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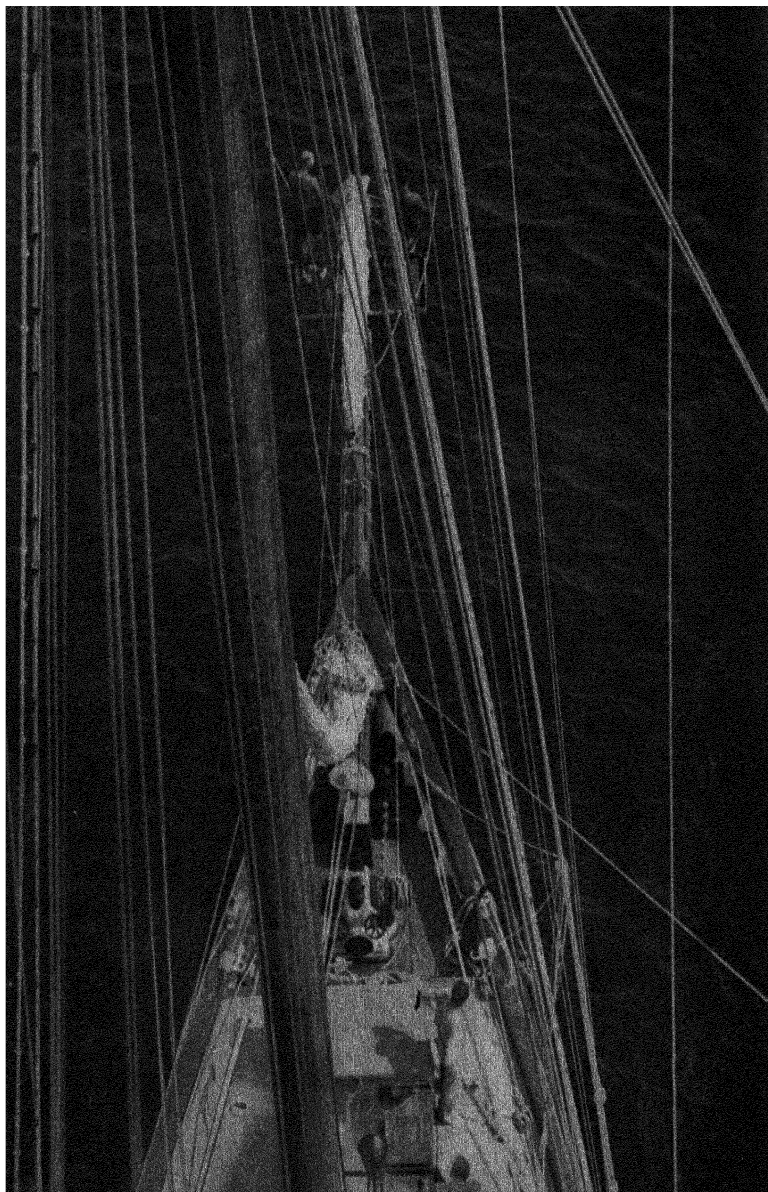
Lava Venture

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ZACA VENTURE

by the same author

HALF MILE DOWN



'ZACA' FROM ALOFT. The foremast and rigging look like a jungle tree and its attendant lianas, while the pulpit at the tip of the bowsprit is visible, fully manned.

ZACA VENTURE

BY

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OF TROPICAL RESEARCH OF THE
NEW YORK ZOOLOGICAL SOCIETY

With 24 illustrations

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JOHN LANE THE BODLEY HEAD

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To Fairfield and Marjorie Osborn

PREFACE

THE *Zaca* is a two-masted diesel schooner, painted black, one hundred and eighteen feet over all, with a gross tonnage of eighty-four; Templeton Crocker is her owner, tanned a pleasant ochraceous tawny, five feet ten over all, with a refined tonnage of about twelve stone. The two, in juxtaposition, with a hand-picked captain and crew, set themselves to aid and abet a scientific expedition.

The Invitation was to spend two months on the *Zaca* in the Gulf of California: the Acceptance materialized as the Twenty-fourth Expedition of the Department of Tropical Research of the New York Zoological Society: the Route included Cedros Island, Cape San Lucas, Guaymas, Inez Bay, the Banks of Punta Arena and Gorda, Mazatlan, and Clarion Island: the Chronology was the year nineteen hundred and thirty-six from March twenty-fifth to May twenty-fifth, San Diego to San Diego: the Personnel included Templeton Crocker, Master and Owner, Alfred Pedersen, Captain, three members of my Staff, John Tee-Van, General Associate, Jocelyn Crane, Technical Associate, George Swanson, Artist, myself, and a crew of fifteen. These latter

PREFACE

were of diverse nationalities, French, Norwegian, Latvian, Irish, Swedish, German, and Samoan, but single-minded in their vital interest and furtherance of our activities. And there was also Toshio Asaeda, Japanese artist, photographer, préparateur—a walking, sleepless incarnation of the word Work.

Our trip took on the character of the spoor of a drop of water meandering down a dusty window-pane, in that we made decisions suddenly as to the details of the exact route, and adapted our plans to contingencies and the incidence of favourable locations.

From our basic plan we never swerved, which was to spend as little time as possible in disconnected and uncorrelated dredging, seining, and diving, but to concentrate our researches in two or three zoologically interesting places. These proved to be the Inez Bay region, Cape San Lucas and the adjoining Banks, and Clarion Island. Whatever of value may accrue to our published scientific results will be due to this course of action.

WILLIAM BEEBE

APOLOGIA

Swuch aventure
bitimeo to summe monne
(ANCREN RIWLE 1230)

THE joy of an expedition such as this lies in the unexpected and exciting adventures which arise day and night. And in my use of the word Adventure I have departed somewhat from the usual concept of the word. That Treasure of Treasures, the *Oxford English Dictionary*, gives as the first definition of Adventure, 'That which comes to us, or happens without design,' omitting but not excluding the assumption of attendant danger, risk, or peril. So by adventure I mean the sudden breathless glimpse under the microscope of unexpected beauty and dynamic living in the world of life on a sliver of kelp, quite as much as the harpooning of a forty-two-foot whale shark.

In this volume I have attempted only two things—to present a few of these adventures as they happened to happen, and to minimize our human stature and self-importance in regard to the wild folk which came to our notice. For in relation to the world of life on sea and land of which we were in search, the

APOLOGIA

Zaca constantly diaphragmed to a chip or expanded to a *Queen Mary*. The whole point is that our vessel and our score of selves were incidental, our presence in this region transitory as our wake; whereas the creatures of which I write have evolved in these waters throughout untold millenniums, and are still there today, living, feeding, fighting, courting, and dying. In our memory they still exist as living fellow beings, and enthusiasm and vital interest must be our excuse for interfering in their lives.

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ZACA VENTURE

I

SOUTH TO SAN LUCAS

THE *Zaca* expedition began before it started, and was christened with a coincidence which Edgar Wallace would have entitled 'The Mystery of the Twin Snipefish.' The yacht was still tied to the wharf in San Diego when, on the twenty-fourth of March, I took my seat in the laboratory for the first time. In the geometrical centre of my table was a small vial containing a small fish. I exclaimed with surprise, for twelve days before (it seemed like a month) I had caught this rarest of rare fish with a lucky sweep of the net in the Gulf Stream off southern Florida, the last specimen to be captured on our recent West Indian trip.

I had gone on to New York and thought I had left the fish there! Fleeing quickly from the bitter cold and the accumulated glaciers in the streets of that city, I started west by a circuitous route to avoid flood-devastated regions, breathed litres of dust on the way, read a delightful book, *Young Mr. Disraeli* by Elswyth Thane, besides reviewing Peter Freuchen's *Arctic Adventure* for the *Atlantic Monthly*, and, thanks

to a train two hours late, at last saw Carriso Gorge by daylight.

After all this I was confronted by what looked like my identical snipefish. It proved, however, to be the first fish caught on this present Pacific expedition. Its story is worth the retelling, for the species is as unknown on our Pacific coast as on the Atlantic side.

Two days before my arrival it was decided to utilize the intervening time by a short trip to Avalon on Catalina Island, and there, in spite of a high wind and rough sea, the submarine light was lowered after dark. The very first specimen of the expedition netted by John Tee-Van was this snipefish. It was only two inches in length, but *Macrorhamphosus gracilis* for all that.

After capture it was placed in a small aquarium and admired both for its strange appearance and its rarity. Between winks or when everyone's attention was directed elsewhere, it vanished. One moment it was in the aquarium swimming around quite happily and the next the tank held nothing but water. The coconut matting on the floor was searched, the laboratory table was examined. Gravitation must have been in operation, but either *Macrorhamphosus* went suddenly glassy and ceased to cast shadows or what? Finally one of the searchers decided to sit down and think it over. A glance at the wooden seat of a tall laboratory stool revealed the snipefish upside down, firmly impaled by the tip of the long,

sharp spike growing from its dorsal fin. Here it had been all the time, wriggling and revolving, suspended, like Mahomet, midway between heaven and earth. The consensus of opinion was that the name of the fish should be anagrammatized from snipe to spinefish.

A bony armature, long tubular snout, together with the long back spine are its chief characters, and it calls trumpet-fish and dragonets cousins, but only distant ones.

The slender snipefish is one of the most widely distributed of all swimming creatures. It calls all oceans home, whether in the Mediterranean, along Portugal and down to the Cape of Good Hope, or off India, China, Japan, and Australia, extending even to such isolated places as Hawaii and Juan Fernandez.

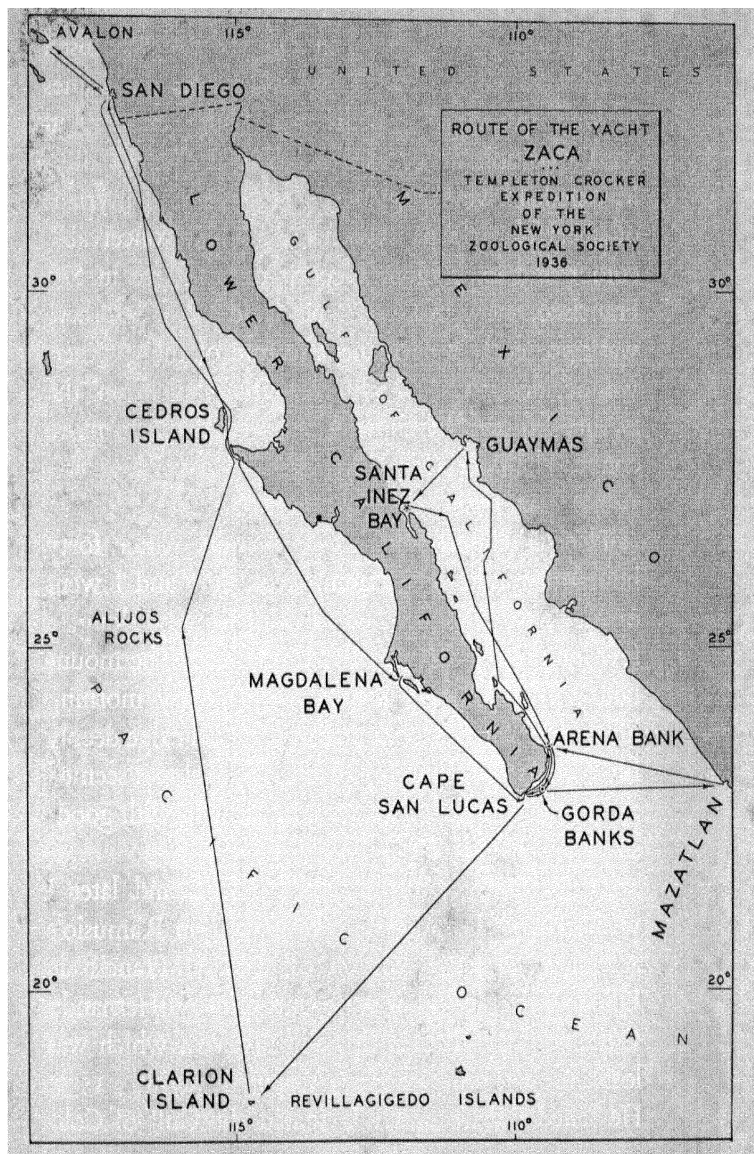
Yet it has never been definitely identified on any shore of North America. When I scooped up my Florida snipefish from its shelter beneath the purple balloon of a Portuguese man-o'-war it proved to be the first ever recorded either on the east coast of the United States or in the West Indies. Our Pacific specimen was also unique except for a small individual washed up eighteen years ago on the beach of Catalina, which may have been this species.

In any event our twin snipefish hold the record for coincidence and rarity and were undoubtedly an excellent initial omen for the expedition.

My brief glimpse of San Diego left a confused memory of cold, penetrating winds, lines upon lines of warships, huddled pelicans and surf scoters, and an Exposition at the stage of the morning after, leavened, however, with a glory of untold myriads of cheerful little pansy faces of every conceivable colour and expression. Reports came of ice in San Francisco, snow in Los Angeles, and as the gale here was apparently a permanent feature of the weather, we decided to leave directly after lunch on the twenty-fifth of March, and be blown south to more congenial climes. (Fig. 1.)

The sudden stopping of the engines after forty hours of continuous running woke me and I went on deck to find the *Zaca* drifting slowly along, a few hundred yards east of Cedros Island. The mountains showed clear as crystal in the early morning light—a dry, dead-looking, lofty, jagged ridge deeply furrowed everywhere by erosion. The slopes seemed a barren desert, but the crest was fringed with good-sized cedars and pines. (Fig. 2.)

This recalled something I had read, and later I went to my Hakluyt and verified it in Ramusio's account of the expedition of General Francis de Ulloa. The Spaniard was sent out by Hernando Cortez and with three tiny ships (one of which was lost almost at once) he left Acapulco July 8th, 1539. He sailed north, circumnavigated the Gulf of Cali-



TRACK OF THE TRIP. Cape San Lucas, Gorda and Arena Banks, Santa Inez Bay and Clarion Island—these were our chosen spots where we anchored, fished, dredged, and dived. (1)



THE CEDARS OF CEDROS. Exactly 144,600 sunsets before this, Francis Preciado sat on his Spanish ship, writing with his quill pen, looking across the water to Cedros, from the same spot where the 'Zaca' is anchored. (2)

fornia, and continued up the Pacific coast until he reached the exact spot where we were floating.

It is very seldom in these days of exploitation of the very ends of the earth that any locality remains wholly unchanged for four centuries, but such is the case in this great island. It is equally unusual for early records to make good consecutive reading, but the narrative of Ulloa is so naive and delightful that I give in full his experiences on one of his first days ashore on Cedros.

