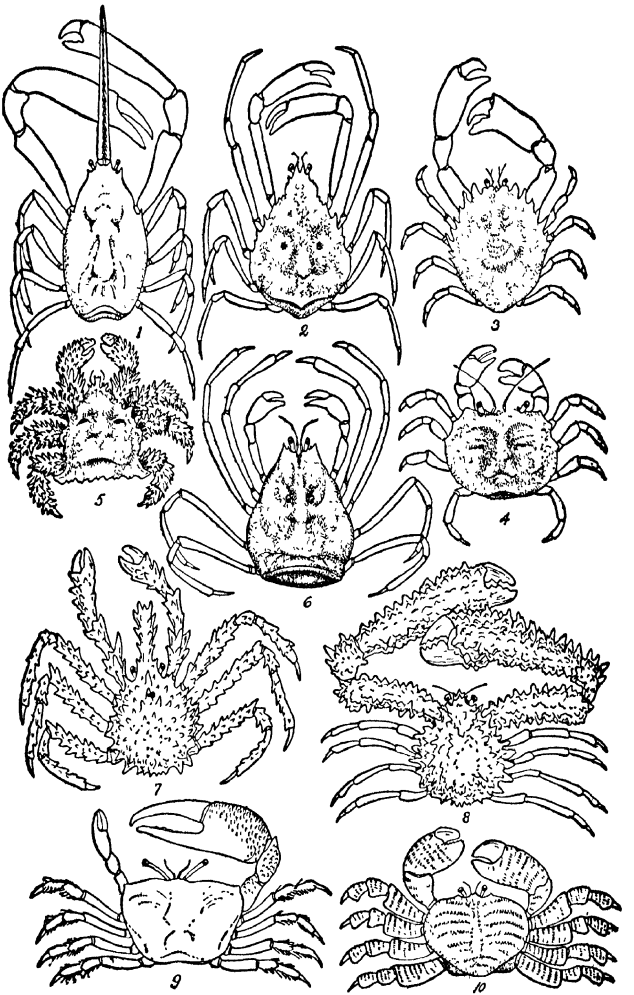
Almost uncanny are the grotesque, fantastic faces upon the backs of these crabs, and it is quite probable that the demoniacal features resulting from the inequalities of the crabs' backs served as the original models for the devil masks and the drawings of corpulent ferocious demons. Many of these masked crabs of the Far East are very large, although like all the members of the spider-crab group, they are mostly legs and have a relatively small body. It may be of interest to mention that the spider crabs are all edible. No one ever dreams of eating the ugly-looking, long-legged spider crabs so abundant on our coasts, despite the fact that their flesh is very tender, delicate, and well flavored, but we all eat the Japanese canned crabmeat which is the flesh of spider crabs.

The spider crabs from which most of the Japanese product is obtained are huge creatures, the largest of all crabs, sometimes spreading more than eleven feet across their outstretched legs. They are captured in especially designed traps, and being such huge, ungainly things to handle, and by no means harmless, they are "spread-eagled" on frames for convenience and safety in transportation. With their long legs firmly lashed to the bamboo frames they look like huge cartwheels with the body forming the hub. An ordinary crab has so little flesh in its legs that it is scarcely worth the bother of cracking, but it is a different matter with these immense spider

crabs of Japan. Their five-foot legs are as thick as a man's wrist and contain the firmest, most highly prized flesh. Few families could consume an entire ten-foot crab, no matter how much they liked these shell-fish. So the Japanese fishmonger disposes of his crabs piecemeal and after cooking the giant crustaceans he sells them to his customers at so much a "joint." Imagine going into a fish market and asking for a "second joint of crab" or requesting the proprietor to pick out a nice juicy "leg of crab" to serve as a roast for your Sunday dinner.

Although all crabs have ten legs, the spider crabs being no exception to the rule, you may come across a spider crab that appears to have only six legs, other than his claws, or only eight legs in all. Of course such a freak might result from the loss of two of the crab's legs, but in that case the missing members would be replaced at the next molting. But the crab to which I refer has not lost its legs by accident, and no matter how many times it may shed its skin it always appears to be minus the last pair of legs. But don't let these common reddish-yellow spider crabs deceive you. The fifth pair of legs are there, but they are so small and rudimentary that they are hidden under the shell, neatly folded within the gill-chambers in the crab's body.

The majority of the spider crabs have well developed nippers, but they are slow-going creatures, awkward in their movements and handling their claws as if it required some time for the nerve impulses to travel through their long legs and actuate



Funny faces

the muscles to operate the claws. But there are certain members of the spider-crab family who are the real "strong-arm men" of the crab world. These fellows have rough spiny shells and spine-covered front legs of enormous size, bearing immense powerful pincer jaws. So powerful are these claws that the crab readily crushes the hardest sea-shells, although he is a rather small species seldom spreading ten inches across his prodigious crushing claws. Perhaps it is fortunate for all concerned that this crab does not grow to gigantic size. Think what a formidable creature he would be if he were ten feet or more across!

For that matter, a crab wouldn't have to be as gigantic as the edible crabs of Japan in order to be a real menace. In Tasmania there is a crab with a body about a foot in width and with claws thirty inches in length which has been known to attack, kill, and devour human beings. No doubt any able-bodied man could drive off one or several of these fearsome creatures, but a castaway, weakened by exposure, hunger,

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Funny faces

1. Masked crab, Europe
2. Spider-crab, Chesapeake Bay
3. Portrait crab, Key West, Florida
4. A masked crab from California
5. Squaw-crab, Mexico
6. The "devil-crab," China and Japan
7. A deceitful crab
8. A member of the "strong-arm squad"
9. Fiddler crab
10. The inquisitive grapsus

and thirst, would fall an easy victim to them. And even a strong man provided with a club or more efficient weapons would face a desperate battle if he were attacked by hundreds of these monsters surrounding him on every side. One has only to watch a horde of the common *Fiddler crabs*, each brandishing its single huge claw and imagine them giants with thirty-inch claws, in order to realize what a horrible experience it would be to be attacked by them. But as a matter of fact the fiddlers, even if as big as the man-eating crabs of Tasmania, would be perfectly harmless unless attacked, for unlike the great majority of crabs, they are strict vegetarians. And they break all accepted rules of crab behavior by retiring to their burrows when cold weather sets in and hibernating throughout the winter. In England these familiar crabs, so much in demand as fish bait, are known as *Calling crabs* owing to their habit of waving their big claw about as if signaling to their fellows.

Perhaps you may never have noticed that the fiddlers are all right-handed, the big claw being on the right-hand side of the body, while the left claw is small, weak, and almost useless. These crabs with the single big claw are the males, the female fiddlers having both claws small, and you might examine thousands of them without finding a single "south claw" or left-handed fiddler. Such freaks do exist, however, but they are as rare or rarer than white elephants or albino giraffes. Even rarer, is a fiddler crab with two big claws—carrying two fiddles, as it

were—perhaps a first and a second violin, for the common name of these crabs has been given them because of the resemblance of the big claw to a fiddle with the small claw for a bow. The similarity is all the greater because of the crabs' habit of constantly rubbing the small claw across the larger one as if striving to draw musical notes from the hard surface.

In our country fiddler crabs are not considered edible, but their large claws are excellent eating and in Portugal they are regarded as a great delicacy. The Portuguese are a thrifty race and in order not to deplete the crab supply they merely break off the claws of the captured crabs and release the creatures who replace the lost limbs at their next molt, only to lose them when again caught by the "claw fishers." By this method there is a never-ending, never-diminishing supply of the desirable claws to be harvested, although the claws garnered the first time are larger and finer than those of the succeeding crops.

It is truly remarkable that so many crabs should wear on their backs masks mimicking human faces, and strange that other crabs should carry claws so much like violins. But no group of animals can boast of more peculiar and often fantastic forms and features than the crabs. Some even resemble turtles, while the strange *Shield-bearer* is a veritable living armored tank. This crab, found on our Pacific coast, is completely invisible beneath its broad, ridged, convex carapace which extends beyond the tips of the crab's feet and forms a perfect shield. Even the crab's head and eyes are protected by the one-piece suit of

mail, the forward edge of the shield extending in a flat rectangular piece with narrow slits through which the creature can project its long-stalked eyes and look about.

Another strange crab, also a Pacific coast dweller, believes in air-conditioning and has provided itself with ventilating shafts. As it moves about on the bottom of the sea it appears merely a heavy, chunky creature covered with short blunt spines or tubercles. But the moment it is alarmed or disturbed it shuts up tighter than an oyster. Bending its stout spiny legs beneath its body, folding its broad serrated claws together to form a neatly fitting front door filling the space between the edge of its back and its doubled-under legs, the crab becomes an impregnable fortress. But occupants of fortresses must breathe, and in order to permit the crab to breathe while secure within his tight casement, Nature has provided the queer creature with circular ventilating shafts formed by semicircular cuts on the joints of the claws and similar depressions in the next pair of legs. These appear as of no particular importance when the crab moves about, but when he withdraws within his shell the nicks in legs and claws come directly in line and form a perfect tubular shaft through which water flows freely to the gill-chambers. Neither are these remarkable crabs small inconspicuous creatures. On the contrary, they are one of the largest crabs known, sometimes weighing as much as eight pounds and measuring a foot or more across the rough spiny shell.

Can you imagine a bashful crab? For such boldly

audacious, pugilistic, courageous, and self-assertive creatures as the crabs, anything savoring of bashfulness would seem wholly out of place—utterly impossible. Yet there is a group of crabs, common on our more southerly shores and in tropical seas, who have earned the name of *Bashful crabs* because of their apparent self-consciousness and their dislike of being seen, and who invariably hide their faces when approached or disturbed. They are rather large crabs and quite conspicuous, with white or pale buff-colored shells streaked or mottled with red or purplish-pink. The body is quite high and rounded and is much wider at the rear than at the front.