It was just three hundred and ninety-six years ago when the following was written: 'Isla de los Cedros, or the Ile of Cedars in 28 deg. and a quarter: On Sunday, Munday and Tuesday (which was the twentieth of the said moneth of Januarie) wee sailed with scarce and contrary windes, and at length came to the cape of the point of the Iland, which we called Isla de los Cedros or the Ile of Cedars, because that on the tops of the mountaines therein, there growes a wood of these Cedars being very tall, as the nature of them is to be. This day the *Trinitie* descryed a village or towne of the Indians, and found water: for on Sunday night we had newly lost her, and had no sight of her untill Tuesday, whenas we found her riding neere the shore, not farre from those cottages of the Indians. . . . While we thus rode at ankor, we saw a Canoa with 3 Indians put out into the sea from their cottages, and they went unto a fishing place, among certaine great and high

weedes, which grow in this sea among certaine rockes, the greatest part of which weedes groweth in 15 or 20 fadome depth; and with great celeritie they caught seven or eight fishes, and returned with them unto the *Trinity*, and gave them unto them, and they in recompense gave the Indians certaine trifles. After this the Indians stayed at the sterne of the ship, viewing the same above three houres space, and taking the oares of our boat they tryed how they could rowe with them, whereat they tooke great pleasure; and we which were in the *Admirall* stirred not a whit all this while, to give them the moore assurance, that they should not flie away, but should see, that we ment to doe them no harme, & that we were good people. As soone as we were come to anker, & beheld all that had passed betweene the Indians and those of the *Trinity*, after the Indians were gone to the shore in their Canoas made of the bodies of trees, the General commanded the boat which was without to be brought unto him: and when it was come, he, and Francis Preciado, and two others went into it, and so we went aboard the *Trinity*. The Indians seeing people comming out of the other ship into the *Trinitie*, sent two Canoas unto the sterne of the ship, and brought us a bottle of water, and we gave unto them certain beads, and continued talking with them a little while; but evening approaching the aire grew somewhat cold. The Indians returned on shore to their lodgings,

and the General and we to our ship. The next day being Wednesday in the morning, the General commanded certaine of us to goe ashore, to see if we could find any brooke or well of fresh water in the houses of the Indians, because he thought it impossible for them to dwell there without any water to drinke. The father frier Raimund likewise went out in our company, because the day before seeing the Indians came to the sterne of the shippe and parlying with us, he thought he might have spoken a little with them, with the like familiarity. In like sorte many mariners and souldiers went out in the boat of the *Trinity*, and going altogether with their weapons toward the shore, somewhat above the lodgings of the Indians, very early in the morning they watched the boats, and perceived that wee would come on land, whereupon they sent away their women & children with certaine of them who caried their goods up into certaine exceeding steepe mountaines and hilles, and 5 or 6 of them came toward us, which were excellently well made, and of a good stature. Two of them had bowes and arrowes, and other two 2 bastonadoes much thicker then the wrist of a mans hand, and other two with 2 long staves like javelins with very sharpe points, and approched very neere us being nowe come on shore. And beginning by signes very fiercely to brave us, they came so neere us, that almost they strooke with one of those staves one of our souldiers

called Garcia a man of good parentage, but the General commanded him to withdraw himselfe, and not hurt any of them. In the meane season the General and frier Raimund stept foorth, the frier lapping a garment about his arme, because they had taken up stones in their hands, fearing that they would do them some mischief. Then began both of them to speake unto them by signes and words, to be quiet, signifying, that they ment them no harme, but only were come to take water; and the frier shewed them a drinking-cup; but nothing would serve to make them leave that bragging, and flinging of stones: and the General continuing still in a mind not to hurt them, commanded his men gently to come neere unto them, and that by signes they should all shew them, that they meant in no wise to hurt them, but that we were come on land onely to take water. On the other side refusing utterly to take knowledge of these things they still insulted more and more: whereupon Francis Preciado counselled the General to give him leave to kill one of them, because all the rest would flee away, whereby at our ease we might take water: but he replied that he would not have it so, but willed them to looze the two mastives Brecillo and Achillo: wherefore the dogs were let loose, and as soone as they saw them, they vanished immediately, betaking them to their heeles, and running up those cliffes like goates. Also others which came from the mountains to

succour them, betooke themselves to flight. The dogs overtooke two of them, and bit them a little, and we running after, laid hold on them, and they seemed as fierce as wild & untamed beasts, for 3 or 4 of us held either of them, to cherish & pacifie them, and to seeke to give them some thing: but we availed not, for they bit us by the hands, and stooped down to take up stones for to strike us with them. We led them a while in this manner, and came unto their lodgings, where the Generall gave a charge, that no man should touch any thing of theirs, commanding Francis Preciado to see that this order were observed, in not taking any thing from them, although in very deed there was little or nothing there, because the women and Indians which were fled had caried al away. Here we found an old man in a cave, so extremely aged as it was wonderful, which could neither see nor go, because he was so lame and crooked. The father frier Raimund sayd, it were good (seeing he was so aged) to make him a Christian; whereupon we christened him. The captaine gave the Indians which we had taken two paire of eare rings, and certaine counterfeit diamonds, and making much of them, suffred them to depart at their pleasure, and in this sort faire and softly they returned to the rest of their fellowes in the mountaine.'

This, and further tales of more bloody encounters with the Indians of Cedros were penned by the hand

of Francis Preciado himself, plying his quill in a cabin of the *Santa Agueda* 'ankored' in the exact spot where we lay. The vividness of his detailed account is equalled only by the patience and humanity of Ulloa—characteristics rare enough in the early conquistadores.

Abeam of us was the valley, and the beach on which the Spaniards landed, but instead of the 'cottages' of the Indians was a handful of miserable adobe huts. Through my glasses I could see a dozen raggedy Mexicans, one distinguished by a revolver strapped to his belt, all leaning against the nearest leanable object. There were no 'mastives' but only a few dejected pariah dogs. Within the whole horizon of land and sea no other change had come throughout the past four centuries. I thought of the transformations wrought by other races and conditions and my mind went back to the beautiful, modern city which we had left less than two days before—San Diego, the site of which was discovered only two years after Cedros, and which, after more than three centuries, in the year 1867, less than seventy years ago, still had no more inhabitants than this Mexican village.

Ulloa and his men got heartily sick of the sight of Cedros, for no less than eight times in the course of the first three months of 1540 they tried to go north or south and every time were driven back by contrary gales to the lee of the great island. They shot

small deer, and 'conies, grey and blacke,' and to this day mule deer, rabbits, and gophers are still found on the island. But the months of waiting for the almost continuous storms to cease must have been dreary, as the men filled their time repairing the 'furniture' of the small vessels, sewing together their shreds of clothing and offering up prayers for good weather.

On the *Zaca* even before breakfast the new dredging rig was in working order and the first haul made. Drifting slowly southward along the island we drew five most interesting dredgefuls from 38 to 44 fathoms. Each haul was richer than the preceding, with a bewildering lot of creatures. The most remarkable thing was the clear evidence of areas on the bottom of pure culture. In the first haul, one of twelve minutes and made with a small dredge, was a vast amount of blue mud and many thousands of small brittle stars; another dredge contained no mud but hundreds of white club-spined urchins; a third had a large number of very beautiful, long-spined, scarlet thorny-oysters, while from the next, oysters were quite absent, there being instead dozens of round, hermit-inhabited shells. Each haul deserved a day's study. To the very last haul I clung to the hope of entangling and bringing up one of Ulloa's 'ankors,' for in the course of riding out the months of heavy gales he lost six and recovered only one.

At noon we drew our last dredge and steamed around the south end of Cedros from which Ulloa had so often been driven back. We passed the lesser island of Natividad and on to the little bay of San Bartolome. It was surrounded by the same dead and desert mountains, all furrowed and gorged with eroded ravines and arroyos.

On Sunday, April 12th, 1540, Preciado wrote: 'Among these Islands are such abundance of those weedes, that if at any time wee were inforced to sayle over them they hindred the course of our ships. They growe fourteene or fifteene fadome deepe under the water, their tops reaching four or five fadome above the water. They are of the colour of yellow waxe, & their stalke groweth proportionably. This weede is much more beautifull then it is set foorth, and no marvell, for the naturall painter and creator thereof is most excellent.'

To-day in San Bartolome Bay we rowed and pushed our way over two large beds of this amazing kelp 'weede.' This was of the greatest interest to me, especially as the life on and around it seems to have been so little studied. I was keen to dive among these great algal portieres, but the visibility of the water hereabouts was only about fifteen inches, and the 56 degrees of water temperature were not conducive to prolonged submersion. Two American egrets and a trio of willets were walking about on the floating kelp fronds, exactly as jacanas tread the water-lily

leaves of tropical swamps. The brief glimpse we had of the rocks and tide-pools showed a wealth of life—small fish, large, deep-green anemones, besides limpets, barnacles, and mussels all gigantic in size to my Atlantic-accustomed eyes.

We left Turtle Bay the same evening and put out to sea southward on our course. At ten o'clock the following morning we stopped to haul on board an immense mass—several hundredweight—of floating kelp. Now that I had some of this wonderful seaweed actually in my hand the marvel of it impressed me more than ever.

I had always thought that kelp was an Indian word but *O.E.D.* quickly disillusioned me. Its origin is obscure but it has been in use for centuries in England as meaning some one of the large brown seaweeds. Its first appearance in English prose was in the translation of Higden's *Polychronicon*, a history of the world in Latin. This was done in easy style by John Trevisa in 1387, and has the high honour, by the way, of being the first delineation of England and her story in native English. Many contemporary copies on vellum were made. Here we find the amusing and very true simile, 'As culpes of the see, waggeth with the water.'

Many years later in a translation of Pliny we read of the ancient uses of kelp: 'Kilpe, Tamgle, and such like seaweeds, are as good treacle. The best simply of all others, be they of the island of Creta, which grow

near the ground upon rocke; and namely for to die wooll and woollen cloth: for they set so sure a colour as never will shed or be washed off afterwards.' These words come to us through Philemon Holland's translation (1601) of Pliny's *Natural History* (A.D. 75), who in turn quoted Nicander, the Greek physician, who wrote his scientific treatises in verse sometime during the second century before Christ. In such devious ways human knowledge of kelp comes down to us.

As to the real history of the brown kelp itself we know that authentic evidences of algae have been found in Pre-Cambrian rocks, which starts the ancestral line well beyond five hundred million years before we hauled this kelp on board the *Zaca*.

The great kelp beds of the Pacific coast form an interrupted belt of seaweed growth offshore from the Arctic down to Turtle Bay. I saw small patches of it even farther south, but this kelp (*Macrocystis pyrifera*) is essentially a northern species. Charles Darwin, writing on the *Beagle*, credits the kelp of Tierra del Fuego with an enormous influence on the interrelated lives of a host of organisms. 'Amidst the leaves of this plant,' he writes, 'numerous species of fish live, which nowhere else would find food or shelter: with their destruction many cormorants, divers, and other fishing birds, the otters, seals, and porpoises would soon perish also: and lastly, the Fuegian savage, the miserable lord of this miserable

land, would redouble his cannibal feast, decrease in numbers, and perhaps cease to exist.'

Two things became very evident from my observations of the kelp beds in Turtle Bay: the value of this seaweed as buoys to mariners, and as breakwaters. On exposed coasts whenever a single plant is seen growing well out from shore a shoal is invariably indicated. Now and then as a kelp plant increases in length and buoyancy it may actually weigh its rocky anchor and float out to sea.

The weed in Turtle Bay looked like elongate reefs of olive-coloured coral and functioned exactly like a breakwater. Outside the bay the waves were rather high with the tops breaking into whitecaps, but as soon as they reached the kelp all motion was reduced to a long, heaving, oily swell. When, from our low seats in the rowboat the horizon was hidden, the silhouette of the water became rippled with fronds, partly exposed or actually waving in the wind. Before we left there came a slight shift of wind and the surface leaves became still more active, giving the effect of a school of large jumping fish. A flick, and the frond would whip clear of the water, turn in the air and flop back, occasionally with a definite but soft spat, like the distant spank of a beaver's tail.

The breakwater location of these plants is most important to their well-being. Two vital necessities in the life of *Macrocystis* are a rocky support and constantly moving liquid. The surface is so extensive

that it must be laved by ever-changing water to enable it to extract sufficient carbon dioxide to supply the need of its growing tissues. A location such as this must be of especial value along a coast like that of California, which is so exposed and shelterless compared with the much-indented Atlantic shore. A more tropical extension of the kelp beds would have made accessible to us many a beach in the Gulf and on Clarion—beaches now pounded by impassable surf.

We encountered floating masses of kelp at sea as far south as Clarion Island, but never in the Gulf. The most southern of these batches were the most disintegrated, so it appears that just as the Atlantic sargassum weed gradually decays and sinks as it drifts into colder waters, so kelp is destroyed by the increasing warmth of the tropics. In addition it must be understood that floating, detached kelp has no power of long-continued life even under the most favourable conditions.

Sometimes a single plant would appear, or a large, confused mass. We thought to pull a few yards on board with the boathook, as we sailed past, but found that even after the yacht was brought to a full stop it required the united efforts of half a dozen men. One great pile of several hundred pounds was a single plant, still retaining part of the basal holdfast. It was of the consistency of rubber and so slippery that it seemed to be covered with slime. Yet none

was evident after handling it. When a heavy pile began to slip overboard the stem was as impossible to hold as a live eel.

Not only in size but in real complexity of organization of structure the giant kelp stands at the head of all marine plant life. There has never been in the sea any development of flowers or seeds, real leaves, roots or bark, but the kelp presents most interesting parallelisms of some of these. Even with its high organization it lacks all sexual methods of reproduction, and can propagate its kind only by means of zoospores. The holdfast of the giant kelp is a mass of interlaced, tangled, root-like fingers, tightly clasped about a stone. From this arises one or several stems, from which, at intervals, spring series of fronds, either double or single, looking, on the whole, like a giant fern frond made of soft, pliable rubber. The short base stalk of each leaf is swollen into a pear-shaped float.

Within certain limits the kelp varies considerably in colour. The young fronds and floats are as tawny olive, or in the sunlight, honey yellow; the adult growths are brownish olive, while sunlight shining through them turns them to greenish gold. The very young and small fronds are flat and smooth but all older leaves are ribbed and reticulated in raised ridges and alternating depressions, irregularly waved. The ridges run into each other in an inextricably confused plexus. A cross section of the leaf shows a

solid body with a waved edge, the ridges and intervening hollows presenting no difference except in direction. There is no upper or under side, and indeed the vertical position in the water, with the sunlight coming from directly overhead, and the constant shift due to change in tide and wind, make upper and under meaningless terms.

In sheer length of growth the giant kelp exceeds the height of the tallest redwood trees, and only the lianas of the tropical jungles far outgrow them. Extreme and improbable lengths of nine hundred and one thousand feet have been reported, but six hundred seems to be an authentic measurement of an Antarctic plant, according to Wells and Huxley. All that I saw were only a fraction of this length.

We loaded the fronds into tubs and began a slow, careful search for the creatures which called this submarine vegetation home.

Again I quote from Darwin's journal written one hundred and two years ago, concerning the kelp of Tierra del Fuego. 'Almost every leaf, excepting those that float on the surface, is so thickly encrusted with corallines, as to be of a white colour. We find exquisitely-delicate structures, some inhabited by simple hydra-like polypi, others by more organized kinds, and beautiful compound Ascidiae. On the flat surfaces of the leaves various patelliform shells, Trochi, uncovered molluscs, and some bivalves are attached.' The great naturalist might as well

have been describing the leaves on deck in front of me.

The delicate patches of grayish white bryozoa were by far the commonest form of animal life on my kelp. They should be named lichenozoa instead, for on the kelp they present to human eyes far more the appearance of lichens than moss. These little beings inhabit a Flatland world of their own, living almost in two planes of space. Each individual, as he comes into existence, fashions his limestone tunnel out of the surrounding water, and moulds it alongside or overlapping his neighbours or parents. Parents, however, is hardly the word, for these individuals are formed by budding. When sexual cells are produced they develop into free-swimming larvae which sail off to found new colonies. To perpetrate a terrible pun we might substitute the phrase 'neighbours and buddies'!

Bryozoa are puzzling creatures, being in some ways as closely related to worms as they are to molluscs. With a more than respectable ancestral lineage of four hundred and fifty million years they are still very abundant to-day. On the kelp leaves they formed flat encrustations, round, oblong, or irregular. Under the microscope they were exceedingly beautiful and varied. I found five species on a single small leaf, each with its individual ground plan and elevation, each with characteristic calcareous ornamentation. Some looked like sculptured, petrified lace-work, and

others were plume or feather-like, resembling frost crystals on a windowpane. A moment of quiet under water on the microscope stage, and a hundred circles of eager little tentacles peered out, and slowly expanded into animal flowers. The tentacles remained motionless, but over their surface untold myriads of minute cilia thrashed back and forth in rhythm, setting up distinct currents, diminutive whirlpools, a cyclone to a diatom—disturbances as infinitely small to our vision as a world war on earth would be to the man in the moon.

A kelp leaf was occasionally thickly covered with hundreds of small snail-like shells all glued fast on one side. These were coiled worms with the rather pleasant name *Spirorbis*. Small compressed crustaceans crept or swam over the surface, varying in colour from pale to deep green, the dominant form of this group being an olive green isopod. Thousands, of all sizes, were found on a single plant, all creeping slowly about and relying upon their amazing resemblance to the colour of the fronds to escape detection.

A small, dense cluster of something resolved under the hand lens into a family of the strange little inch-worm shrimps *Caprella*. They looked like the skeletons of some more buxom forms, and clung tightly by their hind legs to whatever they touched, rearing straight upward like the stems of ocotilla on the distant desert mountains. The shape seemed pro-

tective enough, but in addition they were ornamented with many red spots—which no kelp ever displayed. Naked molluscs crawled about, recalling their sargassum cousins. These, too, were kelp-colour, and their several pairs of waving gills were nothing but the torn and frayed edges of the fronds.

I was prevented from diving and wandering among the forests of kelp, but now and then there comes a vision of these rubbery groves of strange plants, clutching to rocks or reef with interlaced fingers, trusting to air bladders for support, perched upon by kelp-coloured fish, affording shelter to swarms of living beings. Who has not seen kelp has missed one of Earth's marvels.

In its first sentence, on one of the first mornings after leaving San Diego, my *Zaca* journal says, 'Rotten night with sinus, rolled terribly, icy cold, caught five bonitos.'

Nothing could put an end to the roll, but the sinus and chill vanished with the first bonito. We were making about eight knots and the wind was cutting off the tops of the waves and strewing the whole ocean with this chaff of foam, yet these amazing fish, one after the other, somehow glimpsed the sodden, white plumage of the feather jig, leaped and seized, it and were hauled in. This wonderful stream-lined, silvery spindle of steel seems the epitome of sheer vitality, and if only its recognition of artificial bait

matched its beauty man would never be able to invent any lure which would deceive it.

I saw the first before it reached the taffrail and unconsciously noted its pattern. Three minutes later I returned to have it photographed and as regards both colour and pattern I found a wholly different fish (Fig. 5).

This swift change was one of the most beautiful of kaleidoscopic miracles, surpassing any more stable colouring. It was second only to the shifts of pigment in the dying dolphin fish which so pleased the Romans of olden time. I shall take the reader with me for a brief glimpse of how the colour change of the bonito concerns the scientific study of fish.

Going to my library of fish literature I found a strange and wonderful amount of information. This fish is known commonly as bonito and it ranges pretty much throughout the belt of warm seas. The Pacific species differs in several details from that of the Atlantic, such as in possessing eighteen instead of twenty-two spines in the dorsal fin, but in all general characters they are much alike. As regards colour and colour changes the two species appear to be identical and in this respect I am treating them as one.

Pliny tells us 'The Tunie is called Pelamis,' and pelamys has persisted as another name. These common names are simplicity itself compared with the technical titles used to-day by various ichthyologists.

Here are a few: *Sarda sarda* (Jordan, 1930), *Sarda pelamys* (Mohr, 1929), and *Pelamys sarda* (from Cuvier, 1831, to Jenkins, 1925).

As regards pattern there is greater unanimity but even less accuracy. To mention only three diverse authorities out of dozens, Bigelow and Walsh in *Fishes of the Gulf of Maine* say; 'While young the back is transversely barred with ten to twelve dark blue stripes but these dark bars usually disappear before maturity.' Mohr in *Die Fische der Nord und Ostsee* writes: 'the young with dark cross bands, the full-grown with about ten bluish-black stripes.' Walford in *Handbook of Common Commercial and Game Fishes of California* says: 'young with vague darker vertical bars.' The majority of recent writers have similar remarks. This idea of the juvenile evanescence of vertical bars is of course based on the study of dead and preserved specimens, and had its origin with Cuvier who criticized Rondelet for describing as a separate species a fish with these markings. Both Cuvier and Jenkins in *The Fishes of the British Isles* give figures showing both markings at once.

We shake off the dust of bibliographic burrowings and return to the fresh air of the deck. During the first four days of the expedition and over an extent of more than eight hundred miles, from San Diego to Cape San Lucas, we caught thirteen California bonitos—*Sarda lineolata* seems to be the most generally accepted name. The first glimpse we had of

these fish when they were being hauled in, and then, for a period of one to four minutes after they were on deck, the only pattern on the dark green and blue back and silvery sides was a series of ten to twelve intensely black, wide, vertical bars, extending from the back far down on the abdomen.

Hardly had the eye registered these bands when a secondary pattern began to appear, a series of eight to eleven oblique stripes, extending clear across the vertical bars, and in a short time completely eclipsing them. Within ten minutes the fish had changed apparently from immaturity to adulthood. Instead of which we have a juvenile pattern persisting in the full-grown fish, either constantly when the fish is swimming undisturbed, or at least suddenly induced by a state of emotion, terror, fear, anger—whatever anthropomorphic name we dare give it. The youthful pattern vanishes altogether at death and gives place to the conventionally described pattern of oblique lines. Eight of these bonitos averaged seven pounds each and lengths of two feet, and were almost or quite ready to breed.

There is no better example of the need for more accurate first-hand, field observation. The matter of the bars may seem an unimportant one, but pattern sometimes affords a clue to fundamental relationships.

On the third day out of San Diego, March 28th, at eight o'clock in the morning, a pair of black-

SOUTH TO SAN LUCAS

footed albatrosses appeared and followed us all day.

The fireside adventurer in the world's literature knows the albatross from that swinging rhythm which I have quoted before:

*'And a good south wind sprung up behind
The Albatross did follow
And every day for food or play
Came to the mariners' hollo!'*

The common people read in their daily rag of an albatross which nearly killed the robber of its nest, and when it was finally overcome and slain it was found to have a wing-spread of twenty feet. The ocean-going tourist has a happy memory for the rest of his life when a shearwater or a fulmar, if not indeed a booby, is pointed out to him as the famous bird. Seamen on lonely seas watch the birds day after day with unintelligent and often superstitious attention, but complete satisfaction at something to relieve the vastness and eternal sameness of water.

The most recent authority on this group of birds begins his monograph with the sentence, 'Our information about the habits of albatrosses is fragmentary and sketchy.'

There are a few characteristics which set apart this small family of seabirds. Of slight scientific import, but of immense popular interest, is size. The wandering albatross is unquestionably the greatest of all

fliers of the sea. Exaggeration of the truth in this respect still persist, like the useless and harmful appendix, in the best of human associations. The latest edition of the *Encyclopaedia Britannica* keeps alive the record of a spread of wing of seventeen feet. The final word of accuracy seems to be Dr. Murphy's statement: 'I conclude that a wing-spread of about eleven and a half feet, with the wings of a dead bird stretched out as tightly as possible, represents the maximum expanse of any known bird on the earth. The twelve-foot albatross needs verification; the thirteen-foot albatross is probably a myth.' As to weight, seventeen pounds seems the greatest accurate record, with a possibility of individuals reaching nineteen.

These figures do not make albatrosses the largest of flying birds, for condors, swans, wild turkeys, and great bustards challenge them in weight as well as in actual square area of flight surface. But for speed, control, and sheer grace albatrosses have no equal in the air.

If the above-mentioned reader of exaggerated newspaper accounts could have been off North-west Africa some fifty or sixty millions of years ago, his desire for records and notorious statements could have been abundantly satisfied, for a distant ancestor of the albatross living somewhere about that place and time may have spread his pinions to an extent of five and twenty feet. Again, if this well-named

fossil bird were living on the earth to-day, the put-upon ocean tourist need not be ashamed of mistaking a shearwater for an albatross, for this great bird of old was something of a connecting link between albatrosses, petrels, pelicans, and frigate-birds.

Even living albatrosses resemble each other so much in their various plumages that a minute inspection of the beak is the surest way of differentiating between certain species. Another important point in telling which is which on the wing is the ocean or the particular part of the ocean in which any one bird is observed. No stranger habit exists in the world of birds than the relationship between the breeding and distribution areas of albatrosses. If we imagine that our American bald eagle wandered throughout part of the year over all the North American continent, from Alaska and Labrador to Florida and Panama, and that at the nesting season every bald eagle in existence flew straight toward New York City, and built its nest and reared its young in an area of one-quarter of Central Park, equal to a square of ten city blocks, we can the better visualize the corresponding life of albatrosses. The sooty albatross, for example, wanders over the whole South Atlantic and Indian oceans, reaching to Australia on the east and to the bitter limits of Antarctic pack ice a thousand miles south of Cape Horn. At the call of the breeding season all the adult sooty albatrosses, hundreds and thousands of them,

head for the tiny islets of Gough and Tristan da Cunha far out in the southern Atlantic. On certain limited areas of these specks of dry land they all nest and incubate.

The feats of actual flight exhibited by albatrosses are almost beyond the possibility of exaggeration. Dr. Murphy has sifted the true from the questionable, and records that a single individual bird has been known to follow a definite ship for three thousand miles. A wandering albatross tagged at its nest was captured three years later six thousand miles away. As to speed, a maximum of one hundred miles an hour is admitted as truth.

One strange thing about albatrosses sets them apart from all their petrel relations: an inexplicable dance between friends. As far as we know these birds are essentially monogamous, indulging in a well-marked courtship, the individuals of mated pairs being devoted to one another, sharing both nest-building and the long tedious period of incubation and the care of the single chick.

Years ago on the breeding grounds of the Galapagos albatross I watched and filmed another type of dance or ritual or give-it-your-own-name, which seems to be quite peculiar to albatrosses. This is an elaborate performance of posturing and fencing with slight vocal accompaniment. I have seen it indulged in by an incubating pair, by one of this same pair and two separate outsiders, by two birds casually

meeting, and by a bird which, in the course of a long and difficult progression through the rookery, met and successively performed with three birds one after the other. And I have induced a bird to go part way through the performance by bowing myself. It is reported to be indulged in well after the proper breeding season, hence is non-sexual in time as well as with partners, more or less indiscriminate and quite apart from the more conventional courtship of the usually accepted definition. It awaits explanation which cannot help but be of the greatest interest.

The real courtship is no rough-and-tumble affair as with the house sparrow, nor purely a vocal performance such as that of the house wren. Nor is it an eternally repeated statuesque posture as exhibited by the golden pheasant. It combines all these with added expressions of passion and devotion which are almost human in variety and complexity. Dr. L. H. Matthews, of the *Discovery* Expedition, has written a most fascinating account of all this, a few paragraphs of which are well worth salvaging from his scientific report of the *Birds of South Georgia*. Concerning the wandering albatross he writes: 'In courting before pairing several males gather around one female and bow to her, bringing the head down close to the ground. As they do this they utter a harsh groaning sound, and the female bows and groans back at them. After several bows the males open the wings

to about half their extent and side-step around her. They then edge into a position so that they are directly facing her and open the wings to their widest extent so that the tips of the primaries are raised above the level of the head and are curved forwards toward the female. At the same time the males raise the head so that the bill points straight up into the sky, and give vent to a loud braying cry. They then close the wings and start all over again. Several males do this at the same time around the one female, but they do not all act in unison so that unless they are watched carefully one gets the impression of half a dozen male birds dancing around the female and going through a series of haphazard actions, but one finds that they all adhere to the same course of action if attention is directed to each in turn.

'After pairing has taken place and before incubation has started the courtship ceremonies are even more elaborate than before. The nests are built on the bases of those of the last season, which are now trodden to about half their full size. The female sits on the half-built nest and the male walks around among the surrounding tussocks picking up bits of peaty moss and mud. He brings these to the female and deposits them on the edge of the nest and bows to her, at the same time making a groaning sound. She returns the bow and groan to him and then takes up the load of material which he has brought and arranges it on the nest, shuffling around on half-bended legs

to stamp it down with her large webbed feet. The male then sits down on the ground close alongside the nest and makes a vibrating bubbling noise in the throat several times, at the end of each call stretching the head up and braying with the bill open. The female answers him, and then they start nibbling the feathers of each other's throats, heads, and necks. This is followed by a further round of bubbling and braying and then the male gets up and goes to fetch another load of nest-building materials.

'After every four or five loads that the male brings to the nest both sexes go through a more passionate demonstration of affection. The male brings his load and deposits it, and after bubbling and braying, and nibbling each other's heads and necks, they both stand up, and the female steps down off the nest. Facing each other they both stretch up their heads and give a harsh bray with the bill widely open. Immediately after the bray the bill is brought so that it points vertically downwards and is thrust among the plumage of the breast. The bray is expiratory, and a lower, inspiratory note is made while the bill is touching the breast. They then lean forward together and touch the tips of each other's bills. After this they both keep the neck bent forwards, and bend the head upwards slightly and vibrate the mandibles very rapidly causing a peculiar rattling sound. The syrinx is not used in producing this sound, which has a slight musical ring, rising

from a low note to a high one during its performance. This is owing to the increasing quickness of the vibrations and to the filling of the lungs with air during the process so that the thorax acts as a sound-box.

‘After these antics are repeated several times the male starts to walk sideways around the female, working his head from side to side with each step, and the female steps around without moving her position so that she is facing him all the time. The male spreads his wings widely, and pointing his head upwards repeats the vibration of the mandibles. He next bends forward, doing it again, and the female answers him, at the same time spreading her wings too. They continue in this attitude, stretching out and touching bills, then vibrating and touching their own breasts with the tip of the bill twenty times or more, after which pairing takes place and they return to the nest, the female sitting down on it, and the male carrying on his work of collecting material for it.’

I have quoted this in detail because its strangeness and mystery typify so thoroughly our abounding ignorance concerning this and vast numbers of other living creatures. Albatrosses may be considered as merely gigantic storm petrels, and count among their relations many other oceanic birds. Yet among none of the others do we find anything like this complex courtship and the still more inexplicable dance which

goes on long after the seasons of courtship and incubation.

The black-footed albatross which we saw from the *Zaca* is so-called from a translation of its technical title *Diomedea nigripes*, which, to the observer from the deck of a vessel, is about as enlightening as would be the information given when walking down Fifth Avenue, that the passing crowd were white-toed Americans. It is one of the dark species, and the plumage on the whole is a delicate sooty brown, slightly paler on the neck and lower parts. A conspicuous field mark is the white area on the forehead and around the bill together with a small white spot behind the eye. It is considerably smaller than the wandering albatross, with a correspondingly less extent of wings. But it is all albatross as regards its infinite grace and power of flight, its wide range and restricted breeding area, and its strange dance ritual.

It wanders from Japan to Alaska over all the North Pacific and from the Aleutian Islands and Bering Sea south to the equator. It nests on a few small islets north-west of Hawaii. Here the birds focus from all directions at the breeding season, court and dance, lay eggs, incubate, rear young, and still dance on and on. Dr. Fisher writing of the albatrosses of Laysan Island says: 'If we wander over the island on a moonlight night a strange scene greets us. Nocturnal petrels and shearwaters are wide-awake and

are sobbing and yowling as if all the cats in a great city had turned up at once. Back and forth in the weird light flutter shadowy forms, and from beneath our feet dozing young gonies bite at us in protest. Down by the lagoon where the herbage is short we can see for some distance and the ghostly forms of the albatrosses shine out on all sides, busily bowing and fencing, while the nasal sounds of revelry are borne to us from far across the placid lagoon, and we know that in other parts of the island the good work is still progressing. And so in the leisure moments of the long summer days, and far into the night, these pleasure-loving creatures seem to dance for the joy of dancing.'

On a late March day, as I have said, a pair of these birds followed us all day long. For some time after they appeared in the distance I paid little attention to them, deceived by their shearwater-like flight and the lack of any scale to show their relative size. But the first time they approached a group of gulls their great spread and larger bodies marked them at once for what they were and my glasses showed all their principal characters. A quartet of herring gulls also kept with the *Zaca* all day and frequently alighted close together in our wake among a flotsam of galley refuse. One of the albatrosses would then soar up, bank sharply, put on all its brakes of wings, tail, and feet, and settle, scattering all the gulls.

The beat of these albatrosses was a slow and

irregular circling of the *Zaca*. Coleridge showed himself a reliable ornithologist when he wrote:

*'It ate the food it ne'er had eat
And round and round it flew.'*

The flight was low, usually close to the surface, following the course of the swells. If their exact flight could be plotted it would be irregularly wavy, reflecting the succession of swells and occasional cross waves which had risen and fallen like malleable mounds beneath them. Their course was never in a straight line, but more like the method of a shear-water, a slow swinging to right and left, ending often in a sharp bank, the tip of the down wing sometimes touching and seeming to press against the surface. A number of times during the morning they alighted on the water well off to one side, fed on some bit of sea food and took off again with much greater ease than could a cormorant or duck under the same conditions.