But the most striking features of the *Calappa*, as scientists have named this crab, are the front legs and their claws. These are very broad and thin, and have a serrated crest, like the comb of a cock, along the upper edges. Crawling about upon the sandy bottom of the sea in shallow water, these crabs do not appear particularly remarkable, but the moment one of the queer fellows is touched or captured he shuts up like a trap, or rather like a box. Quickly drawing his legs beneath his body where each fits snugly into a little depression, he folds his front claws in front of his face, with the claw joints locking in perfectly and leaving only his eyes visible above the combs atop the claw doors. In this position the crab resembles some odd sea-shell more than a crustacean, and any one not "in the know" might easily mistake him for a dead and empty shell, especially as he allows himself to be rolled about by the currents and quite frequently is

carried ashore by the waves. But his tight boxlike shell protects him from being injured by any buffeting he may receive, and as soon as he feels that all danger is over he unfolds in most amazing manner and scurries back into the sea. In some places these crabs are called *Box crabs*, which is a most appropriate name, although personally I think that "bashful crab" is much better for when his claws are folded over his face the crab has every appearance of being bashful.

Although a great many species of crabs swim as readily as fishes, even these active creatures have their homes upon the bottom of the sea and take to swimming merely as a means of locomotion or to capture their prey. But there is one species of crab who never willingly visits the bottom of the sea and never voluntarily sets foot ashore. Throughout their lives these crabs voyage the oceans, true sailors, whose craft are the bits of floating sargassum or "gulfweed" or bits of wreckage drifting about on the surface of the sea. Owing to their abundance among the gulfweed they are known as *Gulfweed crabs* or *Sargassum crabs*, although sometimes called *Floating crabs*. Nature has fitted them perfectly for their wandering life, and through the countless ages that have passed since the remote ancestors of these crabs took to life on the ocean wave, their shells have become so similar to the sargassum weed in color that they are almost invisible when motionless.

Occasionally, after severe storms when great quantities of the weed have been washed ashore, thousands

of the crab voyagers will be thrown upon the shore with it and will become real castaways. At such times the poor things are most bewildered and utterly at a loss, quite as helpless as any human castaway washed ashore on some uninhabited island. Everything is new and strange to them. Beneath their feet is coarse rough sand or hard rock instead of the soft moist weed to which they are accustomed. On every side are countless creatures such as they have never seen before. They are beset by enemies new to them and from whom they cannot escape. Frightened, not understanding just what *has* occurred, the shipwrecked crabs run aimlessly about, now and then hurrying to the edge of the sea as if about to plunge in and swim away, yet hesitating to attempt such a perilous undertaking.

What ultimately becomes of these ten-legged castaways I cannot say. Many no doubt fall easy victims to the countless voracious inhabitants of the shore and to crab-eating birds. Perhaps a few may survive and adapt themselves to shore life. And undoubtedly a great many again put to sea, clinging fast to bits of weed or driftwood as the flotsam is carried from the land by the next high tide and offshore breeze. All I do know is that they completely disappear in a very short time. On one occasion, after a hard storm in the Bermuda Islands, I found hundreds of thousands of these sargassum crabs swarming upon the beaches where masses of the gulfweed had been washed ashore. Yet three days later not a single individual

could be found anywhere along the beach where they had fairly swarmed such a short time previously.

Interesting as these ever-voyaging crabs are, their greatest interest lies in the fact that had it not been for these crabs Columbus might never have discovered America. When his men became frightened and mutinous and demanded that he should turn back for Spain, Columbus called their attention to the hordes of crabs on a fragment of driftwood bobbing on the waves near the *Santa Maria*. Crabs, he reminded his sailors, were shore animals and never were found far out to sea, which proved land was near. This did much to quiet the sailors' fears and they agreed to sail a bit farther westward. Possibly Columbus, being a resourceful individual, was well aware of the crabs' habits but knew that his men were unfamiliar with them. But the chances are that he was as ignorant of the habits of the crabs as were the men.

Be that as it may, the little sargassum crabs played a most important and vital part in the epochal voyage and perhaps some day, some one with the monument mania may erect an imposing statue of a crab in commemoration of the incident.

Chapter XIV

CRABBED GARDENERS

WE human beings are very apt to underestimate the intelligence of other members of the animal kingdom. Being the most intelligent of creatures (or so we believe), we have become rather conceited and are accustomed to credit our species with being the only animals possessing true intellect and a capacity for reasoning. Scientists in particular are prone to deny the so-called lower animals the right to true intelligence. Although some scientific men do admit that man has no monopoly of intellectual behavior and intelligent activities, very few indeed will credit animals, other than *Homo sapiens*, with the power of reasoning. Why, I cannot for the life of me explain, for granted that man's intelligence and reasoning powers are in the brain, why should any creature with a brain be lacking in intelligence and reason? But when one of the "lower animals"—with the possible exception of the higher apes—exhibits some trait or characteristic or does something which savors of true intelligence and reasoning powers, it is regarded as a demonstration of "habit," "experience," "instinct," "heredity," "mimicry," or just pure coincidence.

But what after all do these terms mean? Where

may we draw a hard and fast line between instinct and intelligence, experience and reason? How much of our own boasted intelligence is not the direct result of hereditary instinct, or experience; the ability to put two and two together to make four, as we might say? Many of our most vital and most important "discoveries" have been the result of chance or accident and not of intelligent reasoning. Even the law of gravitation was discovered through an accident. So was the principle of the wheel, the arch, gunpowder, and countless other "great inventions." No savage ancestor of ours ever reasoned out that by rubbing two sticks together or by striking one stone against another he could produce fire. No cave-man ever reasoned that by taming wolves he could breed domestic animals that would become dogs.

No human being in the dim and distant past possessed the intelligence to reason that he could produce totally new and superior varieties of food plants by means of primitive agriculture. And it was not until we were driven by vital necessity during the World War that we "invented" camouflage as a means of protection. Yet millions of years before the first human being, or for that matter the first vertebrate animal, appeared on earth or in the sea, countless "lower" animals had discovered the use and value of mimicry or camouflage. And millions of years before the first vegetarian savage planted a seed or a tuber there were skilled gardeners among backboneless animals who do not even possess true brains.

Ants of many species, as for example the agri-

cultural ants of our Southwest, had "discovered" how to prepare ground, plant seeds, remove weeds, and harvest their crops. And many species of crabs had learned not only how to transplant vegetable growths, but also the value of artificially cultivated plants as a means of self-protection.

Many species of crabs have no need of greater protection than the means bestowed upon them by Nature. Clad in armor and carrying most powerful and efficient weapons of offense and defense, they are quite capable of taking care of themselves. And being active, swiftly moving creatures, they can "fight and run away" and thus "live to fight another day," or can avoid danger or superior foes by taking to their heels—or legs.

But there are certain crabs, popularly known as *Spider-crabs*, who lack these means of self-protection. Although they are long-legged fellows and one might assume that they can move swiftly if occasion arises, they are really very slow and deliberate in their motions, and quite incapable of outdistancing their enemies. Moreover, although their front legs are provided with pincers, these claws are designed primarily for picking up food rather than for fighting. Many species of these awkward long-legged spider-crabs are very retiring creatures and seek protection from fishes and other enemies by burying themselves in mud or sand or hiding in cracks and crevices in rocks or coral. Others make their lairs within sponges and only venture forth on foraging excursions when the coast seems clear. But many others live in the open

or among seaweeds, and these resort to most remarkable means to remain as inconspicuous as possible.

They are, in fact, true agriculturists, real crabbed gardeners, who plant and cultivate various sea plants, as well as plantlike marine animals, with as

Spider-crab planting weeds on its back

much care and often with even more skill than human gardeners. Moreover, these ten-legged agriculturists carry their farms about with them, for they use their own backs for their garden plots. Very possibly you may have seen spider-crabs whose shells were covered with seaweeds, hydroids, bryozoans and

other growths. The chances are that you gave the matter scarcely a thought, assuming, quite naturally, that the weeds had taken rootholds upon the crab's back and legs just as they would upon stones, rocks, or any other convenient objects. But in reality these growths had been planted by the crab itself. It is a most amazing and interesting experience to watch one of these crustaceans setting out his garden.

Searching about, he will select some certain seaweed or perhaps a hydroid and will carefully snip it off at the roots. Then, while holding it firmly in his claw, he will insert the end in his mouth as if about to eat the plant. But not he. He knows that in order to take root and thrive when transplanted to its new home the stem of the plant must be softened and frayed, so he chews it with his hard mandibles and at the same time coats it with a sticky gluelike secretion so when placed upon his back it will adhere firmly to the small stiff bristles covering his shell. When he feels that the plant stem has been thoroughly prepared he raises it in his claws, moves it about to just where he wants it, and presses the chewed, sticky end upon his back. How the strange gardener can determine exactly where he is setting out the plant, or how he knows it is in precisely the right position is a mystery, for the crab has no rear-vision mirror to guide him and he cannot see his own back even if his eyes are provided with stalks.

But he manages it somehow, perhaps by feeling or by judgment, and having fixed the first plant in place he seeks for another. One by one he gathers

the bits of growth and transplants them, until he is satisfied that his newly made garden contains enough cuttings to serve his purpose. This purpose, however, is not to provide a food supply and neither does he take the trouble to make a garden of his shell for ornamental purposes, but to serve as a screen to conceal his true character.