On another day four albatrosses and the same number of small black storm petrels kept us company. I watched one of the former slither down into the water off our starboard quarter within a landing space of not more than six feet. As it alighted I could clearly distinguish the white rump and upper tail-coverts which proclaimed it a bird of the year in not fully adult plumage. It picked up a dead squid, gulped it down and shook its beak several times in

the water. Then in the face of a very slight breeze it spread its wings, took off with exactly two paddles of its great webbed feet and rose easily.

For an hour or two around mid-day the albatrosses disappeared entirely, but at two o'clock when we were on deck after lunch a bird came up rapidly from behind. Crocker took a chance on a long shot, when the bird shook itself but was apparently unhurt, although it soon alighted on the water. A second albatross now appeared and soared twice over the sitting bird and vanished. The *Zaca* made a quick revolution on its course. As we approached, the bird rose without difficulty and started off, but turned about almost at once and flew directly toward us. A second shot, well within range, killed it instantly. Again we steered toward it and gathered it up in a hand net as we passed. It was almost in full plumage, weighed six pounds, and had a spread of wings of exactly seven feet.

In the early afternoon this incident was repeated in almost every detail. Both proved to be females, showing no hint of an approaching breeding season. While one had eaten a large number of short stems of seaweed forming a good-sized wad in the stomach, the other had swallowed forty squids, some of which must originally have been of large size.

Superstitiously inclined readers may be interested to know that an hour after we had shot the second albatross we lowered three deep-sea nets to three,

four, and five hundred fathoms respectively where the chart showed a depth of twelve hundred. When the wire was reeled in it was quite devoid of nets, rings, and bridles, having evidently landed upon, scraped along, and torn away on some uncharted, rock elevation less than three hundred fathoms below the surface.

“*God save thee, ancient Mariner,
From the fiends that plague thee thus!—
Why look’st thou so?” “With my crossbow
I shot the Albatross.”*’

But you see, ‘O Best Beloved,’ the mariner shot for pleasure and the only use made of his *Diomedea exulans* was to have it, unpleasantly enough, hung about his neck, while we examined, described, measured, compared, skinned, and preserved, as well as recorded, food, parasites, and all the minutiae which go toward a better understanding of the What? Why? and How? of an albatross!

Early in the morning of Sunday, March 29th, the *Zaca* slipped between two dead headlands, Entrada and Rodonda, and entered Magdalena Bay. For many yards cascades of living spray rose ahead of our bow—hundreds upon hundreds of eared grebes, each of which leaped up, forward and down, disappearing in a curved dive and a single kick. We anchored off a little settlement of a dozen ramshackle

houses, constructed chiefly from the timbers of the ancient wreck of a three-master. Thirty years before, almost to the day, E. W. Nelson had photographed this place, and the only change in this time that I could see was a bigger and better graveyard.

As we lay quietly at anchor in the early morning light a line of cormorants passed, then another and another, and there was no cessation until late in the afternoon. Sometimes they drove by five or ten lines deep, either actually head to tail, or at most with a two-cormorant interspace. Sometimes the lines bowed toward one another but never by any chance merged or broke. Single file is the ancestral, inviolable flight pattern of these birds. They barely skimmed the mirror surface, but now and then some object invisible to our eyes caused a temporary upwelling of the unending rosaries of black bodies. Occasionally a densely packed raft of surf scoters caused the animated thank-you-ma'am, and long after the ducks had swum away or dived, the upbending of the following hundreds persisted and marked the spot of the long-past occurrence. It was the memory of a past event continued into the present and made visible by the spirit-of-the-flock absorption in the action of its fellow immediately ahead. It would be interesting to know the percentage of ocular attention paid to the flock movements as embodied in the direction and trajectory of the preceding bird, compared with the individual attention to lateral

dangers or objects of importance to the life and activity of the respective individual cormorant.

A dense white fog came in before mid-day, crawling slowly past the rocky mountains of the island; at first a slender, opaque white line, gradually billowing out above and below. It also drifted across the bay, yet drifted was not the word. I never realized before the necessity for active verbs as applied to fogs. They have always seemed the thoughtless terms of a writer of fiction. But this fog had an active, dynamic personality, although a sinister one: an inexorable, evil advance, without hurry, without sound, engendering a desire to escape quickly in the opposite direction, almost as from a gas cloud. I had none of the mariners' fear for I had never experienced a fog in any dangerous situation. This was a wiping out, a complete dematerializing of everything, and none of us liked it. I think I could imagine the feelings of some ultramicroscopic organism in the path of an imminent amoeba, whose unrolling, sightless pseudopodia would soon effect a complete encompassment and obliteration.

As the fog swept across the bay the cormorants came nearer the *Zaca*. As their fear of losing sight of the shore increased, their fear of us diminished. Now the beating of their wings became audible, a strange, feathery, muffled whistling or sizzling. It seemed to contain an element of beating rain, and made one imagine the fog flicking in great drops

off their throbbing pinions. The nearer they came, the deeper the roar. Only now and then did I hear a rather soft, high, muted note, more like the voice of a goose a long way off than the guttural croak which is the usual utterance of a cormorant.

The custom men who came aboard said the birds roosted but did not nest on a large island on the far side of the bay, and every day flew out to sea to feed. They called the cormorants *patos* and said they were good to eat, which cast doubt on all their information.

When at last the fog lifted slightly, I saw, with my number twelves, thousands of the birds as far as visibility permitted, all coming toward us across the bay, and all head on in transverse lines of several hundred. This was a very unusual formation and lasted only until within a hundred yards of the *Zaca*, when they turned without haste on their own axis, bird and bird as one, and then passed us in the usual head to tail pattern, in many parallel but individual lines.

Beyond our bow each line curved slowly to the west and then swung across nearer the shore line as the fog held tight across their path. This brought the skeins parallel to the shore and in this alignment they vanished, headed full speed for Entrada Point and the open sea.

Small paddles of surf scoters and scaups together with a few grebes were all about us, while on shore

were hundreds of gulls close to the water, and numbers of great ravens walking about higher up.

Magdalena Bay has held the headlines of newspapers and kept diplomatic wires hot on more than one occasion. It has often been the favourite winter practice ground of the American navy; the Japanese threatened to occupy it at one time; when whales still existed in these waters, the whalers foregathered here; a great company once rented it to exploit orchilla—which is the dye from a lichen used to colour the liquid in thermometers. Yet these have all come and gone and left no trace. Cactus and mangroves, ravens and coyotes, gulls and cormorants—all proceed according to plan, unaffected by man's lethargic, inconsequential presence.

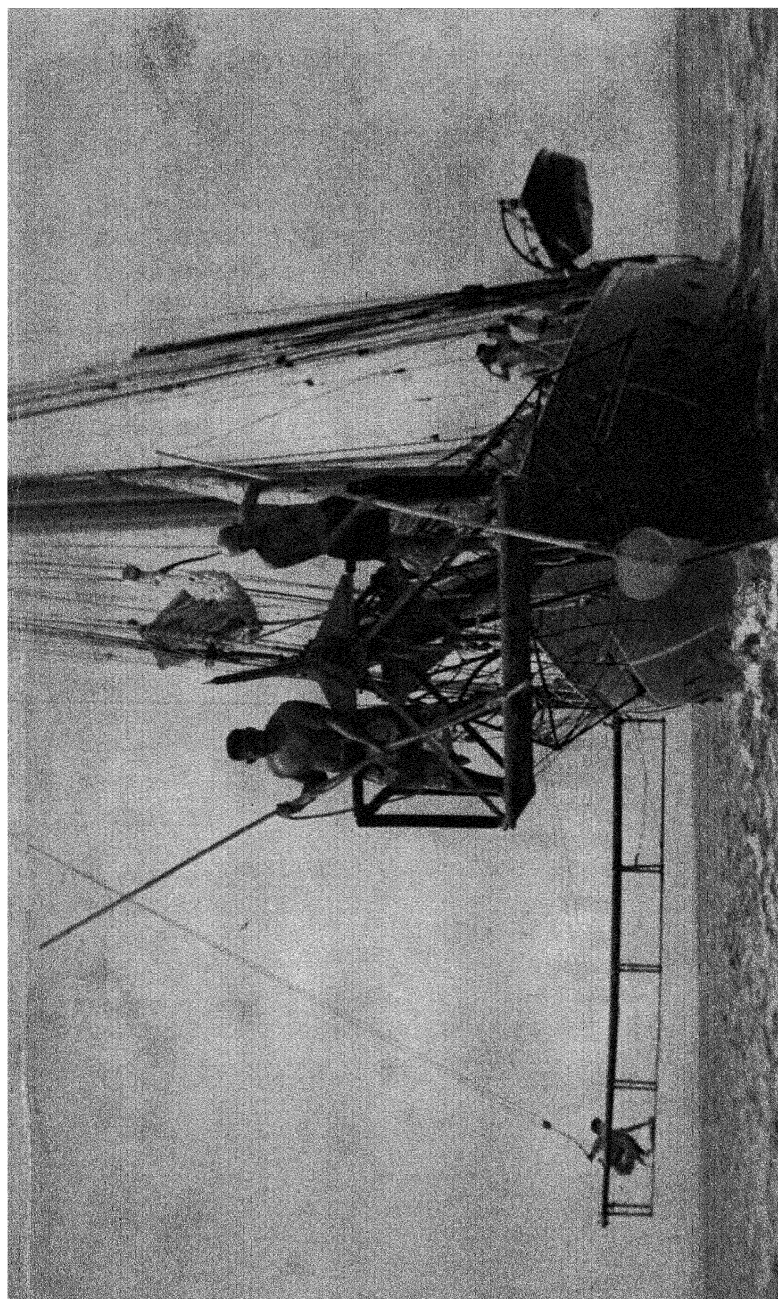
I suppose if I lived here, with prospects of dying in the course of time and adding my bit to the farther rim of the graveyard, that cormorants would not be of the vital interest which they now are to me; that their daily seaward migrations would not savour, in marvel and extent, of the precession of the equinoxes. But in spite of the Mexican customs man they are not ducks, nor are they *bueno para comer*. The flesh of corn-fed crow is not nearly what legend has it—I have eaten it half a dozen times—but an experiment on parboiled cormorant, many years ago, elucidated a taste which was neither fish, flesh, nor fowl, but with a decided accent on fish—and fish neither present nor future.

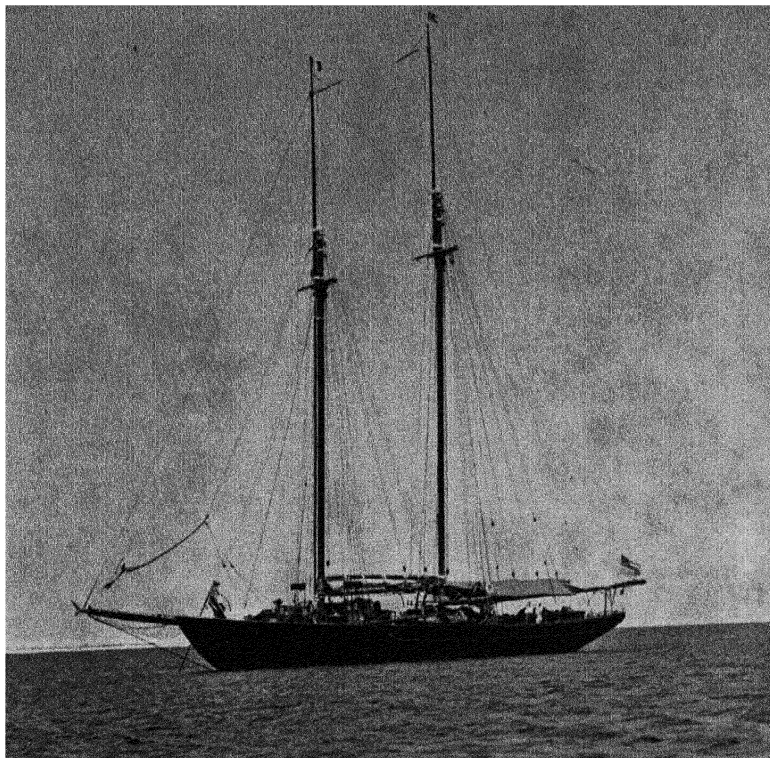
II

WITH THE GRAY FRIARS

THROUGHOUT Sunday afternoon and Monday the thirtieth of March, we steamed slowly down the coast of Baja California, with occasional stops for five hundred fathom hauls, or for collecting around the night lights. Monday afternoon, when the last meter net reached the surface, we were about a dozen miles south of the tip of the great peninsula. As we pulled in the net and secured its treasures a sailfish leaped clear of the water astern and turned quite over in mid air, and a school of bullet-headed blackfish whales rose, heaved mighty sighs and slowly sank again.

We turned toward the north and east and steered direct for the pale giant rocks which mark the tip of Lower California. The boom walk was down and we all crept out on it and watched one of the most lovely of all landfalls. The great backbone of the peninsula stretched away northward, becoming grayer with chaparral in the middle distance and finally purpling into invisibility. We headed for the lighthouse which loomed a desolate stubby finger in the midst of an arid sahara. Some giant of long





THE 'ZACA'. Whether circling the globe, creeping into land-locked bays, weathering any gale, or affording the steadiness of a shore laboratory, the 'Zaca' fulfils all the requirements of a scientific expedition and delicate technical work. (3)

[Overleaf.

OUTBOARD ON THE 'ZACA'. The pulpit and the boom-walk, first used on the New York Zoological Society's 'Arcturus', are installed on the 'Zaca' and account for many a rare specimen. (4)

ago might well have taken a huge double handful of sand and let it pour down over the mountain sides and foreshore, in one place forming a solid arenaceous plateau sloping steeply to the ocean, and farther along letting it trickle over and around great outcroppings of rounded ridges. It glowed warm in the light of the lowering sun, and as we rounded Cabo Falso the colours ran riot and shifted before they could be defined. Sand and rocks alternated along the shore, both defying the onrushing swells and blocking the strongest breakers, in the one case by the resistance of mobility and in the other by sheer solidarity.

Our goal appeared ahead of us—a group of lofty rocks so mingled that it was impossible to tell which was islet, which was promontory. They were the southernmost dry land in this part of the world. There is always something dramatic and exciting about a point of land which lies farthest north or south of any great area; the extremity of Cape Horn and of the Cape of Good Hope far exceed in interest the land a few miles to the north. When we rounded the uttermost austral rocks of the peninsula we found them abounding in superlative attributes. The early Spaniards called them *Los Frailes*, and a small, unimportant shred of their destiny is to have been painted as the background of the sailfish group in the American Museum.

As we approached and encircled them they shifted and altered like moving, living creatures. A herd of

I recalled that this was after all only the middle of time and that as much stretched ahead as behind.

The last breath of wind died with the setting sun but, as compensation for this peace, fish came in shoals and seized upon every bait at once, with the result that the deck became an active arena of great groupers, sharks, and other sea folk. After dinner, when the afterglow still balked the night, we took the launch and went over to the shore and along the east side of the Frailes. Before we reached the foot of the pale heights the darkness settled down and only with our searchlight could we distinguish details.

We passed a whitened islet packed with pelicans refusing to be roused from slumber. At the sudden strange light which illumined them they merely opened an eye half hidden among the feathers of the back, blinked once or twice, and closed it again.

Slowing the engine, we crept quietly along the rocks, the water so still that hardly a ripple marked the boundary between stone and liquid. Deep within an inlet, between two majestic heights, a sloping rock thirty feet square rose a little above the tide. On it in front lay two great sea-lions and close around and over all the rest were scores of cormorants, leaving only a small area near the highest part where four small sea-cubs were ensconced for the night. The birds woke at once and grunted their displeasure and shifted restlessly. One of the young mammals

hitched forward interestedly and finally dived and swam out toward us. As we drifted nearer, we reached the inevitable dead line so perfectly visualized by all wild creatures. The rock cleared amid uproar and confusion, croaks and roars, splashing flippers and flapping wings, until only a single pup remained. We were surrounded by a dense mass of cormorants, straggling alone or packed so densely that they could hardly swim. Pelicans appeared from somewhere and threatened to fly directly at us. Soon all vanished and the cove was as quiet as before, the rock wholly deserted except for the one lonely baby sea-lion.

I swept the light up over the face of the cliffs and a hundred black paper cormorants appeared, pasted flat against the sheer walls. They were on such tiny ledges and their bodies were so close to the rock that they cast no shadows. Near the summit were two birds which if possible seemed even blacker than the sea-birds—a pair of ravens watching us. On the way back to the ship the whistling swish of feathers against air of invisible birds in flight came from all around and overhead. I was glad that the Mexican customs official was away drinking tequila at the fiesta at San José del Cabo.

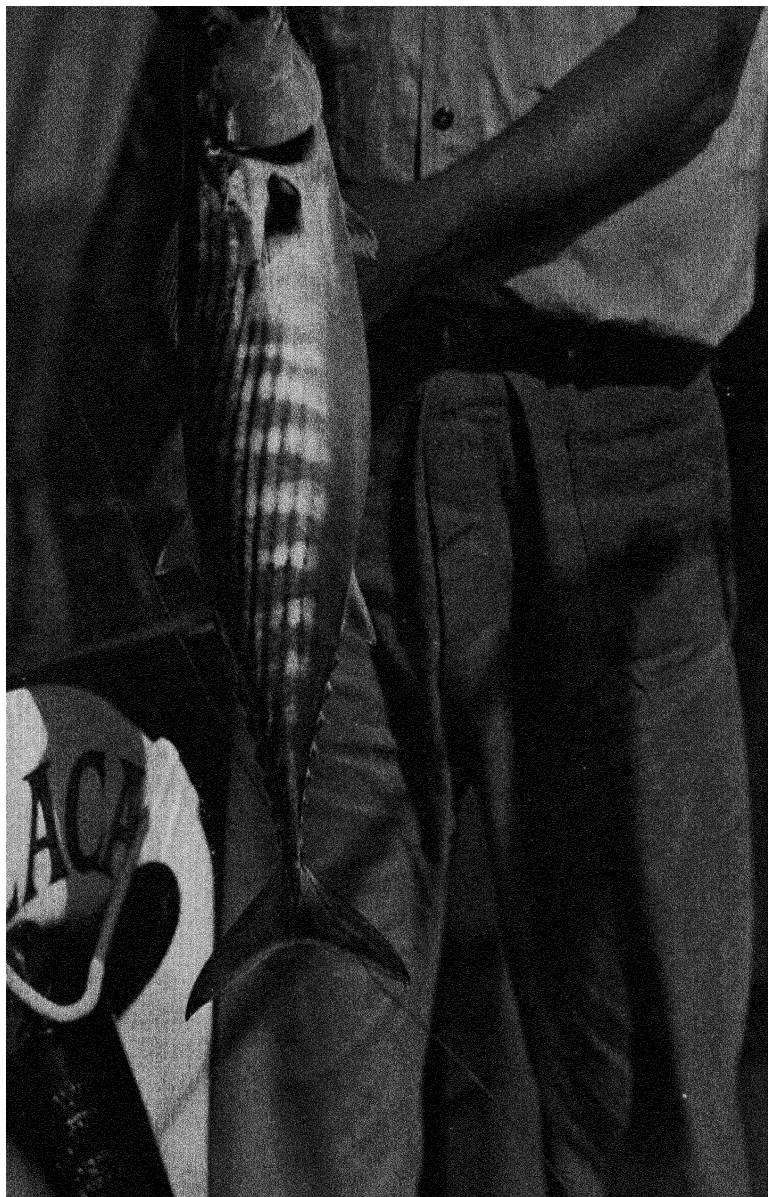
In the early morning light of April 1st the shore of San Lucas Bay appeared almost deserted. Far up at the extreme end was a small, rusty-roofed building with a diminutive wharf, and a single tunaboat

moored alongside. The sole reason for the existence of this corrugated cannery lies in the fact that at certain seasons of the year enormous schools of tuna and skipjack appear from no one knows where, and that their flesh is delicious. They are powerful, chunky, spindle-shaped bundles of energy, as ultramarine above as the water of the open sea and as white below as foam.

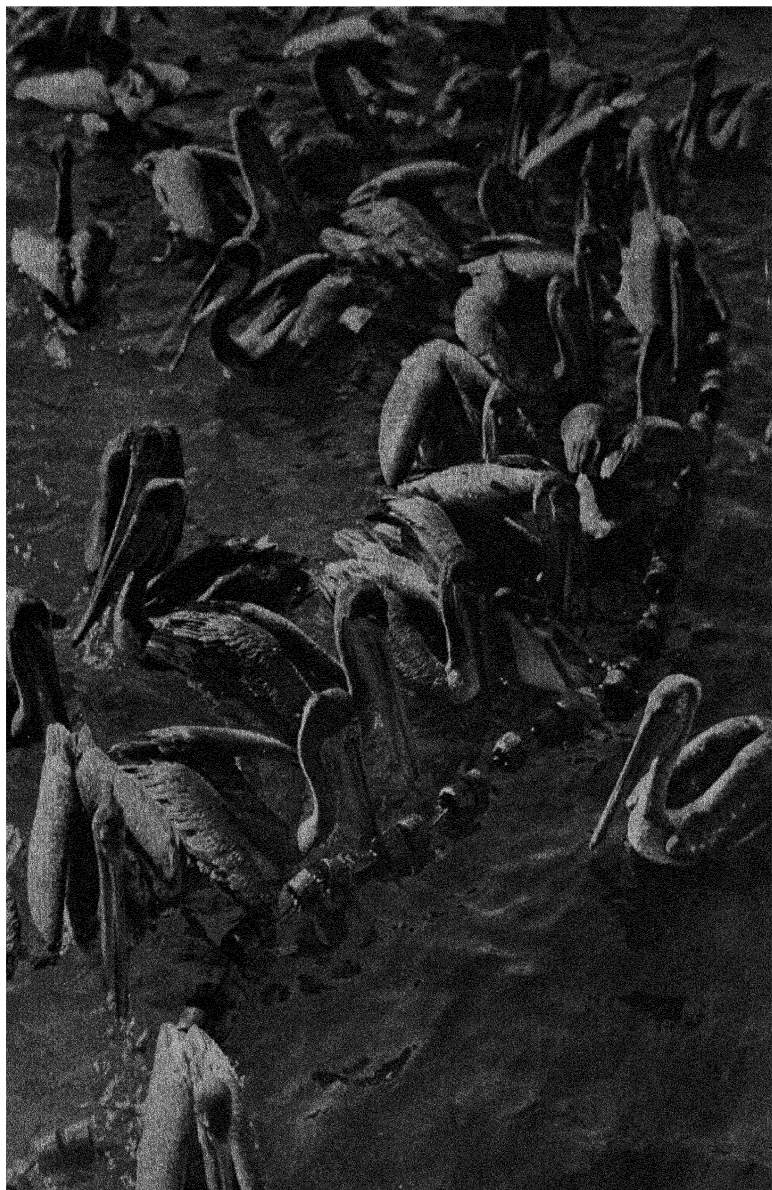
Eastward along the shore past our moorings stretched a high dune of sand, cut through in one place by a great gash or shallow gorge, beyond which the dune began again, still higher and steeper, and extended to a distant pile of rocks which marked the beach horizon.

When I reached the wharf a long seine was being drawn, pulled by men in two boats. No fish were visible, but the entire enclosure of the net was filled with an almost solid mass of pelicans, all except two in brown immature plumage. They were in and out of the net, their claws catching in the meshes, and now and then they fairly bumped against the boats in their fearless eagerness to snatch at any stray sardine which came near the surface. Not until the catch was actually pulled aboard and dumped into water casks did the pelicans retreat, and then they gathered in small groups like the financial conferences of little black boys who have been diving for pennies. (Fig. 6.)

This securing of bait seemed like an ordinary event



CALIFORNIA BONITO. Photographed alive, just lifted from the water, this bonito shows two evanescent patterns of bars and stripes. (5)



PELICANS. *The comic, friendly pelicans are omnipresent, beloved by us, tolerated by the Mexicans, superb fliers, skilful fishers and forever striving to remember to be dignified. (6)*

in the lives of these Mexicans, but I was soon to find that the seining was not an isolated thing, for it had neither beginning nor end. It was only a short segment of a complete circle merging without seam into past and future. From the wharf itself I looked down and saw the scraps and entrails of tuna which had enticed the sardines and young jacks into the net.

I followed the destiny of these small fry. They were taken over to the tunaboat and put on the upper deck into huge live-tanks already inhabited by hundreds of their own kind. I went over the boat which was captained by a Japanese and manned chiefly by Portuguese. One little cabin had been transformed into a Roman Catholic shrine with a Virgin, whose silver tinsel and filmy lace glowed with more-than-oriental splendour in the light of tiny electric bulbs camouflaged as candles.

When all is ready the boats put to sea, sometimes to get a full cargo within sight of the cannery itself, sometimes to search vainly for many days. When the lookout on the ladder-mast discovers a school of tuna, the boat approaches slowly, and live and cut bait are thrown over, chumming the fish closer. Then the angler crew gets to work with stout bamboo poles, four-foot lines and barbless hooks. If the fish bite well there may be a steady curving stream of flashing tuna in mid-air, from the water into the fish wells. When days are spent in the search some of the tuna caught are cut up and fed to the

live bait which must be kept alive at all cost. The frenzy of a school of tuna excited by a rain of living and dead bait is indescribable, and they often bite at bare hooks as readily as at a white rag lure or a living sardine.

When several tons of the splendid creatures are piled on the decks, they are packed into the ice room and the tug-like craft heads full speed for home. One boat, the *Venetian*, came in on this first April day and I followed the tuna circle through its full sequence. One by one the fish were thrown up on the wharf, where they were loaded into a steel weighing cage. When this was filled with eighty or ninety fish, totalling around eight hundred pounds, the crate was shifted to a hand car which one of us inevitably dubbed a tunaville trolley! This was trundled back to the open cannery shed, where the fish were cleaned by most expert Mexicans, the entire process being accomplished with three motions of incredibly sharp knives. The tuna were then packed on steel trays and wheeled in racks into great ovens where live steam was turned on.

We were sufficiently interested to make an accurate count and found that this particular boat had taken 6,750 fish, of which the tunas outnumbered the skip-jacks three to one. Most of the fish were two feet or less in length. Of 535 stomachs which we examined only 46, or less than 10 per cent, held food other than bait. And even this was of the scantiest

description, consisting, in the order of their abundance, of larval squillas, primitive shrimps, squids, small lobsters, and fish. The squilla larvae were present in great numbers in spite of the fact that these organisms, all in the transparent phyllosoma stage, were of the thickness, consistency, and apparent general vitamin content of minute bits of cellophane. Yet in the food of both Atlantic and Pacific tuna these are favourite items of diet.

It is an unsolved mystery why these stout, virile fish, all well-grown, keen-eyed, and extremely strong swimmers, should so often be empty and yet apparently voraciously hungry. With all the richness of life in the open sea from which to choose, nine-tenths of the tuna examined either have empty stomachs or else have stuffed themselves with half-inch, almost invisible, paper-thin larval crustaceans.

As the entrails of the tuna are removed they are dropped overboard as bait for the sardines presently to be caught in seines, and with this the circle is closed; entrails to bait, bait to live wells, bait to tuna, tuna caught, cleaned and again entrails to bait.

The thoroughly steamed, cooked bodies of the fish are the centrifugal product thrown off by this revolving circle. When they come steaming from the ovens they are skinned and boned, leaving the clean long strips of meat which are taken by lines of Mexican girls and pressed by hand into tins. These last are placed on little moving tracks and mechani-

cally fed with the requisite amount of salt and oil. Near the farther end of the cannery room they are capped and soldered and finally dropped into a vat, where terrific heat kills every possible bacterium unfortunate enough still to inhabit the tins.

After my return from this expedition I stopped one day at a New York grocer's and asked for a can of tuna-fish. It made a delicious sandwich and as I looked at the sprightly, gorgeously coloured and wholly impossible tuna on the label my mind went back to the diminutive cannery at San Lucas and the unending circle of life and death. More than anything else I visualized the uncounted hosts of these grand fish and the absolute mystery of their eggs, young, migrations, and food. Almost twenty million tuna and skipjack are caught and canned along this Pacific coast in a single year and yet the fishermen told me that they can detect no diminution in their numbers.

At the first opportunity I assembled Frank, the Samoan with the bulging muscles, to pull up the nets, and Jocelyn Crane to help sort the catch, and with our two-foot dredge in the otter boat began a series of hauls close to the *Zaca* in the shallow water of San Lucas Bay. Only forty feet from shore and twelve feet below the surface Frank brought the dredge up almost full of sand, and when we had washed this away we found a residue of little turreted

snails. Later, on board, I devoted a half hour to them, whereupon they became distinct recognizable individuals with marked personalities.

Their man-given name proved to be *Mazatlanian hesperia*, especially appropriate here in the Lucas shallows, which are about two hundred miles due west of that Mexican city.

The little creatures were barely a half inch in length with about six complete whorls, and in their two-fathom-deep kingdom of sand must have found life congenial, for we brought up fifty after only a minute or two of dredging. On the whorls there was a low sculpturing—thin, longitudinal, ivory-white ridges interrupted by the valleys between the spirals. Some of the shells were plain with a neat, dark band along the upper slopes, but more often the lower three-fourths of the whorls were vividly stencilled with rich red-brown zigzags, arrows, V's, and abbreviated lightnings. In fact I picked out several which I am sure could be read by the ancient priests of the Temple of the Tooth in Kandy, Ceylon, for the twists and angles appeared, to my ignorant eyes, to be sheer Pali for beauty. It is rather a pleasing thought that, through all the deep sand of these Pacific shallows, these Mazatlan sunset shells forever carry about with them some age-old truth of the Bodisat, or a Sanscrit invocation.

The proverbial army which travels on its stomach is sheer metaphor, but in writing of these snails when

I say *foot* I mean the whole lower surface of the body. This part of the hesperian is slender but strong and ends behind in an elongate flagellum-like whip which twists and curls about as the owner creeps along, vivified by whatever excites the tail of a snail. The pinkish head is a mere projection with a pair of long, slender tentacles, and two faint eye-spots near the base. From the rounded spout of lime which projects from the very base of the shell, a tube can be stretched out as long as the shell itself, with many reddish spots and bands on the terminal half. All we can do is to compare this structure with nostril or windpipe for it admits the oxygen-bearing water to the gills. One interesting thing in the make-up of this mollusc is the correspondence in pigmentation of the shell and the soft parts of the snail itself. If the shell is pale and only faintly marked, the body, siphon, and foot are also immaculate; if the writing on the walls of the whorls is sharp and abundant, the foot and siphon are dotted and lined with the same red-brown colour.

I have never seen such active or combative molluscs in my life. When a dozen were placed together in a dish of water they went insane with rage at the too intimate proximity of their fellows, whanging their bodies and robust shells about, thrashing their whip-like tails from side to side with real force, banging each other with all their might. The skill and effectiveness of the caudal filament left no doubt that its

flail or lash-like form was an adaptation as an organ of defence.

Many of the hesperians were covered with small, oval packets of eggs, which were wedged neatly in the flat areas between the north and south ridges, two to each of the larger and one to the smaller whorls. Each cluster contained fifty to seventy eggs or embryos. When still undeveloped they were opaque white and arranged in a single layer around the outer part of the transparent capsule. When hatched and at varying stages of development, so far from being damaged by the unmolluscan warfare of their parents, they, all unintentionally, waged a lesser, intracapsule battle of their own. Although they may have reached only the veliger stage of two bands of cilia and an infinitesimal shell, yet they unceasingly rushed about, crashing into their brethren, bouncing off, yet never shifting from full speed ahead. As I watched them under the lens I could see an unexpected proportion of dead embryos.