Covered with the weeds and other marine growths the crab is perfectly camouflaged when crawling slowly about among seaweeds, and while remaining motionless he appears merely a bit of stone overgrown with seaweeds, hydroids and corallines. It is surely wonderful that a crab should possess the intelligence or instinct—whichever we may call it—to transplant growths to his shell and transform himself to an animated portion of his surroundings. But even more remarkable is the fact that these crustaceans realize that if their back-borne gardens are to be of protective value they must not differ from the natural growths about them. If a spider-crab dwells where the seaweeds are green he invariably plants green weeds upon his person. If the bottom of the sea is overgrown with weeds and hydroids of mixed colors and kinds he is careful to select just the right number of each to harmonize with the natural growths. Never does he make the mistake of cultivating soft delicate seaweeds where corallines are the predominating growths or *vice versa.*

This is not a matter of chance, not because a certain class, color, or type of growths happens to be nearest at hand and more readily transplanted. The

crab actually seems to reason that if he carried a garden of red weeds upon his back, any hungry fish or other foe would spot him instantly among green, yellow, or brown growths; that he would stand out like the proverbial sore thumb if he dwelt among red or brown weeds while decked with green plants and that among corallines or sponges seaweeds would be likely to render him more conspicuous than otherwise. So if he decides to move from one spot to another where marine growths are of a different type from those upon his shell he adjusts his garden to suit conditions.

If a crab decked with green seaweeds and olive-colored hydroids is placed in an aquarium where red or yellow growths predominate, he will at once begin to uproot his back garden, tearing the plants off recklessly and will replace them with new cuttings selected from the growths about him. If the captive has been dwelling where soft broad-leafed weeds such as the sea-lettuce abounds, or where there are fine feathery weeds and ribbon-like growths, his back will undoubtedly be planted with these. But if he is placed among corallines or bryozoans, off will come the weeds and in a very short time the crab gardener will bear a thriving growth of the plantlike animals upon his back and legs.

Many species of spider-crabs whose homes are in localities where sponges abound, will use cuttings of these animals for their gardens. Very often one will see a good-sized sponge moving most astonishingly about as if it had developed legs. And upon investi-

gation a spider-crab will be found beneath it, the sponge rooted firmly to his shell. Frequently the sponge may grow so rapidly that it completely covers the crab's back and extends far out on all sides, thus forming a real sponge house for the crustacean. Sea-squirts or ascidians are also added to the crabs' portable gardens at times, while some species of spider-crabs inhabit sandy or pebbly areas and hence would be most conspicuous if covered over with weeds, sponges, or similar growths. So these fellows transform themselves into a bit of the sea bottom in much the same manner as the crabbed gardeners conceal their true identities.

Instead of planting weeds or other living things upon their shells, these crabs cover their backs with pebbles, bits of broken shell and coral, and other debris. How they ever succeed in making these objects stay put is a puzzle, for they cannot chew the end of a pebble and, as far as is known, they do not stick the stones and other things in place by means of a saliva glue. It is no easy task, for a crab often tries again and again to fix a bit of stone or a rounded pebble in place before he finally succeeds. But patience and perseverance overcome all difficulties, the old adage assures us, and these spider-crabs possess an abundance of both. Eventually the little fellows wedge or balance the various objects between the knobs and spines upon their shells, and thus counterfeiting a portion of the ocean's floor, they escape many a hungry fish and other enemy.

Crabs, however, are not the only sea creatures who

are marine gardeners. Certain worms even outdo the spider-crabs in this respect, for instead of growing plants upon their backs they have their gardens within their bodies. Moreover, their gardens not only serve to conceal the creatures, but in addition they furnish the worms with food. But it must be admitted that these worms do not do their gardening intentionally, for the plant growths are forced upon them.

The *Convolutas*, as these strange sea-worms are called, inhabit the temperate seas and are particularly abundant on the coast of France, especially along the sandy shores of Brittany. When young the worms feed upon other animals and plants like other marine worms, but while consuming these foods they swallow numerous one-celled green plants which float about in the water. Instead of being digested, these single-celled plants thrive in the stomachs and intestines of the worms and increase in numbers until the Convolutas become wholly green, thus becoming completely camouflaged. Then a most remarkable change takes place in the worms' lives. The plants within their bodies secure their sustenance from the waste material within their involuntary hosts, and in return for their accommodations they produce food to supply the worms. So abundant is this plant-made food that the Convolutas abandon all their former habits of dining and depend entirely upon the plants to provide them with food.

It seems most remarkable to find a marine worm furnishing living-quarters for plant tenants who pay their rent in the form of food for their landlords.

But there are other sea creatures who have even more wonderful habits, for they form true business partnerships, or perhaps better, mutual benefit associations, with other creatures of totally different orders.

Chapter XV

STRANGE INFANTS

WHENEVER you bathe in the sea and accidentally swallow a mouthful of salt-water you devour hundreds, or maybe thousands, of tiny creatures. For that matter many are not so very tiny, but are quite sizable, half an inch or even an inch or more in length, for even if the water appears perfectly clear it teems with life.

The majority of these unsuspected inhabitants of the sea are very minute and practically invisible to the naked eye, but many of the larger animals are so transparent that it is almost impossible to detect them even in a bucket of sea water. But if you agitate the pail of seemingly lifeless water at night it will flash and gleam and glow like liquid fire, for most of the little creatures it holds are highly phosphorescent.

And if you place some of the water in a glass dish resting on black paper or some other black surface, you will be mightily surprised to find what a host of queer creatures it contains. Some are plainly visible to the unaided eye, others must be viewed through a lens of a good reading-glass, while countless others will be revealed by using a low-power microscope.

Perhaps, as we examine the water, we will see two black specks moving swiftly this way and that, trailing a slender, twisted, dark-colored thread behind them. Then, if we look closely, we will discover a wraithlike outline surrounding the odd things, and to our astonishment will find they are the eyes and intestine of a slender shrimp as transparent as glass. We see little patches of yellowish-brown and threads of green moving by spasmodic jerks through the water and find that they are the internal organs of another crustacean whose body is practically invisible.

But what is this queer chap swimming gaily about? Each side of his minute, translucent, bluish body is provided with a broad, transparent, oval wing, fringed with countless tiny hairs which are ceaselessly in motion. You would never even suspect that this creature is the larval form of a sea-snail, but that is just what it is. But how about this other weird atom traveling swiftly here, there, and everywhere? One moment it is almost globular in form, the next instant it is egg-shaped. Its internal organs are faintly visible as fine grayish or bluish lines and dots; there is a tiny dark-colored spot on one side—or is it on the top or bottom of the restless creature?—and at one end of the body there is a circle of long, slender, rapidly vibrating hairs.

A person not in the know might make many a guess as to the identity of this odd mite without hitting upon the correct answer, for this is an infant oyster. It seems strange to see a young oyster swimming freely about in the water propelled by the vibrating

hairs or cilia, and so very different from its parents in appearance. But the youngster's freedom will not last long. In a few days, if left to itself, it will dive to the bottom of the water, attach itself to some convenient object and very quickly will develop a hard shell and become transformed into a "set" as the oystermen call these "seed" oysters.

But don't expect this next minute creature to develop into a clam or any other bivalve. At first sight it appears very similar to the infantile oyster, for it has similar swimming hairs at one extremity, its body is more or less the same form although rather more cup-shaped, and its entire body is fringed with little hairs with others visible in its interior. In a very short time this tiny creature would also descend to the bottom of the sea were it given its freedom. But instead of attaching itself to a rock or a dead sea-shell or some other solid object, this queer infant would burrow into the mud and in time would develop into a handsome marine worm with a gorgeous corona of brilliantly colored tentacles waving above its head.

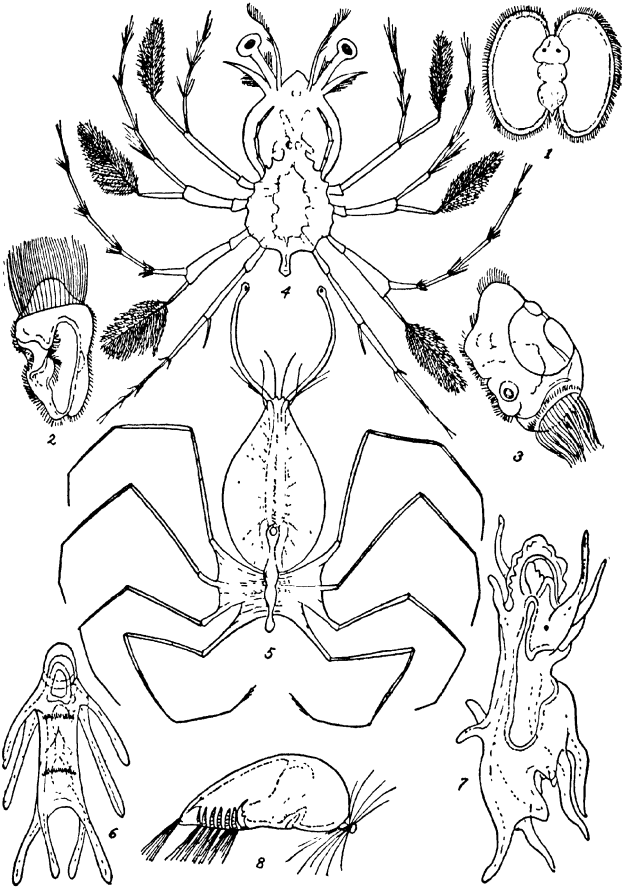
What, you want to know, are these remarkable little creatures all crowding to one side of the dish, struggling, pushing, and milling like a flock of almost microscopic sheep? In form they resemble capsized boats. Near the "stern" are tufts of swimming hairs resembling banks of oars. At the "bow" is a single tiny speck of an eye. Faintly outlined in translucent gray is a transparent shell, and visible through the gelatinous body are three pairs of minute legs. A scientist would tell us that this is a *Nauplius*, which

has no connection with nautilus, even if the two words are somewhat similar. But what is a nauplius?

If we watch these odd creatures for a few days we will learn the answer and will also witness one of the most interesting events that take place in the world of wonder creatures of the sea.