At this early stage the black eye-dots were very distinct, much better developed than in the full-grown snail. The minute shells were porcelain white at first, and eighty of them in a row would barely span an inch. Later, they changed to transparent greyish horn, and so increased in size that they were packed tightly in the capsule, unable to move anything except restricted segments of the bands of cilia which waved frantically but to no purpose. At this

stage they must be almost ready to hatch for when I pried off one capsule and ruptured it, the infants swam happily off in all directions.

The capsules are of the consistency of hard rubber which insures their safety from attrition against the mud and sand, and especially from the violent contortions to which their parents are prone on the slightest provocation. In a few cases I found the entire shell of the snail covered with capsules, to the number of fifty, attached on all sides of every whorl. So there is no apparent instinct to protect them by gluing them only to the upper surface of the shell.

I could glean no clue as to how the parent attached the egg masses. They are evidently produced at different times for in the midst of a half-dozen capsules of new-laid eggs there would sometimes be a single dark one with its three-score of occupants ready for launching.

Beneath these calm waters and among gently moving, quiet young crabs, starfish, and stargazers, it was incredible to find this host of mother snails, some bearing upwards of three thousand offspring on their houses, living such vigorous, tumultuous lives.

New to me, although another species is found in the West Indies, were little sea-pansies, small colonies of polyps related to sea-pens and less directly to sea-fans and plumes. These were very lovely purple and violet plaques, looking from above like the

stylized spread-eagles of heraldic insignia. This spread fan furnished the base for the radiating polyps. The whole affair was only an inch or two across and it stood about the same height on the slender stalk. Like the snails, the pansies apparently lived in large associations in limited areas, for we brought up thirty-five in a single dredge.

Continued dredging in from three to thirteen fathoms along the San Lucas beach revealed the fact that these shallows were a nursery of sorts for many creatures which, when full-grown, lived in the deeper water of the off-shore banks. Here were young shrimps, crabs, hermits, and spiders, urchins, sea-eggs, clams, olives, cones, brittle stars, flounders, and stargazers.

Comparisons are among the most necessary things in the world. Without valleys, mountains would be nothing; lacking warmth, how would we name cold? I had looked at the green water in San Lucas Bay for three days and the thought of diving never occurred to me, for the opacity seemed so great that I could not conceive any possibility of underwater observation. On the morning of this second day of April, when dredging in the shallow water, we took a sounding before each haul, and I was much surprised to see the sounding line with its coloured tape marking off the fathoms showing clearly far beneath the surface.

After lunch three of us set out with a boatful of diving outfit, towed by the launch. I chose the side of an islet about ten feet across close to the steep draperies of the magnificent Frailes. We tied the bow to the rock after dispossessing several pelicans and cormorants, and threw the anchor far astern. Both ropes were tightened until we rode steadily between the two holding points. Through the water-glass I could already detect angelfish and eight-inch puffers, the latter rich blue starred with myriad white polka dots. Down I went, sinking beneath the surface of the Pacific for the first time since my last dive in the Galapagos many years ago, on and on until I felt the soft sand beneath my feet. And now as always, I realized anew how much we should have missed of undersea life if we had confined ourselves to more conventional methods.

Before me I saw the sandy expanse sloping gently up until it piled against the very foundations of the Gray Friars. To my left the islet rose steeply, its deep clefts filled with a gorgeously coloured animal rock garden of purple gorgonians and yellow sea-fans. Here and there slender-fingered starfish clung to the crevices like strange, lavender, sessile blossoms. Others were thorny, with a multiplicity of stumpy arms, well deserving the name sunstars. Beneath my feet and behind, the sand sloped so steeply that I dared not let go of the ladder or I should have slithered down into what, to my eyes, were un-

fathomable depths. This abyss was so dark that when a fish appeared, it materialized in mid-water. I stood fascinated and watched this black, watery pit. A trio of groupers drifted slowly toward me, first visible as disembodied, gaping mouths, set forever in a half-grin like submarine Cheshire cats. Two of them were more than a yard, while the third was quite as long as myself. Then came two other monsters, deep for their length, with a great hump on their shoulders. They wandered along the rocky cliff, grazing slowly as they came. The great blue and green scales, and solid teeth like the beak of a huge macaw, marked them as parrot-fish, but veritable giants. They rolled their eyes at me, hung suspended in mid-water for a time and gradually sheered off, melting again into invisibility.

Clustered about my helmet and feeding on the slopes of the little island were fish in great abundance. I was constantly watched by surgeons, by dark demoiselles with their profile traced in brilliant wine colour, and by wrasse, wholly new to me. There was a school of forty or more old friends of the Galapagos, yellow-tailed *Xesurus*, whose philosophy of life I had tried to fathom in years past.¹

I crept up-sand until I could stand without fear of sliding, looked ahead and fell on all fours. This was chiefly an instinctive desire for concealment, which, I was to discover, was quite needless. Before

¹ *The Arcturus Adventure*, Chapter XI.

me, covering the considerable expanse of sand within view, was a garden of eels. From the pale surface, in every direction, there arose perhaps fifty forms. They resembled iron rods as much as anything, slightly bent above the middle of their length, sticking up from the sand, but, unrodlike, swaying very slightly. As I crawled toward them, those nearest me, without effort, and so slowly that the motion was scarcely observable, sank gently into the sand, until only the heads were visible. When even the latter disappeared the sand closed over the small holes and the eels were as if they never had been. There was a perfect gradation from the vanished ones nearest me to those twenty feet away which projected two feet or more. They were all in profile, facing up-current, and paid no attention to me other than to sink from view at the deadline of about six feet. We were fated never to capture one of these eels, for although I set a baited trap near by, none of them was taken, and a dynamite cap exploded over them simply stirred up a cloud of sand. There was no doubt, however, that they belonged to the tropical group of eels known as *Taenioconger*.

By this time I was too cold to observe further and turned to the island wall, pushed my dynamite-capped pole as near as possible to one of the strange blennies and signalled for the explosion. After the debris had cleared I saw a small reddish form lying on the sand and seized it. By the time I had reached

WITH THE GRAY FRIARS

the surface the blenny had begun to recover and it was in full vigour when the time came for it to sit or rather swim for its portrait. It proved to be a species new to science which we named for Mr. Crocker.

III

IN THE GULF OF CORTEZ

FROM the point of view of intellectual entertainment and, in fact, all the mental delights of life, our *Zaca* cosmos seemed perfectly self-contained. Only the possible limitations of our respective life-spans prevented us from assuming that anything this side of eternity would interfere with our timeless, joyful occupations. In more mundane matters, however, pragmatic considerations began to rear their heads, to use a sea-serpentine simile. In spite of the fact that we wore as little as the law allowed and that bathing suits were more often than not our interprandial garb, yet in the course of time there was broadcast the announcement "Laundry Calling!" Also a mysterious fuel tank was reported empty. So the Committee of Ways and Means, which was Crocker, said "Don't you think?" and we all heartily Yessed.

We up-anchored, rounded the blunt tip of Lower California, and steamed northward, proceeding slowly so that at daybreak we were close to Ceralbo—our first island actually within the great Vermilion Sea, or Gulf of California or Gulf of

Cortez. I wish, without arousing the ire of geographers, I had confidence enough consistently to use the latter name, which is so much more appropriate than continuing the title of the State so far to the north.

Friday, the third of April, dawned warm, sunny, and calm—a trilogy which spells perfection in sea exploration in the tropics. We left San Lucas Bay at six o'clock and steamed slowly for El Gorda Banks, twenty-two miles to the eastward and five miles offshore. Later in the month we were to return and come to know these banks and their hidden inhabitants better than we could have foreseen. To-day six tunaboats were at work close together, the crews chumming and slapping the water with their long bamboo poles, striving to attract the schools of tuna which were ruffling the water in various directions.

On our leisurely way to the banks we were never out of sight of fish leaping singly, or in great schools which troubled the surface like tide-rips. Then dolphins came and rolled and curved and sighed all about us. Pe, the Samoan, went into the bow with a harpoon, struck, and lost his balance. I happened to be watching, and saw him begin to fall flatwise. In some miraculous way he twisted in mid-air like a cat and hit the water in a half-dive. Instantly he turned inward toward the boat, drifted along, caught the life line, and hauled himself out.

There was no flurry or fuss, his instant reaction made an accident seem like a usual, practised event. Frank then took his turn in the pulpit and struck a dolphin on the second try, and we pulled it aboard.

When out of the water cetaceans, at first glance, always seem very poorly constructed for any successful rôle in active life. On land we always connect extreme speed or swift movement with a mobile neck and free, slender limbs, while these aquatic mammals look as if well adapted for a sack race. Even the tail flukes are twisted cross-wise instead of, as in a fish, up and down. But the dolphins swimming past showed how infinitely more efficient this shapeless, chunky but marvellously streamlined creature is than any turbine, propeller or other human mechanism, or than any swivel-necked and free-limbed land mammal could possibly be in the water.

Dolphins and penguins have much in common. If the former would bend their flukes forward and stand erect on them, and turn their heads somewhat out of a straight line, the imitation, however superficial, would be absurdly close. Still more interesting and striking is the resemblance in the pattern in certain species. Both have white underparts with a waterline which does not mark the contour above the water when they are swimming at the surface, and both the black-footed penguin and the common dolphin have a curious, narrow black line on feathers

and skin, extending from the anterior base of the flipper to the head, curving around the neck and breast in the bird, and merging with the black of the dolphin's chin. The multiple, peg-shaped teeth have no counterpart in the penguin, and the skin of the newly caught dolphin looks like porcelain and feels like warm, very soft, smooth rubber.

I call these virile beings the 'common' dolphin, for while little is known of the habits of the creatures and even the extent and meaning of the great variation in pattern and colour, yet, far as San Lucas is from Athens and Corinth, this dolphin appears to be identical with that of ancient art and mythology.

We usually think of whales as creatures quite different from dolphins, but the latter are in reality only diminutive copies of their mammoth brethren. A single family contains such diverse cetaceans as white whales, narwhals, and killer whales, as well as porpoises and dolphins. The narwhal is the unicorn-like beast with a single, forward-projecting tusk of twisted ivory; the killer is a thirty-foot terror of the seas, and from the stomach of a single individual have been taken thirteen porpoises and fourteen seals.

We know that dolphins are descended from four-legged, land-living creatures, and it is interesting in this connection that some of the living forms which spend their whole existence far up rivers are decidedly more primitive and still retain hints of characters nearer those of far-distant ancestors than are ever

found in the physical make-up of dolphins which live wholly at sea. In some, for example, the cervical vertebrae have not yet been soldered together, so that they still possess a neck which is slightly movable. Some of these fluviatile dolphins are mud-coloured like the water they inhabit, and others are of a curious light pink. So the pattern of our ocean dolphin is very evidently an adaptation to life in the open sea.

Although hundreds of dolphins had for hours been gambolling about the *Zaca* in the vicinity of hosts of fish of all sizes, the individual which Frank harpooned had only squid in its stomach, eighty-five of them, from four to eight inches in length. It weighed one hundred and eighty-three pounds.

Near the *Zaca* we saw occasionally a school of tiny anchovies leaping in fear of some pursuer; then six-inch fish would break forth and fall back with a splash. The tunas were farther away but fairly boiling. Now and then we watched a great sail or sword-fish leap clear of the surface. Crocker suggested that we go after one of these big fellows, so we set forth in the fishing launch. Ben, one of the seamen and an expert fishing guide, took an elongate piece of dorado or dolphin fish which we had caught the day before, and laced it carefully on the hook. A wooden, spindle-shaped piece of wood called a teaser was paid out astern, and so cunningly was it carved and pivoted that it never ceased to leap and wriggle and

twist like all kinds of delectable bait rolled into one. I was seated in the fisherman's throne seat, a swivel chair, and was trussed up in the complex harness which would help me hold and manipulate my rod and reel, just as in days of old when about to joust, a knight held his lance braced in some gadget of his armour. All this was quite new to me, for I had never caught any fish over twenty pounds in weight, and these usually by the good old jerk and haul-in method.

My bait trailed out beyond the teaser and with my eyes fairly goggling with concentrated excitement I saw a sailfish come up to the bait, touch it and vanish. I reeled in and although I had not felt the slightest jerk, a piece had been bitten out and an entire fresh *filet dorado* had to be prepared and sewed on.

Ten minutes had not passed, although I was convinced it was two hours, when another fish came up and took the bait. Against my instinct to jerk with all my might, but acting under strict orders from Crocker, who with Ben stood at my shoulder and coached me from the side lines, I let the reel run gently under my fingers, then threw on the brake, struck, and hooked him. The fish ran out some distance and then rose high out of the water, without effort, as if he had been shot forth by some unseen force. With widespread fins, he curved in mid-air and shook his head and sword from side to side exactly as he should have done according to all the

conventional accounts, whether in words, stills, or motion pictures. At that moment he seemed as big as the *Zaca*.

The fish then started south, headed straight for the Galapagos and the equator and the line sung (as the sports' writers and big game fishermen say), although to my ears it seemed rather to groan and scream as I thought of all that interminable strand having to come in again. Then began the technique and routine of game fishing, I learning it as I went. Never have I enjoyed anything so much or been so excited. According to dictation, whenever I was able I would slowly raise the rod to high heaven, then quickly drop it again, reeling in what I could of the slack. Then the fish would run out a little more, taking all I had retrieved, and the process would be repeated. At one stage I discovered that I was not reeling in at all, but merely going through the motions, yelling loudly at each drop of the rod. (I made the mistake once of referring to my 'pole' instead of rod, which is equivalent to the use of 'boat' when ship is meant!)

After a time there was a little more slack and I got quite a lot back on my reel, finding that it piled up at one side unless I was careful. Someone said, speaking from quite another world into the one I was inhabiting at the moment, 'Ah, he is getting tired,' whereupon the fish sounded and went toward the centre of the earth with such enthusiasm that I was certain he

had broken my bathysphere record. Dry, unused line appeared on the reel and I fully expected to see the bare axle at any moment.

No one had instructed me what to do in case the last of the line was reached, and the thought flashed across my mind that, as one would heave over a life preserver to buoy up some valuable thing, or throw a barrel after a harpooned leviathan, the most sensible act would be to pitch rod and reel overboard with the hope of retrieving them later and renewing the fight. Fortunately I did not reach this crisis, for the fact that I was buckled fast to the rod had not occurred to me, and to be consistent I would have had to include myself in the jettison.

Little by little I began to get the hang of the trinity of rod, reel, and line. When I had learned, after repeated correction, to use both hands on the up-pull and to lower the rod parallel with the surface I improved rapidly and after a long, long stretch of time as we know it on the earth, the great fish actually seemed nearer when he made his astonishing leaps. He even appeared now and then at the surface merely to roll over and sink, which I hoped was a sign of weariness.

Once, quite unexpectedly, he dashed full speed *toward* me, and when very close, dived and was lost for ever. At least, that was what I felt as I reeled in yard after yard of sagging, loose line. I had given up all hope when again came that sizzling rush and there

he was, somewhere deep in the Pacific Ocean, still at the end of my tackle. As he tore off once more I caught a glimpse, out of the corner of my eye, of the distant Frailes and vividly recalled the tableau, almost identical with my present experience, of the museum sail-fish group.

The time came when, although I was ready to give up, even through my aching muscles I sensed that the fish, too, was nearly exhausted, and with shorter and shorter rushes he finally came alongside. The first attempt at a gaff failed, and my heart sank, for well I knew from even vulgar hand-line fishing the almighty difference between getting a fish alongside and having him in the boat. But a bight of rope around his tail and a gaff in the gills, and in he came, lying athwart the hatch.

Names, whether technical or popular, mean little to me except as necessary handles, but an exception to this now irritated me. From my earliest boyhood I had read of sword-fish and always hoped to see or capture one. Now I had succeeded, and then found to my disgust that if I was to defer to the world-wide distinctions held by fishermen, I had to call my fish a marlinspike, shortened to marlin, and not a sword-fish. After a brief mental struggle I gave up my boyish resentment and admitted that he was a Pacific striped marlin with the decidedly Mongolian scientific name of *Makaira mitsukurii*.

All this as we made our way back to the *Zaca*.