Very soon the little nauplii will wriggle out of their skins and will appear in a new guise. They will have two eyes, two shells, and they will now have six pairs of legs, while a number of threadlike antennæ extend from a short "nose" or stem at the forward end. Having thus been transformed, the queer creatures swim to the bottom of the sea, and after searching about until they find suitable locations for their permanent homes, each attaches its head to the rock or other object by means of the sucker-like antennæ. Then, to make certain of remaining securely anchored, they secrete a cement-like substance which fastens them as firmly as though a portion of the rock itself. This accomplished, the creatures once more shed their skins when, wonder of wonders, the free-swimming transparent creatures reveal their true identity at last. They are barnacles!

One famous scientist once remarked that a barnacle was "a crustacean holding on by its nose and kicking food into its mouth." That is as excellent and as accurate a description of the creatures as he could have given by pages of scientific terms. And we have only to watch the metamorphosis of a nauplius to a full-fledged barnacle to appreciate the accuracy of the naturalist's half-humorous definition.



Strange infants

1. A baby shell
2. Young marine worm
3. Young oyster
4. A "glass crab"
5. Infantile spiny lobster
6. Baby sea-urchin
7. Young starfish
8. Baby barnacle

Of course we cannot follow these queer infants through their cycle from babyhood to barnaclehood when they are confined to a dish of water. And we have not yet seen and identified a fraction of the numerous other infant sea creatures.

Here is one who certainly is a weird-looking beastie. It is long and rather slender, with a broad, rounded front end, and has four long gelatinous legs on either side. Within its almost transparent body are various internal organs, but there is no trace of eyes or of vibrating swimming hairs. No one but a scientist familiar with the larval forms of common sea creatures would ever suspect the parenthood of this tiny animal, nor would any one but a naturalist recognize this other freaky-looking creature with its writhing legs or arms or tentacles or whatever they may be. But a scientist familiar with marine life would instantly recognize the first individual as a baby sea-urchin and the other as a young starfish.

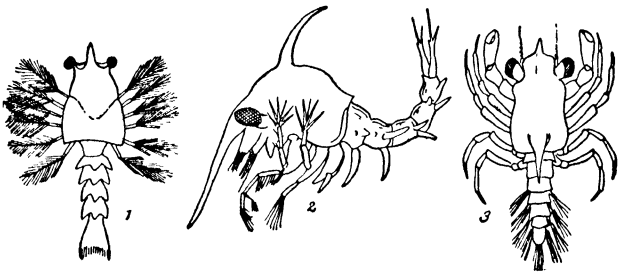
"Ah ha!" you exclaim triumphantly as you catch sight of still another denizen of the dish of water. "Here is one creature I know. It's a shrimp."

The little fellow you indicate does look like a shrimp of some kind, for it has a pointed head with big dark-colored eyes, an abdomen made up of several rings or segments, a well-developed tail, and ten legs tufted with feathery hairs. But you are wrong in your identification of the creature, for instead of a shrimp, this chap is an infant lobster.

"Then this must be a lobster also," you declare, as another ten-legged miniature crustacean swims into

view. It does look like a baby lobster to be sure, for it has big eyes on stalks, a large thorax or shell, a jointed abdomen and pincer claws on its forward legs. But you are wrong again, for this lobsterish youngster will develop into a crab if he lives long enough to grow up.

To scientists, crabs in this stage of their childhood are known as *Megalops*, a name bestowed upon them



More youngsters

1. Young lobster
2. Baby crab, "Megalops" stage
3. Young crab

when naturalists thought that they were a distinct class of crustaceans. In the same way the infant barnacles were christened nauplius, while to make it all the more confusing another stage in the life of the young crabs was called *Zoea*. We can scarcely blame the zoölogists of former times for thinking these queer creatures were distinct species, for there is as little resemblance between a Zoea and a Megalops as there is between a barnacle and a nauplius.

In all probability there will be a few of the Zoeas in our dish of water, and what strange, fantastic things they are! No fossil monster, no dinosaur of millions of years ago was more remarkable in its make-up. With its big body and attenuated slender abdomen the Zoea gives the effect of having lost a goodly portion of its anatomy, while its spiked tail, which is carried "cocked up" in a vertical position, gives the creature a perky alert appearance which is enhanced by its huge black eyes. Its legs are weak and are tipped with bristles and seem to be forever getting in one another's way as the little freak swims about. But its most striking and distinctive features are a long curved sharp-pointed horn rising high above the Zoea's back, and an even longer pointed "beak" extending downward from the forehead, so that its head reminds one of a miniature elephant with goggle eyes and a rhinoceros horn. Who would ever dream that this bizarre creature would shed its skin and become transformed into the lobster-like Megalops?

If you happen to be in Florida, the West Indies, or some other tropical or semitropical spot, or if you dip up the water from the Gulf Stream or even along the New England coast during the warm summer months, you may find some most remarkable creatures among the horde of infant oysters, crabs, sea-snails, barnacles, lobsters, and what not.

Weird in form, with leaflike bodies that appear to be made of the finest lace or built up from countless snow crystals, they are truly beautiful things. Most

appropriately they are called *Glass crabs* by the fishermen of England's coasts where they are very plentiful. Not only do their semitransparent bodies resemble spun glass, but they also have extremely long, slender legs that might well be composed of delicate glass tubes, while their eyes are at the tips of glass-like stems.

Even their own mothers would never recognize these infants, for they are the young of the big spiny lobsters or sea-crawfish, and the flat lobsters or sea-cockroaches (*see* Chapter XI).

When we compare these strange crystalline creatures with the hard-shelled, heavy-bodied, spiny crustaceans dwelling among the coral reefs, we can well understand why no one, not even scientists, realized they were one and the same until quite recently. Abundant as are the sea-crawfish in nearly all tropical and semitropical seas, yet a deep mystery surrounded their breeding habits and their young, until some one discovered that the infants of the spiny lobsters are the well-known glass crabs.

Chapter XVI

QUEER CHUMS

Of all sea creatures, the sea-anemones seem to be most addicted to forming partnerships with other animals. Perhaps it is the other way about, the anemones' pals taking the initiative. But regardless of which member of the firm first realizes the benefits which will result from forming a merger, the fact remains that the flower-like anemones believe thoroughly in coöperation and become intimate chums of other creatures of various kinds and of totally different groups of the animal kingdom. They or their pals learned ages ago that under certain conditions two could live as cheaply as one, and that mutual benefits resulted from a combination of talents and habits.

Among the commonest partners of the sea-anemones are the hermit-crabs. Probably the first hermit to acquire an anemone chum did so by accident rather than by design when the crab took possession of an empty shell with an anemone growing upon it. Being quite impervious to the nettle-like stings of the dweller on his housetop, the hermit had no reason to remove the bright-hued squatter, and he may have rather fancied the decorative effect of a living flower-garden on his roof. As crabs are very

intelligent creatures, the hermit doubtless realized that his comrade served a useful as well as ornamental purpose by keeping enemies at a safe distance—a sort of danger signal, as it were. On its part, the anemone may have resented being trundled about hither and yon regardless of its own ideas of touring, but finding its efforts to injure its abductor futile (assuming of course that a sea-anemone possesses brains or a glimmer of sense or reason), it was forced to make the best of the situation. In other words, the anemone was in much the same situation as a person who, seeing a friend off on a liner, fails to heed the "all ashore" warning and finds himself an involuntary passenger outward bound for foreign ports.

Very soon the anemone upon the crab's shell would have discovered that there were decided advantages in being carried from place to place without effort. Far more prey came within reach of its lasso-cells than when it had remained in a more or less fixed spot, and in addition there were the crumbs from the hermit's table. Crabs are sloppy eaters and as the hermit dined many a particle of food floated within reach of the anemone's tentacles. As a result of all this, the two strangely assorted creatures became fast friends, and when moving day came around and the crab was compelled to seek new and larger quarters, he couldn't dream of abandoning his anemone pal so he carefully removed the creature from the deserted house and transplanted it upon the new domicile.

Scientists assure us that an acquired characteristic cannot be inherited, but it is easier to believe that the hermit-crab's offspring inherited the acquired characteristic of having an anemone for a partner than it is to believe that the hermit publicized the advantages of such an arrangement. But irrespective of how it happened, whether by reasoning, by instinct, by heredity or by example, the fact remains that from time immemorial, ever since human beings have observed inhabitants of the sea, and for ages previously, certain species of hermit-crabs and certain species of sea-anemones have always been inseparable companions, both figuratively and literally speaking.

Some species of hermits are not at all particular as to the anemones they select as chums, and transplant various species to the surfaces of their shell houses. But there are others who insist upon one certain species of sea-anemone as a partner, and whose shells invariably bear one or more of these creatures. Moreover, and most remarkable of all, there are species of sea-anemones which have never been found anywhere other than on shells occupied by certain species of hermit-crabs.

One of these exclusive chums of the hermits reverses the usual order of things and instead of flaunting its tentacles from the top of the house, it grows on the door-sill where its tentacles can reach the crab's mouth and share the latter's meals with him.

Perhaps it was mere chance, or perhaps it was the result of intellect on the part of the crab and his

ability to put two and two together to make four, as we might say, which caused certain species of hermits to plant their anemone chums on their big claws instead of on their shell houses. But whether through accident or design, there are hermit-crabs who habitually carry a large sea-anemone attached to the outer surface of the large claw where it serves a very useful purpose, for when the hermit withdraws into its shell and uses its claw for a door the anemone guards the portal as efficiently as any savage watch-dog.

This may seem a most remarkable partnership, but there are crabs inhabiting the Pacific Ocean who go even farther. These fellows, who are related to our spider-crabs, carry a sea-anemone on each claw where they serve as efficient weapons—stinging boxing-gloves or "brass knuckles," as we might say.

Of course all of these crab chums of the anemones are forced to transplant their partners each time they shed their skins or move into new shells. Although they accomplish the delicate task without injuring the anemones—and if you think this a simple matter, just try to lift an anemone from the rock on which it is fixed—yet it is quite a task at best.