Being now, in very truth, a Big Game Fisherman, I deemed it right to force an interest in the two sacred facts of the average B.G.F.—length and weight. If only the grown-up infants comprising this league would realize that they could add so much more to human knowledge and gain equivalent fame for themselves by reporting the exact colouration, fin count, food in the stomach, condition of the roe and strange parasites on the skin, than by the very human but childish competition concerned only with a world's record of length and weight, the enormous gaps in our knowledge of the life histories of these splendid fish would soon be filled up.

After the fish came on board I guessed his weight in my ignorance as seventy pounds. Crocker thought one hundred and forty, but the marlin proved to be a full two hundred and seven pounds, with a total length of eight feet ten inches. We hoisted the big chap well off the deck of the *Zaca* and like every B.G.F. since the flood I was photographed alongside!

According to my own private sensations I had landed the sword-f—I mean marlin—in something around two weeks, but by watch Crocker made it thirty-five minutes. My wrist ached long afterwards, but during the struggle the more I enjoyed it the more my muscles said: 'Sure, go ahead, don't blame us, we've got to let you know we are here but we are good for hours yet!'

I had hooked him quite near the tunaboats and in

his throat was actually one of the live sardine baits the men had thrown out. In the stomach were two more baits and the remains of one small squid. As in the case of the tunas the normal diet of these fish is inexplicable. The food of a second marlin caught by Crocker two weeks later consisted of three cornet-fish and two trigger-fish—creatures as spiny and as incredible as could be imagined.

My marlin was very dark, almost black above with the base of the tall dorsal bright lavender and the under parts paler. Thirteen light vertical bands were ranged along the sides. After death the fish paled considerably and the bands turned to purple. The iris was turquoise blue.

In spite of my insistent use of 'him' throughout my account of the capture, the marlin proved to be a female, but, as usual, with eggs far from well developed. We know nothing of the ripe eggs, larvae, or young fish of this species, although full-grown adults are not uncommon along these coasts and as far away as Japan and the Hawaiian Islands. Although this fish was fully adult yet it was a baby in weight compared with the largest known, which weighed five hundred and seventy-three pounds.

Glancing back over several preceding pages of manuscript, I am dismayed to count more than three-score *I*'s, *me*'s, and *my*'s, which slipped thoughtlessly from the tip of my pencil. But ashamed as I am when I see them all lined up with such ghastly prominence,

I can think of no honest way of eliminating them; certainly not by smugly transposing them into *one's*. The experience of catching the great fish was as supremely personal as could be imagined. While the contest lasted the planet Earth contained nothing but the fish and myself. So I will let the spate of *I's* have it.

Another marlin of one hundred and seventy-five pounds, caught by Mr. Crocker, had both pelvic fins broken off an inch or two from the body. These strangely specialized, bayonet-like fins must have some definite purpose, some useful function, but what it is we do not know. In this case, instead of the much larger and infinitely more fragile dorsals and pectorals having suffered, it was these lower ones which had both met some mishap. A third marlin, a two hundred and five pounder, possessed perfectly developed pelvics only two inches long. These fins had perhaps been regenerated after an accident.

The most beautiful things about the first marlin, as it lay on the deck of the *Zaca*, were the two hundred-odd little parasitic crustaceans, copepods, which were clustered between the two dorsal fins. They were of a much more intense lavender than any part of the fish itself, their bodies picked out with purple and black. In shape they were oval, notched behind, and most of the little creatures trailed two long strings of bright coral eggs. They looked more like some strange Aztec or Inca symbols than living organisms.

Whenever I attempted to catch them they scuttled briskly away.

Clinging closely to the skin of the great fish were five other strange beings, which turned out to be parasitic flatworms. They were round and translucent white, and consisted of a curved, concave disc with two small suckers at one end and a single large one at the other. Their motion when pulled from the skin was a frenzied flapping, which got them nowhere.

Then Toshio found a slender, black thread protruding from the body of the sword-fish, and we cut out the bit of skin which surrounded its root. Under the lens I pared and trimmed until the whole thing fell out. It consisted of a whitish, slender, rather knobby root which went through the skin for a quarter of an inch, the head measuring another quarter inch. Then came a slender, thin, pale thread which ended in an elongate twist of red, gill-like affairs. Although it looked like some unhappy seaweed growth, it turned out to be a perfectly good member of the animal kingdom—the female of a normal-looking male copepod, in fact a near relation of the so-called *Penella* which burrows beneath the skin of the Atlantic swordfish, but it was doubtless a new species.

Along the stem towards the gills were several little objects which baffled me, as I tried to connect them with some copepod structure, until suddenly I realized they were very tiny but actual barnacles,

of the stalked-goose type. Here was a complex of life: the barnacles living on the copepod, which lived on the marlin, which was caught on the line, on the rod, in the hands of myself, in the launch, now on the deck, etc., etc.

Even in the midst of the capture of my first marlin I felt a twinge of pity for the great creature. After a life as long and as successful as hers must have been, to fall victim to a bit of bent steel hidden in a slice of fish meat, and manipulated by a human being wholly without practice or skill in this art, seemed an end without dignity or honour. But when she had yielded up all her secrets to us, I felt that after all, she had fulfilled a not unworthy part of her destiny, and had acquired merit in her passing.

My only other large fish caught on rod and reel came some time later and not far from the marlin ground. In this case the overwhelming abundance of surrounding life ultimately became more interesting than the single focus of activity. Late one afternoon I went with Crocker northward along the coast, past Arena Point. For a long time I got no strike. Big devil-fish were jumping everywhere, we saw many sharks, and a school of black-fish rolled and blew in their slow, dignified way. Finally one summoned sufficient energy to leap into the air, and the resulting foam was like breakers on a reef. We turned south far past the *Zaca* and in the distance saw the boiling of a great school of small fish, with their

pursuers driving them out and pelicans and gulls attacking them from above. Near this foaming life I had a strike which my companion thought was a big yellowtail. It held on for a time and then tore loose.

Almost immediately something else took the hook and for half an hour I had the hardest kind of a fight before what proved to be a large shark came alongside the boat. He was gaffed and tied and cut open and still he seemed as full of life as ever. Until I saw him I had no idea he was a shark, for he fought and sounded, slackened and then ran off again along the surface at apparently the speed of a railway train. It all proceeded in regular big game-fish manner until he suddenly gave up and we got him alongside. It was the best kind of practice and taught me much about automatically putting on the brake, and the knack of using my back as well as my arms to raise the rod, pumping in order to lower it quickly and reel in what I could.

Another strike came at once and I had a quick but vicious fight with something which rushed doggedly around and around and then gave up. It proved to be a crevallé or jack, one of the pursuing fish. There must have been thousands of them, for at one time the line of smashing, crashing spray and leaping bodies extended a full half mile in front and to each side of our boat. After this I could not put my bait into the water without hooking a crevallé. After

taking five we gave up and went back. Several times the pursuers and victims came within a few feet of the launch and we could plainly see the hosts of fleeing fish and the powerful, thick-bodied golden jacks in relentless pursuit. Seldom have I had a more vivid picture of the devouring machines typified by these fish.

When we returned to the *Zaca* I found that the shark was a new one to us, the bay shark. There was no food in the stomach, but four embryos were ready to be born. In a tub of water they snapped at each other and swam for an hour swiftly around the circumference. The patterning has not been described and was unlike any species of shark I knew—a long line of white extending forward from the tail, projecting into the dusky bronze of the back and upper sides. This and the conspicuous black tips to all the fins were even more pronounced in the young. The mother was almost seven feet long and weighed one hundred and twenty-three pounds, while the youngsters weighed three pounds each.

A pelican which we had shot during the afternoon had a freshly taken fish in its pouch, a strange-looking species. It had a transparent eyelid covering the whole eye and small paired fins which could be withdrawn into slits, so that the fish was as streamlined as a sword-fish. It belonged to the soft-rayed group, one of the small round herrings, *Etrumeus micropus*. All the crevallés had been feeding on the same species, so

these composed the numberless hosts which were scattered far and wide over the ocean hereabouts, and which we could never have identified without the aid of the pelican and the jacks.

The last time the crevallés touched our lives was when we went in the evening to look at a trap. There were no fish within, but milling swiftly around it, attracted and held by the odour of the broken urchins and crabs which composed the bait, were dozens of these jacks, some of them more than four feet in length, larger than any we had seen or taken in the afternoon.

Another indirect discovery of the presence of an unsuspected type of fish was an aftermath of hand-line fishing outside the Frailes. We had just started fishing from the launch when I had a terrific strike and the line tore through my hands with such suddenness and force that, before I could drop it, my fingers were burned deep. When, with the help of my linen cap, I landed the fish it proved to be a Pacific amberjack which, a few years ago, had been described from a dried skin. This one weighed only twenty-seven pounds, but it pulled like a hundred. I did no more hand fishing for a week while my fingers were healing. After Crocker had landed nine sierra mackerel, Toshio, who was photographing, got a bad bite from one of the fish and we headed for home. *En route* Crocker secured two cormorants with one shot. In the beak of one of the birds and

in the stomachs of the mackerel were small sand launces known as *Ammodytes*, which on examination proved to belong to an unknown species, halfway between those living in the tropics and those from Alaskan waters. Here, again, we would never have suspected the presence of these fish were it not for the gastronomic aid given by the cormorant and the mackerel.

Late in the afternoon we set a straight course to the north for Guaymas on the mainland, half-way up the gulf. The wealth of life in these waters was evident everywhere. Sail-fish and huge manta rays leaped high out of the water, while smaller devil-fish in even greater numbers and often in pairs somersaulted above the surface. These mobulas formed a species new to science, as we were later to discover. Gold-spotted sierra mackerel splashed into the air, while tropic birds and black-headed gulls swooped as near to the surface as they dared, in pursuit of the fry driven forth by the fish.

Then a long-threatened storm caught up with us and developed into the worst full gale of the year. The mirror of the gulf was breathed upon and fogged over by ripples which changed to waves, increasing swells, and finally spume-borne whistling winds. These in turn gave place to raging blasts and a blinding uproar which almost effaced the boundary between sea and air. Bubbles and foam commingled

in a roaring mass—spindrift striving to become cloud, air-filled lather of wave-tops threatening to turn the whole gulf into snow-white foam.

Snug below decks we held our dishes in our hands, and braced between bunk and walls attempted no more than intermittent reading and sleeping, waiting for the captain *cum* compass *cum* chart to bring us to some stable haven if such still remained in this tossing world. Some time on Sunday I crept up and looked astern at the maelstrom which was our wake, and there, blown about like helpless motes, was a small company of storm petrels—all perfectly at home and safe amid the turmoil—using the very might of the gale to provide support for their tiny pinions, their only worry the scarcity of scraps available from our sketchy meals.

After a day and a half of unceasing rolling amid enormous waves we neared the high red cliffs which marked the harbour of Guaymas. In the very teeth of the lashing wind skeins of pelicans and boobies met us, while individual frigate birds and gulls searched the air for eddies or crevices in the gale through which they could make headway. A pilot was more or less washed aboard and took us into the deep, winding harbour.

I had never been within hundreds of miles of Guaymas, but when I stepped ashore and walked up the inevitable Avenida Central it all seemed familiar. I dusted off a memory file and again saw

Vera Cruz and Guadalajara and Manzanillo, as they were three and thirty years ago, quite indistinguishable from this Guaymas, always, of course, excepting the motor-cars. To-day the city seemed something scarcely apart from the surrounding desert. The gale which had followed us ashore coated everything—houses, foliage, cars, people—with a thick epidermis of dust, and the hot air was saturated with whirling, inanimate particles, all seeking a resting place. Also it was mid-day and the world was taking invisible siestas. Like Pompeii or St. Pierre emerging from their eruptions, Guaymas was shrouded in dusty death. All the stores were close-shuttered; two somnolent Mexicans leaned against a post in the middle distance; and I passed a sleeping burro yielding everything possible to gravitation without actually falling to earth.

On my way back, two hours later, a motor horn gave forth a husky wail and, as at the last trump, the city began to awake. Protesting gears and clutches heralded movement, and to the accompaniment of the clanking of bars and bolts and the banging of shutters, attractive window displays were revealed.

In addition there appeared the glory of these Latin towns—the patios. We walked up and down the streets, peering into oases of fresh green, lush palms and bougainvilleas, cool pools, and masses of flowers. There was not a single tree or bush in sight throughout the long street, and nothing on the surrounding

mountains but the seemingly half-mineral, half-dust of cactus and chaparral. But here were glimpses through doors and windows of enchanting, undusty gardens and clean jungle growth. Only to vultures and aviators are the full beauties of Guaymas apparent, and from the air the multitudes of patios must look like a mosaic of tiny, emerald, chess-board squares set in the everlasting grayness.

Through the atmospheric haze of grit the cathedral loomed, promising dim coolness and perhaps clarity of air. But I had forgotten the present status of State and Church in Mexico, and I found the ancient edifice blind and dumb. For the first time in my experience anywhere in the world all doors were locked against me, and windows vacant and opaque. Yet there was life of sorts in the patient structure; it proved to be not quite dumb, for even as I attempted to swing the great doors, the bell rang out the hour—*son las tres*—even Beelzebub must recognize the reality of Time. The plaza opposite was a bedraggled, gray-powdered green and the band stand had no hopes of future occupancy except by straggling *perros*. Even all the grackles we saw were females, and hence with plumage dust-coloured by nature.

We wandered into the market where clouds of dust were depositing themselves with unusual success. In one stall a piratical, grizzled old Mexican was hopelessly fashioning countless kites, all eternally awaiting a purchaser. Yet his craftsmanship had

deteriorated in no way, and for ten minutes of my life in Mexico I watched him carefully cutting out tiny gold stars and pasting them over the hole through which led the white guy threads. The very next compartment was a diminutive meat market innocent of customers, where the flies strove successfully with the dust for resting place, and a circle of worshipping and slaving dogs waited with unflagging patience for a miracle to happen.

I heard of one Arturo Lelevrais, the fish and game commissioner, who might tell us of fish and of the best location in the gulf for concentrated work. When I inquired about him from the owner of a hardware shop he pointed to the lad, who was acting as my guide, as the son of Lelevrais. The boy's father, it appeared, was away, but we went to his office in the Casa Municipal. His keys had gone with him, which, however, did not much matter for his library was small and rather irrelevant, containing, besides zoological primers, only old copies of *Esquire* and odd volumes such as *What a Young Woman Should Know*. Hypo-yellowed photographs of barely distinguishable strings of fish were pinned above several dust-dimmed jars of shrimp and crabs.

We were told on every hand that during the following week (from April thirteenth on) the warm water would reach Guaymas from the lower gulf, bringing yellow-tails, marlin, sword-fish, and other game species.

IN THE GULF OF CORTEZ

We remained two days at Guaymas waiting for the storm to pass and the laundry to be finished. There was an intimate connection between the two and the storm finally won by a night. Meantime we dined excellently at the barely finished, elaborate hotel Playa de Cortez, planned and decorated in most pleasing taste and intended to attract big game fishermen. The two things which persist in my memory are first the little bay fronting the hotel, a welter of foam at this time, with six lines of breakers into which, like a barrage of aerial bombs, scores of pelicans dropped unceasingly, labouring up again into the air, drooling shining anchovies which flashed as they blew away in the wind, like slivers of silver. Secondly, in the garden there was a horseshoe-shaped vertical sundial of Aztec appearance, with a most interesting gnomon. Only its great weight plus the ubiquity of endless unemployed bell-boys kept me from stealing it bodily.

After a lunch at the virgin hotel we motored back by a road which included a map name—San José de Guaymas. We hardly knew when we reached this hamlet, so completely was it a part of the general aridity. A wide extent of treeless, sun-baked plaza marked the alignment of the few, tumbledown 'dobe huts. Six gaunt children peering out of a door indicated the school.

We went across to the small wrecked church and found the windows and almost all the roof gone,

torn away by hand; only two little closet-like rooms were even partially intact, and in one of them Christ and the Virgin were apparent as cloth-wrapped figures, each about four feet in height. Although they were completely swathed and leaning crazily against a pile of rubbish, yet several bowls of utterly dried and faded flowers sat in front of each. Broken earthen bowls and pitchers were in a wrecked cabinet and bits of the cheap, coloured window glass were scattered everywhere where they had fallen after a shower of stones. Already St. Francis had begun his healing—house finches were singing and building nests among the broken rafters.