But there are species of hermit-crabs who are never compelled to do this. No matter how rapidly they may grow, regardless of how often they molt, they never have to find new shells and their anemone pals are always with them. Here indeed is a real mutual benefit association, for the anemone placed upon the crab's first shell house dissolves and ab-

sorbs the shell and forms a horny cavity in its base to accommodate the crab's body. Moreover, as the crab grows, the anemone increases the dimensions of its hollow base to suit, thus relieving its crab chum of all moving-day problems. Quite a number of anemone-hermit-crab partnerships are conducted in this way.

Queer chums

1. Hermit-crab with sea-anemone house
2. Hermit-crab with sea-anemone on its shell
3. Hermit-crab with a sponge home

In European waters the *Velvet-cloak anemone* always builds the house for its crab tenant, and in the deeper waters off our Atlantic coast there is a scarlet sea-anemone which is always found serving as a living domicile for certain species of hermit-crabs.

Crabs, however, are not the only chums of the sea-anemones. Several species of shrimplike crustaceans are most intimate friends of the anemones for they

actually dwell within the stomachs of their pals. It is not by accident that they play the part of miniature Jonahs for they are colored like their hosts. Neither do the anemones resent the presence of these dwellers in their tummies. Perhaps they rather enjoy the tickling sensation caused by the lively little occupants of their innards, or it may be that the shrimp relieves indigestion by consuming the surplus of stomach contents resulting from the anemone dining not wisely but too well.

It is strange indeed for a crustacean to be at home in an anemone's stomach, but much more astonishing that numerous fishes should have the same habit. On the Great Barrier Reef of Australia there is a species of giant sea-anemone whose stomach affords shelter for numerous bright-colored coral fishes who swim in and out of their strange friend's mouth without molestation, although the huge anemone customarily dines on fish which it stings into helplessness. Although these butterfly-like fishes merely "drop in" on the anemones for an occasional visit, and when close-pressed by a foe seek refuge in their tentacled friends' interior arrangements, there are other fish who make the anemones their permanent homes.

These fish are known as *Fierasfers* and are always found associated with certain sea-anemones, while some species are chums of the sea-cucumbers or holothurians. Very rarely do they venture far from their hosts, and at the first sign of danger dash into the

mouths of the anemones or holothurians where they are perfectly safe.

It is rather difficult to understand where any mutual benefits arise from these remarkable associations. The fish of course have a safe retreat and they pick up an easy living on fragments of food dropped by the anemones. But aside from what food the anemones and sea-cucumbers may secure when the fish dine, they would appear to derive no material advantages from their finny friends' intimate relationship.

It is as much a puzzle as why a sea-anemone and the glass-rope sponge of Japan should be inseparable companions. In this particular case all we know is that there is a large species of sea-anemone which has never been found except when adhering to the sponge, and that the sponges are very rarely or never found without the anemones. So invariable is this strange association that for a great many years the long tassel of glasslike threads forming the roots of the sponge was supposed to be those of the sea-anemone which often covers the greater portion of the sponge proper.

The beautiful Venus's flower-basket sponge also has its chums. In this case, however, the sponge's partners are little shrimps, who benefit by dwelling in such safe apartments as are the chambers of the sponge, while the sponge is repaid for its hospitality by the fragments of food dropped by the crustaceans. So universal is this sponge-shrimp partnership that it is practically impossible to find a Venus's flower-

basket which does not contain the dried bodies of one or more of its defunct tenants.

Sponges of many kinds have their particular pals, for like the sea-anemones, they possess stinging organs and are avoided by fishes and other predatory sea creatures and hence afford protection to their friends as I have said. Many species of crabs plant sponges upon their backs where they serve the dual purpose of a camouflage and an armed guard. When actually planted upon the crab's back it becomes necessary for the latter to transplant the sponges when he changes his skin. But there are a number of crabs who overcome this difficulty by carrying a detached sponge about with them, holding it in place by means of the rear legs which are designed especially for the purpose. Very frequently these sponge protectors grow so large that they are many times the size of the crab who is completely concealed by them and occupies a cavernous recess formed about him by his burden.

Certain hermit-crabs also have sponges for their partners. These are most beneficial, for the hermits select brilliant red or orange sponges, thus flaunting conspicuous danger signals and a warning to keep off, while the sponges dissolve the shell on which they are planted and thereafter the hermit is never compelled to change his residence.

Crabs appear to be particularly fond of having close friends, and some species carry their friendliness to the extreme and take up their abodes within their pals' homes, sharing their bed and board and

depriving them of all privacy. Such is the *Pea crab* or *Oyster crab* often found in oysters, especially those from Chesapeake Bay. Although the males of these little crabs live quite normal humdrum lives and never dream of intruding upon a bivalve, the females cannot survive unless snugly ensconced between the shells of a living oyster or mussel. For so many generations have the female oyster crabs been "mooching" accommodations from the oysters that their shells have become soft and membranous through lack of need for protection, while their legs, being of no particular service within the bivalve's shell, have become atrophied, weak, and almost useless.

This is still another instance of what appears to be a very one-sided sort of arrangement, for while the timid little female crab may find snug and safe quarters by forcing herself upon the oyster, the oyster would seem to derive no benefit from her presence. It is much the same in the case of the marine worm who dwells in the attic of the hermit-crab's shell or the scale-worm who makes its home in the arm of a starfish, as I have described in Chapter III.

No doubt there is some reason for these partnerships, even if they are puzzles to us, for unless there were a spirit of reciprocity, and mutual advantages resulted from the association, the firm would soon be dissolved by the member who received nothing in return for what it rendered the other. There are cases, however, where it is very obvious that regardless of the feelings of one of the partners, nothing

can be done about it. Nature has doomed the creature to remain a helpless as well as a silent partner, as in the case of the Gorgonias or sea-fans and sea-rods. If we examine these carefully we will be almost certain to discover numerous shells clinging tightly to the stems and branches. Slender, elongated, perfectly stream-lined in form, these shells exactly match the color of the Gorgonia which they select as their host. Even the same species will be yellow on a yellow sea-fan, lavender on a lavender Gorgonia, or black, purple, carmine, or brown, if on Gorgonias of these colors. So perfectly do their forms and colors blend with the animals on which they live that numbers may be attached to a single sea-fan and yet remain undetected, hence it is very obvious that the shells are safeguarded by a perfect camouflage although the Gorgonia may receive no recompense from the shells.

Even the deadly Portuguese man-of-war has its pals, although we would suppose that every sensible and sane inhabitant of the seas would give the colorful creature a wide berth. Yet several kinds of fishes have no fear of the terrible stinging tentacles but actually live among them. The best-known of these shock-proof fishes is the *Pastor fish* or *Portuguese man-of-war* fish, as it is also called owing to its close association with the floating colony of hydroids. To this fish the mass of streaming, writhing, poisonous tentacles is a delightful bower wherein he is safe from foes. Of course the pastor fish benefits by this habit, for surrounded by the stinging tentacles he is as safe as if ensconced behind electrically charged wires. But

does the man-of-war gain anything by involuntarily acting as a guardian for the fish? Possibly the eating units of the strange marine communism may secure morsels of food dropped by the fish as it devours its prey, but the chances are that the Portuguese man-of-war has no voice in the matter. Nature has provided the pastor fish with a thick coating of slime which is impervious to the stinging cells of the man-of-war, so even if the creature tried to injure the fish its efforts would be in vain.

Many of the true jellyfishes also serve as refuges for fish, and as many as one hundred small fish have been found dwelling within the body cavity of a large jellyfish. Another big jellyfish with powerful stinging tentacles serves as a shelter for young horse-mackerel, and it is practically impossible to find a specimen floating on the surface of the sea that does not hide half a dozen or more fish.

All of these queer chums, with fully as many more which I have not mentioned, are most interesting and strange, but perhaps the most interesting and strangest of these partnerships is that existing between a sea-shell and a shrimp.

The shell is a lovely purple mollusk known as the *Ianthina*, a delicate fragile snail-like shell with most remarkable habits. Unlike other shells which crawl about, the Ianthina is a true sailor and navigates the ocean by means of a float or raft composed of innumerable air bubbles confined by sticky mucus excreted by the strange shell. Clinging to one end of its pontoon raft, with its head and tentacles thrust from

the purple cabin, the Ianthina drifts about on tropical seas, sometimes voyaging as far north as New England as the Gulf Stream current carries the rafts with it.

Handsome as the sailor-shell is, the Ianthina is a merciless blood-thirsty creature, a real pirate whose prey are the jellyfishes. In every respect it is a most remarkable and interesting creature and it has a companion as interesting and unusual as itself, for the purple mariner carries a crew, or possibly it is a passenger, upon its raft. This other voyager is a queer shrimplike crustacean who has never been seen alive except when occupying the deck of the Ianthina's pontoon-supported vessel. Evidently he was intended by Nature to accompany the pirate-shell on its cruises, for he is clad in a uniform of exactly the same shade of purplish-blue or violet as that of the shell.

Just what purpose the crustacean may serve is a mystery yet unsolved. Perhaps he is merely a friend of the Ianthina, a traveling companion on the shell's long voyages. But on the other hand he may serve a very useful purpose. The Ianthina is blind—not in one eye like the typical pirate of fiction, but totally blind, for it lacks eyes. So possibly the shrimp-crew of the raft serves as a lookout and, scanning the surface of the sea, notifies the shell-skipper when the gaily tinted sail of a Portuguese man-of-war heaves in sight, for like a true pirate the Ianthina regards all jellyfishes as its prey and boards and butchers

them without mercy. And doubtless, like all good pirates, it shares its loot with its crew of one and the shrimp gets its "lay" in the form of rations when a jellyfish is taken.

Chapter XVII

THE OLDEST INHABITANTS

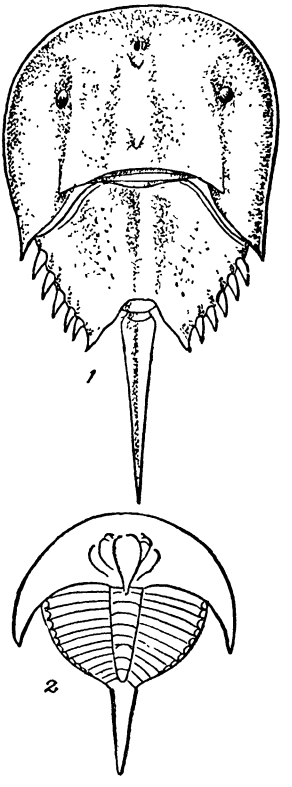
IN a great many localities the most conspicuous creatures washed ashore by the waves or left stranded by the tides are the so-called *King-crabs*, *Horsefoot-crabs*, or *Horseshoe-crabs*. Strange-looking things that they are, they invariably attract attention and usually arouse interest and curiosity, especially in the minds of persons unfamiliar with marine animals.

And if persons accustomed to finding the horsefoot-crabs scattered about the beaches knew more about the creatures or realized what truly remarkable things they are, they would be far more interested in them. But very few persons, other than naturalists, know anything about the lives, habits, or other strange and interesting features of these familiar denizens of the sea. Comparatively few even know that the majority of the horsefoot-crabs stranded on the beaches are merely the empty shells, the cast-off skins of the creatures, and that only now and then do we find a living individual above low-water mark. But if we examine these shells we will find a slit or opening along the forward margin where the former occupant crawled out of its old suit when it became too small to be comfortable, for

horsefoot-crabs shed their skins frequently, and like crabs and lobsters emerge in the "shedder" or soft-shelled state.

When we speak of these creatures as horsefoot or king "crabs," we are really making a great mistake, for they are not crabs, not even crustaceans for that matter, but are much more closely related to the spiders, their nearest living relatives being the scorpions or the whip-scorpions. This may seem very strange, for surely, you think, the horsefoot-crabs are far more like crabs than like scorpions. But if you compare the two you will find that feature by feature there is a much closer similarity between scorpions and horsefoot-crabs than between the horsefoot-crabs and other crabs.

Both scorpions and horsefoot-crabs have pincer-like claws on the front legs, both have eyes set in the head instead of on stalks like those of true crabs, and—no doubt you will be surprised by this discovery—the horsefoot-crab has a third eye in the center of its forehead. Neither do any self-respecting crabs or other crustaceans possess such a tail as that which the horsefoot-crab can boast. But the whip-scorpion has a very similar spike tail, while the common scorpion has a horny spike on the tip of its abdomen, although it is curved and forms a wicked-looking poisonous sting. All these similarities are external, however, and scientists depend largely upon the internal anatomy of a creature in order to classify it. And they all agree that in many respects the remarkable horsefoot-crab, or *Limulus*, to give it its



1. *A king- or horsefoot-crab*
2. *A fossil ancestor of the king-crab*

proper name, has little real resemblance to any living creature and that the animals most closely allied to it became extinct millions of years ago and are found only as fossils.

As a result, scientists have given these creatures not only an order all their own, but have put them in a class by themselves, although there are only two species found anywhere in the world, one being American, the other Asiatic. Of course this is a great distinction, but the horseshoe-crabs have the even greater distinction of being the oldest inhabitants, the last surviving representatives of a long-vanished race, real left-overs from the remote past.

Every one knows the purpose of the scorpion's tail, but why, you may wonder, should queer old Limulus be given such a strong, long, sharp tail which is not poisonous or even dangerous? Just turn one of the creatures upon its back and you will find the answer. Moving its tail far to one side the animal will force the tip into the sand and, using it like a crowbar or lever, will flop himself right side up in no time.

In their natural haunts, just below low-water mark, the horsefoot-crabs or Limuli, whichever is preferred, live a very easy uneventful existence. Pushing their broad heads into the mud they root and wallow like so many pigs, grubbing for worms which form their diet, and often remaining motionless for hours at a time. Although ordinarily they move slowly and very deliberately, gliding over the bottom as if their tanklike shells concealed caterpillar tractors, they become quite frisky after nightfall. Although incapable of really swimming, yet they manage to travel through the water by a series of spurts of jumps. Raising themselves on the tips of their long strong tails they kick themselves upward

and forward by a quick jerk of the tail, and paddle furiously for a short distance, gradually sinking until they rest upon the bottom, when they repeat the performance.

Unlike true crustaceans, these strange animals lay their eggs on land and during the breeding season hundreds of the clumsy creatures crawl from the water like so many sea-turtles. The eggs are deposited in little hollows excavated by the females and are abandoned to their fate. But it would not be true to form if the eggs and the baby Limuli followed ordinary rules. As the embryos develop, the eggs become transparent and presently, blown from the sand by the wind, they go rolling about like so many glass balls, each with a tiny infant Limulus curled up inside and plainly visible through the transparent shell.

When they finally emerge from their crystal-like spheres, the young horsefoot-crabs are queer-looking youngsters, for while obviously horsefoot-crabs, yet they lack all traces of their parents' long and useful tails which do not appear until after the first molt.

Although we never think of dining on these strange inhabitants of our shores, yet Limulus is excellent eating—that is, what meat there is within the shell is excellent—and many who have tried it insist that the flesh is even better than that of the lobster.

But the only commercial use to which the horsefoot-crabs have been put is to serve as fertilizer. Millions of the creatures have been taken and destroyed for this purpose, and in many localities where they were once exceedingly abundant they are now almost

extinct. It really does seem a great pity and a shame that these last survivors of prehistoric creatures should be threatened with extermination, and that such distinguished members of the marine world should be put to such an ignominious use.

Being the only representatives of a most ancient lineage and boasting the distinction of being so ultra-exclusive that they have a genus, an order, and a family of their own, they may well be called king-crabs. And it is scarcely surprising to learn that they actually have blue blood.

Chapter XVIII

CREATURES OF THE DEEP SEA

ALL of the wonder creatures I have described in the foregoing chapters are inhabitants of shores or shoal waters, with the exception of a few mentioned briefly for comparison. But what about those whose homes are the abysmal depths of the sea, thousands of fathoms below the surface? Surely if there are so many strange and remarkable forms of animal life to be found along the shores and in shallow water, there must be far stranger and far more remarkable animals in the depths of the oceans.

But if we assume this to be the case, we will be disappointed, for aside from the bizarre and amazing deep-sea fishes, and the equally weird members of the squid and octopus group, the creatures dwelling miles beneath the surface of the sea are not so very unusual. Some, to be sure, have forms very different from those of their shallow-water relatives. Many possess far more powerful illuminating devices, for in their world of eternal blackness every inhabitant must light its own way. But as far as we know, the habits of these deep-sea animals are very similar to those of their more familiar cousins, and with few exceptions the members of each group or class or order are easily recognizable.

A deep-sea shrimp may be quite different from any crustacean living in shoal water or along the shores, but it is unmistakably a shrimp, as obviously a shrimp as though it had been caught on one of our own beaches. A sea-shell from the black depths may differ greatly from any sea-shell we have ever before seen, yet we would have no trouble in identifying it as a bivalve or a gastropod as the case might be. Moreover, the variety of life in the ocean's depths is not so great as in shallow water, for many groups are wholly lacking, as far as is known, even if the total number of individuals equals that of shallow waters. This of course is to be expected if we stop to give the matter due consideration, for many forms of marine life are wholly dependent upon certain plants for their existence and plant life is non-existent and impossible at extreme depths where no trace of sunlight penetrates. Yet all living creatures must have plants in one form or another, and Mother Nature has provided a way for the animal inhabitants of that plantless home to obtain the vegetable material essential to their existence.

At the surface of the ocean and for many fathoms beneath, plant life abounds. To be sure, little is visible to our poor eyes, for aside from the floating sargassum and other drifting algæ the oceanic plants are minute, often microscopic things. But small as they are, these millions of plants afford food for millions of animals.

Many of these creatures descend to greater depths where they fall victims to voracious denizens of the

zone where there are no plants. These in turn are devoured by the inhabitants of still greater depths, and thus, by the transmission of chemicals through a series of bodies eaten and re-eaten, even the creatures at the greatest depths secure the essentials contained in plants, although without a single exception every denizen of the great depths must by force of circumstances be carnivorous.

Another astonishing feature of deep-sea animals is that so many of them possess well developed and often enormous eyes. As they dwell where there is no trace of daylight, where the darkness is practically absolute, we would suppose that eyes would be useless—mere superfluities. But we must remember that nearly all deep-sea animals carry lights or are phosphorescent, and hence are quite visible. So eyes are highly important organs both for observing the approach of enemies and "spotting" prey.

A further strange and surprising feature of deep-sea life is that such a large proportion of the animals are brightly colored, for in a world dimly illuminated by phosphorescent creatures it would seem as if colors were of no importance. Yet not only are the deep-sea animals variously colored, but there are regular more or less well defined areas of color in the sea.

At and near the surface the various creatures are mainly blue, silvery, iridescent or green. At a considerable depth below this, the inhabitants of the area, dimly lit by sunshine filtering down from above, are transparent or pale pink, yellowish, faintly bluish-gray, or greenish. But instead of finding the animals

more and more lacking in color as we descend, we discover that they reverse the process and become darker and more colorful, and below half a mile from the surface many of the inhabitants of this midnight area are vivid scarlet, intense crimson, or deep black.

Now let us see what manner of creatures these are who dwell here in the ocean's depths. As I have said, the fishes predominate. Of course we could not expect to find corals, Gorgonias, or even sea-anemones, for all these creatures require solid foundations, or at least solid objects upon which to take up their abode, and in the deeper portions of the sea there is nothing solid resting upon the bottom. Strictly speaking there is no bottom, for the floor of the ocean, if floor it may be called, consists of bottomless ooze, a soft, almost gelatinous mass composed of trillions of trillions of dead creatures who have died and sunk to the bottom. Nothing solid can rest upon this unstable mass. Anything having weight would sink out of sight instantly as if swallowed by a quicksand.

So we cannot expect to find sand-dollars, sea-urchins, starfishes, sea-cucumbers, sea-squirts, or even sponges on the ocean floor. But there are marine worms, hordes of them, for worms do not necessarily require solid matter in which to burrow, and the deep-sea worms have adapted themselves to conditions and swim about, some kinds, such as the *Arrow worms*, darting hither and thither with amazing speed as they chase their prey. We would scarcely expect to find shells in this strange undersea world, yet they are abundant. But unlike the sea-shells to which we are

accustomed, these deep-sea mollusks have shells as thin and light as cellophane, and many even carry bubbles of gas within their shells, thus transforming themselves to submarine balloons floating about as light as feathers in the water. In addition, a number have developed powerful fins with which to propel themselves through the sea, moving in a series of jerky undulations as they flap their winglike appendages.

But by all odds the most numerous of these deep-sea creatures, other than the fishes and squids, are the crustaceans. Among these are countless shrimps, many brilliantly colored with scarlet, golden-yellow, or purple. Some are tiny creatures, while others are large enough to be classed as prawns. Among them are species very similar to our everyday shrimps of shallow water, but there are others of weird, strange forms; hunchbacked or bent at right angles, long and slender, with spearlike heads or spiked tails, while many have enormously developed antennæ several times as long as the bodies.

Far outnumbering these shrimps are the *Copepods* some of which were among the host of odd creatures Dave the diver found so interesting (*see* Chapter X). Every color of the spectrum and every possible combination of colors may be found among these swarming little crustaceans. And their forms are as varied as their hues. Many are equipped with a confusing array of feathery feelers and other appendages; some resemble cockroaches or other insects familiar to us;

some are blind, others have well developed eyes, while still more are true Cyclops with a single eye.

Living as they do where there is no chance of crawling about, these queer little crustaceans have become swimmers and rowers with many different devices for self-propulsion. Some swim in quite an ordinary way by means of their legs and feathery feet, others jerk themselves about by spasmodic motions of their bodies, while the majority are provided with large oarlike antennæ with which they row themselves through the water very much in the manner of the "water-boatmen" insects so common on our ponds and streams.

Many persons are always puzzled to know how it is possible for any animals to survive in water where the pressure amounts to many tons to the inch. But we must remember that the terrific pressure is equal in all directions, that water is non-compressible, and that a marine animal is full of water and hence cannot be "squeezed flat" as would a hollow, air-filled container were it lowered to the depths where these creatures dwell.

Another popular belief is that fishes and other animals from great depths will fall to pieces or collapse when drawn to the surface where there is normal atmospheric pressure. This, however, is not the case. Some deep-sea animals *do* go to pieces it is true, but so do related species dwelling in shoal water, for they voluntarily break themselves into fragments when captured or attacked. Other creatures, such as certain squids, are so soft and pulpy that when taken

from the water they slump down into shapeless, jelly-like masses, but so do related species of shoal water. On the other hand the lovely delicately tinted jelly-fishes, which abound in the deep sea, are often in better shape when drawn to the surface than are the common jellyfishes found at the surface of the sea. Many of the crustaceans from the profound depths of the sea come regularly to the surface at night and suffer no inconvenience by the tremendous change in pressure, while others, who never come to the top of their own accord, survive for some time when captured and placed in ice-cold sea water.

Although many of the really deep-sea fish are soft-bodied creatures, they are no softer than many of our common fish such as suckers, bullheads, and others, while a great many species from the deepest water are firm-fleshed and are covered with large scales. With few exceptions these deep-sea fishes are in perfect condition when drawn to the surface. There is no reason why any changes should take place in the bodies of these various inhabitants of the ocean's depths. As I have said, the pressure of the water is as great within them as without, but there is no internal high pressure which will "blow up" and tear the creatures into fragments as soon as the outside pressure is relieved.

Were these various deep-sea creatures yanked suddenly from their homes to the surface they might be seriously damaged, just as a deep-sea diver will be seized with the "bends" and may suffer dangerous and permanent injuries if drawn to the surface too

quickly. But the diver avoids danger and comes up unharmed by entering an air-lock where the pressure is gradually lowered. When a deep-sea creature is slowly hauled up through thousands of feet of water to the surface, the pressure is gradually reduced, just as in the diver's air-lock, and there is no likelihood that it will suffer from an attack of the "bends." In fact it is far more liable to die of heat prostration than by a change of pressure, for the depths of the sea are not only inky black but icy cold.

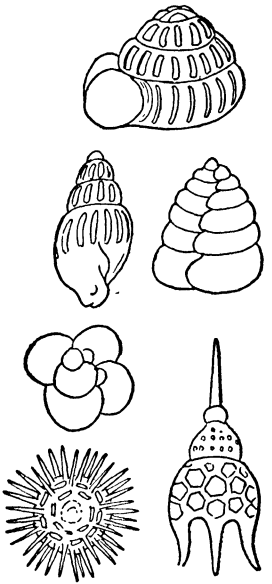
Chapter XIX

FOOD FOR THOUGHT

WHEN you admire some marble statue or an impressive building of limestone; when you use a white chalk crayon, or when you employ tooth powder to cleanse your teeth, do you ever realize that the gleaming white or delicately tinted marble, the stick of crayon and the flavored dentifrice are all composed of sea creatures?

Perhaps I should say that all are composed of the skeletons of sea creatures, for the animal tissue that gave them life and the power of movement vanished millions of years ago, leaving only the calcareous shells or skeletons of the minute animals which once swarmed in the sea.

These creatures are known as *Protozoa* and are the simplest of all animals, for instead of being composed of millions of cells as are other creatures, each Protozoa consists of a single cell. Yet simple as they are in their structure, they possess digestive apparatus and means of locomotion, while many are equipped with shells, some of which are very beautiful in form. These, however, are not single-cell animals, but are made up of several cells which are united to form a single organism. Like the sponges, they spread



Foraminifera

or increase by subdivision, but unlike the sponges and other animals they do not produce eggs and have no larval forms.

The shelled species of the group are known as *Foraminifera* and *Radiolaria*, and until 1835 they were considered true mollusks related to oysters, clams, and other sea-shells. Some species are visible to the naked eye, but the majority are tiny things less than one-hundredth of an inch in diameter, while many are so minute that they are only visible by the aid of a microscope.

So inconceivably numerous are these sea creatures that the waters of the ocean are filled with them. You might dip up a bucket or jar of water fairly teeming with millions of these animals and it would appear as clear as crystal and utterly devoid of life. But if you wait until night you may see them, for a great many are luminous or phosphorescent. Even though each individual emits an infinitesimal amount of light, the millions that occupy every cubic foot of sea water cause the ocean to gleam and glow like liquid fire.

No human mind can conceive of the countless trillions of these tiny creatures who fill the sea with their minute bodies. For that matter no mathematician could ever hope to compute their numbers, even in a small area of sea water. Although so small that the majority are scarcely visible to the unaided eye, yet their numbers are so vast that their skeletons have formed beds of fine ooze covering hundreds of thousands of square miles of the bottom of the ocean for thousands of feet in depth. Think of it! Try to imagine animals so small that a score would find plenty of space to roam about on the head of a common pin, and so numerous that a large portion of the ocean floor consists wholly of the shells or skeletons of the creatures. Try to conceive the number of these minute shells in all this vast accumulation of foraminiferous remains when a single ounce of the material contains more than three millions of the creatures' skeletons.

Even this does not convey any adequate idea of

the incredible numbers of these animals. Entire mountains, as well as the chalk cliffs of England and elsewhere, are composed of the fossilized shells of these creatures, yet it requires over a million of the shells to form a cubic inch of chalk. These are fairly large as these creatures go, and there are others so infinitely small that their shells or skeletons form material so fine that it is used for tooth powder.

At the other extreme are the hard marbles and limestones which are masses of fossilized ooze that once formed the bed of the ocean. Many of the world's greatest buildings are constructed of stone composed wholly of the petrified shells of these sea animals, even the mighty pyramids of Egypt being built of blocks of the fossil skeletons.

Perhaps you are puzzled to know how high limestone hills, great beds of marble, and chalk cliffs can be formed from the skeletons of animals who dwell in the ocean. Millions of years ago these rocks and hills and cliffs were all soft ooze at the bottom of the sea. Gradually, or perhaps in some instances quite suddenly, the beds of foraminiferous shells were pushed up above the water; the stupendous pressure to which they were subjected and the passing of millions of years fossilized the ooze and transformed it to stone, and the one-time bottom of the sea became marble, chalk, or limestone according to the particular type of the original ooze and the conditions under which it had been formed.

If you are interested in mathematical statistics and have a long lifetime to spare, you might try

your hand at computing the number of foraminifera in the stones composing one of the pyramids or even an ordinary limestone building. But if you lived long enough to complete the arithmetical undertaking you would wear out all the pencils in the United States many times over, and would require the entire output of many great paper mills in order to set down the figures, for it is known that a single ounce of the stone of the pyramids contains approximately four millions of the minute shells.

Here indeed is food for thought. But these tiny, active, simple creatures also supply food for countless fishes, and even more countless crustaceans, sea-anemones, corals, sponges, worms, and other denizens of the sea, not forgetting the largest of all living things—the mighty whales.

It seems ridiculous that these gigantic mammals should dine on such minute creatures. But it is the volume of food which counts, rather than the size of the food eaten, when it comes to a matter of filling a stomach. However, it must be confessed that even if whales must consume countless billions of Protozoa, the huge animals probably are quite unaware of the fact, for it is larger game, mainly the small crustaceans known as brit, which the whales seek. Whales, however, are not at all finicky about their food, while their manner of dining is far from being dainty, and to paraphrase a well-known saying: All is food that comes into the mouth.

Foraminifera, the strange swimming shells known as *Brachiopods*, small fishes, various crabs, shrimps

and other crustaceans; the larvæ of starfish, barnacles and mollusks; small squids or any other small creatures—all go the same road down the whales' throats, for the big fellows' method of feeding precludes the selection of foods or the separation of the various inhabitants of the sea who enter the whales' mouths.

It must not be assumed that all whales feed upon these Lilliputian denizens of the ocean. The sperm-whales with their strong, sharp teeth feed upon giant squids and other large creatures which they seize in their jaws and cut or tear into swallowable fragments. But the right whales or bowheads, the finbacks and huge sulphur-bottom whales, and the various other species of the baleen or whalebone group, all depend upon minute animals for their food.

Unlike the sperm-whales, the baleen whales do not possess true teeth, but have enormous cavernous mouths, resembling gigantic scoops, and very small throats. Their tongues are thick and muscular and just inside the lips there is a fringe of stiff, horny plates known as the "baleen," which is the so-called "whalebone" of commerce and manufacture. This strong flexible growth is edged with stiff hairs, the whole being most perfectly designed to fulfil the purpose for which it is intended—that of a strainer. When the baleen whales are hungry they merely open their vast mouths and swim through the sea until they decide that they have secured an ample mouthful of food. Then, closing their jaws, they bring their tongues into play and force the water out through the baleen strainers, leaving the hordes

of creatures it contained within the whales' jaws ready to be swallowed.

As the Protozoa far outnumber all other sea creatures ten thousand to one or more, the whales must devour immeasurable quantities of these animals, although the greater number are far too small to be retained by the baleen strainers.

Even if whales do not intentionally dine on the Foraminifera and other Protozoa there are plenty of sea animals who do. As I have already explained, the sponges and many other creatures secure their food by causing currents of water to circulate through their bodies, and feed upon the minute animals the water contains. Even a small sponge or coral will devour millions of Protozoa every day, and as there are millions upon millions of sponges, corals and other animals which depend upon these tiny creatures for their sustenance, and as many are of enormous size, the stupendous numbers of Protozoa which are consumed in this way are far beyond human conception. Yet all this inconceivable wholesale destruction does not affect the abundance of these minute sea creatures in the least, for as rapidly as they are destroyed they are replaced by others. Thousands of trillions still swim in every ton of sea water, moving rapidly but erratically by means of their tiny vibrating *cilia* or swimming hairs. Tens of thousands of trillions are devoured every minute by billions of billions of other creatures. And there are thousands of billions of trillions which die a natural death and sink to the bottom of the sea and add their mi-

nute skeletons to the vast accumulation of similar remains known as foraminiferous ooze, or *Globigerina ooze*, owing to the fact that the Protozoa known as the Globigerina is the most abundant species in the deposits.

Practically everywhere in the ocean where the water is not more than 2,400 fathoms or 14,400 feet in depth, the bottom is formed of this soft ooze, although at greater depths there is little of it, for below the three-mile limit the greater portion of the Foraminifera shells are dissolved. In most places, where the ooze occurs it is covered with a layer of slimy, gelatinous material which was a puzzle and a mystery to scientists for many years. Unable to account for it in any other way, they declared that it was a special organism created for the sole purpose of providing food for creatures dwelling in the depths of the sea. But we now know that the strange material, which lies like a blanket over tens of thousands of square miles of the ocean's bed, is composed entirely of the dead bodies of Protozoa. In the ice-cold water and terrific pressure of the deep sea, animal matter decomposes very slowly and the countless numbers of dead Protozoa, constantly sinking to the bottom, keep adding their atoms of flesh to the jelly-like mass as fast as it decays.

For millions of years this has been going on, for millions of years in the future—for as long as there is one ocean on the face of the globe—the tiny sea creatures will continue to live and die and add their shells to the ever-accumulating ooze, which may be-

come transformed to limestone hills and chalk cliffs, just as millions of years ago the ocean's ooze which had been forming for millions of years became the rocks of to-day. Perhaps, everything considered, these lowliest of all sea creatures are the most wonderful of wonder creatures of the sea.

INDEX

Æolian limestone, 103
Albunæa, 173
Alcyonaria, 90
Algæ, 67, 124
Alpheus, 166
Amphioxus, 85
Amphipods, 133
Annelids, 27
Archer, 165
Aristotle's lantern, 41
Arrow worms, 254
Ascidians, 21, 61, 72-86
Atolls, 101

Back-swimmers, 141
Ballahoo fish, 142
Barnacles, 17, 226, 229
Bashful crab, 209
Basket starfish, 57
Bath sponges, 72-76
Bêche-de-mer, 63
Bird's-head bryozoa, 3, 4
Blue crabs, 191
Boilers, 104
Bootlace worm, 33
Boring sponge, 71
Box crab, 210
Brachiopods, 263
Brain corals, 118, 122
Brit, 135, 136
Brittle starfish, 55
Bryozoans, 1, 2, 3, 21
Bugula, 4
Butterfly-fish, 119

Calappa, 209
Calling crab, 206
Caprella, 24, 145
Cestus, 94, 95
Chitin, 70
Cilia, 6
Coconut crab, 185
Convolutas, 221
Copepods, 133, 255
Coral islands, 102
Coral reefs, 98, 98, 99-129
Corallines, 3
Corals, 24, 96-106
Cotton spinner, 62
Crabe enragé, 190
Crabs, 170-186, 187-222
Crawfish, 159
Crinoids, 58
Crustaceans, 17

Cup sponges, 72
Cyclops, 136, 256

Dead men's fingers, 67
Decapods, 132, 170
Devil-crab, 205
Devil's coach horse, 147

Echinoderms, 37-64
Elk-horn coral, 8

Feather-stars, 59
Fiddler crabs, 193, 206
Fierasfers, 237
Fish-line worms, 33
Flask sponges, 67
Flat lobsters, 166
Floating crabs, 210
Foraminifera, 260

Ghost crab, 195
Glass crabs, 230
Glass-rope sponge, 72
Golden star, 79
Goose barnacles, 19, 20
Gorgonias, 90
Grapsus crabs, 198
Great Barrier Reef, 105, 237
Green crab, 190
Grunt, 119
Gulfweed crab, 210

Henslow's crab, 193
Hermit-crab worm, 30
Hermit-crabs, 24, 174, 231 239
Hippas, 170-173
Holothurians, 60
Horsefoot-crabs, 245-250
Horseshoe-crabs, 245-250
Hydroids, 1, 6, 7

Ianthina, 242, 243
Irish moss, 16
Isopods, 133

Jellyfishes, 6-15
Jewfishes, 168
Jonah crab, 194

Keyhole sand-dollar, 37
King-crab, 245

Lady crabs, 191
Lancelet, 159
Langosta, 159
Lasso-cells, 9, 21
Limulus, 246
Lobsters, 150-168

Madreporic, plate, 41, 48
Mangrove crab, 197
Mantis shrimp, 147

Maredpore coral, 109
Medusæ, 6
Megalops, 229
Mermaids' gloves, 67
Millepore coral, 8, 127
Mole-shrimp, 170
Morro crab, 194
Mouse-fish, 140
Mud crab, 193
Mushroom coral, 120, 123

Nauplius, 225, 226, 229
Neptune's cup sponge, 119

Octopus, 119
Oculina, 123
Opossum shrimp, 132
Organ-pipe coral, 91
Oyster-crab, 240

Palolo worms, 34
Pastor fish, 241
Peacock worms, 29
Pill-bugs, 133
Planarians, 31
Porpita, 13
Portuguese man-of-war, 9, 12, 241
Prawns, 130, 131
Precious coral, 93
Protozoa, 259-267
Purple shore crab, 200
Pycnogonid, 23

Radiolaria, 260
Rataria, 13
Robber crab, 185
Rock crab, 193, 194
Rose coral, 123

Sacculina, 134
Sagittarius, 165
Salpas, 79
Sand-builders, 29
Sand crab, 195
Sand-dollars, 37
Sand-fleas, 21, 133
Sand-hoppers, 133, 143
Sand star, 50
Sand-wheels, 37
Sargassum crabs, 210
Sargassum-fish, 140
Sea-anemones, 21, 87, 88, 89-94, 233
Sea-cats, 119
Sea-cockroach, 166
Sea crab, 191
Sea-crawfish, 118, 159
Sea-cucumber, 60
Sea dianthus, 28
Sea eggs, 54
Sea-fans, 90
Sea-hares, 119
Sea-lilies, 57
Sea-mats, 4
Sea mice, 31
Sea mole, 31
Sea-peach, 81
Sea-pens, 90

Sea-plumes, 90
Sea-rods, 90
Sea-spiders, 22
Sea-squirts, 21, 61, 78-86
Sea-urchins, 24, 39, 46
Seaweeds, 1, 2, 3
Sea-whips, 90
Sea-worms, 24, 26
Seed oysters, 225
Serpent-starfish, 21
Sharks, 115
Shield-bearer, 207
Shrimps, 130-132, 238
Snapping lobsters, 166
Soldier-crabs, 181-186
Sow-bugs, 133
Spider-crabs, 200, 215
Spiny lobsters, 118, 159-165
Sponges, 24, 65-77, 238-239
Squilla, 147
Stag-horn corals, 109, 117
Star corals, 118, 123
Starfish, 46-57
Stone crab, 193
Swimming crabs, 190

Tide-pools, 16
Tree corals, 109
Trepang, 63

Velella, 12, 13
Velvet-cloak anemone, 236
Venus's flower-basket sponge, 72, 238
Venus's girdles, 80, 94, 95

Walking crabs, 190
Wheel-urchins, 37
Worms, 24, 26-34, 254

Yellow shore crab, 200

Zoanthus, 89, 90
Zoea, 229
Zoöids, 79