In this poverty-stricken place of less than a dozen houses, prolonged and determined efforts had been made by alien hands at eradication of the only outside thing in the lives of these peons—a symbol at least of an emotion which could focus their thoughts and imaginations on something beside the daily grind and the desert vista. The result was a ghastly commentary on the uselessness of the communists' activities. If half the energy and force wasted on this wrecking had been devoted to driving a well or erecting a windmill, San José de Guaymas might have achieved relatively better heights of living. There were rumours that before long the churches would return to comparative life.

As we left the hotel on our last night an optimistic cricket dared to raise its voice amid the newly painted

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walls of the hostelry. Outside, the moon turned the dusty, arid mountains to crisp, sharp-edged cardboard silhouettes—badly made theatrical props. I suddenly hated to leave Guaymas, and wanted again to visit San José de Guaymas.

IV

A WEEK IN PARADISE

SOME of the most wonderful discoveries have been made by accident or inadvertence; one often gets the most penetrating visions by an oblique glance; and it was pure hunch which made me select the Bay of Santa Inez in which to spend the forthcoming week. On the chart my eye had caught a cozy indentation in the coast straight across the gulf from Guaymas, offering perfect shelter from any storm such as we had just experienced; and the *West Coast Pilot* had paragraphs of beaches, undercut cliffs, shallows, reefs, and other formations dreaded by mariners but beloved by all manner of underwater creatures; and I liked the name Santa Inez. As I have said, in all this region one could not land on island or cape, enter bay or stream, touch at a point, cross plain or climb mountain without having to call them by one or another member of the saintly hierarchy: The early priests who accompanied the conquistadores must have been aware that more lasting than altars or monasteries, more permanent than converts or conquests, was geographical nomenclature.

So here was Santa Inez—Her Bay. I have always thought the story of her life and martyrdom was more filled with vital happenings, more terrifically dramatic than the corresponding account of any other Saint. The idea of a thirteen-year-old girl pitting herself against a frantic suitor, the noble Roman father of the suitor, the Roman populace, soldiery, and executioners leaves little to the imagination of even a Hollywood script writer.

Before daylight on the morning of Wednesday, April 8th, the laundry came alongside, and about five o'clock the captain weighed anchor and we began to slip through the water. On deck I found the Guaymas dawn sharing the world with a slightly unsymmetrical moon. The mountains were faint and ghostly in the dim light, with no present hint of heat or dust. Every particle of the latter had settled, drawn by the pull of gravity to roof, leaf, or ground. The storm had gone wherever storms go and had vanished completely, leaving no aftermath: nowhere in the world have I known a gale to pass, to be completely and utterly obliterated, as rapidly as here. Yesterday the water had been a mass of the smother of which I have written; to-day there was not a ripple on the expanse of the gulf which could not be traced to bird, fish, or the *Zaca*; there was nothing with which to compare the calm but the worn-out simile of mirror, and I almost thought to hear it crack as our bow broke through. Yet before we left

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Guaymas rumours had come to us of the terrible toll taken by the storm; six tunaboats had not been heard from and a steamer was on the rocks on the ocean side.

Cathedral towers, houses, sleeping boats, wharves, soon merged into the Mexican sea coast, and at sunrise we saw only what the eyes of Cortez must have discerned when he first approached it, hundreds of years ago.

In the outer harbour birds were everywhere. Scores of pelicans were diving, making innumerable splash holes, each the focus of outward-circling ripples. As in the West Indies and a half-dozen other places I saw the same friendly or at least tolerant intercourse between these birds and the small, black-headed gulls. As soon as a pelican made an arrowhead of its beak and wings and began to drop, several of the gulls would fly full speed toward the living plummet. The moment the great bird reappeared at the surface and began to strain out the quarts of water from its capacious bag, one gull would settle on its head and others alight very close, all intent on snatching one or more of the tiny silver fish which by chance might ooze forth with the cascade of water. When the pelican had deflated its pouch and raised its beak preparatory to swallowing, the gull lost its balance and fell off. I have seen a gull thus perched for several minutes on the crown of an unprotesting pelican. It is a pleasant little relationship apparently world-wide and I have never seen it abused or resented.

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Far from shore a few petrels appeared, an occasional booby, and once a small flock of phalaropes. We caught an abundance of sargassum weed from the boom-walk, and found young fish under almost every piece. One mass, about twenty feet square, sheltered many young horse mackerel, coloured the most brilliant iridescent blue and green viewed from the side; yet when seen from above—from a booby or pelican-eye view—they were wholly dull and weed-like.

In mid-gulf, tempted by the calmness of the water, I decided to pull three meter nets at 300, 400, and 500 fathoms. These, as well as later hauls, showed that a relatively meagre abyssal fauna exists in the gulf. In the three nets there were only forty-eight deep-sea fish of a bare half-dozen species. Nineteen round-mouths represented the several hundred which would have been taken in a corresponding haul in the open sea, and fifteen lantern-fish was a scant number. A silver snipe-eel, almost two feet in length, was a most interesting capture as it was living and in excellent condition. It was indeed the only eel of the species ever taken alive, and although it came up from a full half mile yet it seemed quite unaffected by the lack of pressure and what must have been, to it, the incredible glare of the sun. Its glistening silver and bronze shone in the sunlight with nothing to hint that it and its innumerable forebears had known nothing but eternal darkness. It nipped my fingers

with its minute teeth, it gazed about with dim eyes. I alone knew of the darkness of its rightful haunts and the shifting, living animal lights which up till now had been all the illumination it had ever experienced.

After drifting slowly all night about thirty miles off the western shore of the gulf, we steamed into an anchorage at daylight. The dead calm still prevailed, and a man kept busy at the line and feather jig astern; first a gold-spotted sierra mackerel, then skipjack after skipjack came in fighting. One of the latter had its right pectoral fin bitten off, but the only visible effect was the presence of more parasitic copepods than usual.

Pelicans again dived in every direction, but rather languidly, probably being already quite stuffed with fish. Here the black-headed gulls hunted for themselves, racing toward every school of fry driven to the surface by unseen submarine enemies. Boobies sped past in twos and threes at full speed on urgent booby business; in the distance near shore long lines of cormorants passed close to the water, having some excellent reason for fishing in thousands instead of singly or in trios. Scaup ducks endeavoured to escape from our path, but could only flip helplessly along the surface, there being no wind upon which they could climb. We slowed up, the anchor rattled down, a great trigger-fish came up on an eager fisherman's line, a big hammerhead shark completely encircled us, and we were at Inez.

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We lay anchored halfway between Santa Inez Island and Santa Inez Point, which formed the northern boundary of the great Santa Inez Bay, and as the constant reiteration of the calendar of saints on this trip was getting on our nerves we assumed an intimacy with the young lady and called her and all her varied geographic features, Inez. When we rowed ashore the blunt cape resolved into three sandy beaches and four rocky headlands. In the centre was a long, narrow, ebony stream of ancient lava, frozen hard in the midst of its headlong flow into the sea. It may have been two hundred or two thousand years since this actually appeared from the depths of Mother Earth, but to-day, as far as appearance went, it needed only that indescribable but unforgettable flame-scarlet of molten rock to have poured forth overnight.

Alternating with these black, petrified rivers were others of creamy white, composed of grains as fine as drops—streams of sand which filled to the brim all the valleys between the lava. The latter owed its origin and flow to terrific heat; the sand had been gathered and moved by high winds which had shifted it gradually into perfect water form.

The sand deltas which spread out into beaches renewed my boyhood's shattered faith in old tropical tales. All my life I had been disappointed in equatorial beaches, which seemed only in books of adventure to teem with life or to be covered with beautiful

shells. But here was a conchologist's paradise, an æsthete's valhalla: for there appeared windrow upon windrow of perfect shells, of amazing size and of a host of species: elongate, pure white spindles measuring full eight inches from tip to tip; conchs of various colours but always with saffron yellow as a base; great cockles like deep-ribbed, exquisitely moulded cups shining golden in the sunlight; spiny murices with mouths of rich, warm rose; tall mitres running half the spectrum from pale green to deep dark chestnut; pectens or scallops such as I have never imagined, 'larger than life,' one valve deep enough for any draught of thirsty pilgrim, the other flat as a medallion, but more beautiful, all in shaded tones of wine. There were cones of beauty sufficient to hold a lover of shells speechless, palest pink with scrolls and strange, almost translatable, characters etched in deep red; olive shells with mosaics of nameless browns; cowries such as made all of *Swiss Family Robinson* credible. We needed no excuse to begin to pick and pick eagerly until sheer weight of loot made us discard and choose more carefully. Tubs and bags were brought into use and filled to the brim on our next trip ashore. After the larger shells had been gleaned we went down on hands and knees and found a lesser world of equal splendour and still more delicate sculpture and architecture.

I am truly sorry for anyone, be he technical conchologist or casual naturalist, who, for some brief

time, has never forgotten all science, all studied objectives, in a wild orgy over unadulterated beauty.

Stretching our aching backs we stood erect at last and looked about. Just ahead, on the outer side of the promontory, was a second wide sandy beach: a beach of pure white sand without a single shell or pebble. Instead there were traces of the recent storm, small wrecks of animal life, some undamaged as in life, others such as the jellies reduced to glistening films. Here and there were starfish of the loveliest gray picked out with a hundred orange knobs. A neat tangle of weed floated in a little bay, which Crocker and I encircled with a small seine and dragged ashore. Here we wrought miracles—turned berries into weird crabs, persuaded fronds to take to themselves legs, sprout jointed bodies, and spring forth as many-coloured shrimps. One branch was covered with an armour of minute white snail shells, but at the slightest encouragement many of them magicked into ivory and black isopods. The denser fronds would have delighted any prestidigitator, for the closest examination revealed nothing but leaves and stems of seaweed, whereupon a sudden quick flick would materialize a pair of brilliant blennies, with scarlet dorsal fins and two staring ocelli which forever gazed steadily in the opposite direction from the natural eyes of the little fish.

Around the next little indentation to the north,

crossing two more streams, one of lava and the other of sand, I came suddenly upon a contemporary kitchen midden, where Indians had recently been feeding—piles of edible mollusc shells and the remains of giant groupers. Eight skeletons of these huge fish were scattered about in an unearthly assemblage of death, the half-open mouths of the skulls grinning at us through serrated teeth. All trace of man was gone, but the recent tracks of coyotes showed that even desiccated bones wholly destitute of nourishment were loadstones to these ever hungry wild creatures. As we examined the skeletons a pair of ravens flew croaking overhead, perhaps in the hope that one of us was a grouper in disguise who might by chance join the stranded relics.

Farther to the south we found long stretches of sandy beach with occasional pure cultures of some particular mollusc. One little bay was crowded with the loveliest of screw shells, three to four inches in length. Their technical name *Turritella*, or little turret, is perhaps more pleasing, but I like to think (correctly or otherwise) of that grand old philosopher, Archimedes, picking up one of these shells on a beach of Syracuse some one and twenty centuries ago, looking at it, revolving it in his hand, and conceiving the screw as a human tool.

Here, lying about both in the water and on the sand, were hundreds of these exquisitely modelled spires, with the fifteen or sixteen spiral ridges ending

in the finest of points. The pattern and pigmentation were as delicate as the architecture—reticulations and cloudings of brown and golden yellow. All were empty, the jetsam of some great storm which had cast them up from the outer depths.

At least we considered them all as empty until on the deck of the *Zaca* we began to wash the sand out of those which had been lying in the shallows. There were few hiding places along this sandy stretch and the round openings of the screw bases were apparently too inviting to be passed by. Out of them came high-finned blennies, two tiny octopi very angry at being disturbed, and a white-clawed crab.

The blenny deserved the sobriquet of flag or banner-bearing, for its dorsal fin rose steadily in front until the rays broke apart into long, waving filaments of bronzy green. Over each eye was an orange and black tentacle, the lower paired fins were azure and the posterior ones were shot with the same colour. Once outside with all fins raised it was unbelievable that the fish had ever been able even to back into the mouth of the screw. Yet when least expected it would creep forth, spreading out the beauties of its body and fins like an animated Aladdin's treasure flowing from the cave.

In early morning on the way to the shore we passed through a long line of many hundreds of cormorants—yet not really through but rather under, for at our

approach (like their fellows on the opposite side of the Peninsula) the line rose slowly and gracefully and we passed beneath. Five minutes after we had left the birds behind, when the flock had become the finest of filaments against the horizon, we could still see the exact place of our passage—the living avian arch we had raised through the endless line still formed and respected by birds who could never have even seen our launch.

Now, on the return to the *Zaca*, we skirted a small bay in which were gathered thousands of these same cormorants, all in long curving lines but all swimming in the water. They were converging upon a certain stretch of shore, and at the heart of this mass there was continual splashing and flapping of wings. As we watched, the outer lines pressed closer and closer in until the whole became an indiscriminate huddled multitude. There must have been some unusual attraction such as great schools of fry to draw together all these fish-eaters. I have read how cormorants converge in far-flung lines upon such schools and drive them into shallow water where they become easy prey. While this looked amazingly like some such occurrence yet I had only the circumstantial evidence of a distant, foreshortened view.

Easter Sunday—the twelfth of April—dawned like all days at Inez in perfect calm, with glorious sky, air, sea, and land. We were preparing to set off in the

launch for Inez Island when a splash announced the falling overboard of a sailor with an outboard motor which he was attaching to one of the small boats. Not being able to swim a stroke he soon, very reasonably, relinquished his hold on the motor and grasped the gunwale. We were anchored in thirty-three feet of water and I had longed to go down and see what the bottom of this great cup of Inez Bay was like. Here was an excellent excuse and I put on the helmet and slid down the folding ladder. The water was quite clear and when my feet touched the sand five and a half fathoms down, the dull greenish light still remaining enabled me to see at least twenty feet in all directions. I landed within a yard of the motor, fastened a rope to it, and signalled for it to be drawn up. There was very little life in sight except a school of fish which kept at a distance, just this side of the veil of invisibility. I could see a few widely planted, tall, thin sea-pens, and a dozen of the large pearl and orange starfish scattered about in a loose constellation. At my feet was a magnificent triton shell, worthy of Neptune himself. I salvaged it as it crawled slowly along and when I had brought it to the surface I found that the owner was equal in beauty to its house—a most gorgeous golden brown set off by a startling mosaic pattern of turquoise.

As the air to a bird, the ground to a mole, the north to the needle, so is an island to me. I rejoiced at the two tiny islets on the outer rim of Inez Bay which

we passed on the first day on our way to anchorage, and when I had retrieved the outboard motor we set out with launch and dinghy. While I was submerged, four Mexicans had suddenly appeared from nowhere in a leaky dugout with oval-bladed Indian paddles. They said they lived some distance to the north, and at present were trapping lobsters and catching turtles off the same Inez Island toward which we were headed.

When we reached the shallow water off the west side of the island we found the bottom sandy with scattered but very dense growths of fine-leaved sargassum weed. We pushed through this and landed in a diminutive bay with a sandy beach, and discovered there the camp of the Mexican turtlers whom we had left at the *Zaca*. It was interesting to see how all the needs of these men could be satisfied with the least common multiple of possessions. A pitiful little boat was drawn up with two sails so porous and small that they seemed hardly worth while. The sails were stretched against a bit of rocky bank shading a pair of large green turtles lying on their backs and trussed motionless by having their front flippers tied together across their shells. Near by beneath the same shelter was the only sign of food, if such it could be called—a pile of salted but odorous and fly-covered chubs. Scattered about were the rest of their possessions, several thin serapes and still thinner pillows held down by a turtle shell, and a

small keg of fresh water protected from the sun by another of these useful shells. Huge tin spoons and small tin dishes composed their plate, a bag of salt and a bottle of oil their condiments, while a hollowed shell filled with turtle oil provided their only source of illumination. The island was destitute of firewood so a small bundle had been brought from the mainland. At the upper rim of the beach was a small, burned-out fire with a half-broiled chub on it. A pair of ravens and several gulls wrangled over another fish at the water's edge, but did not dare to go under the sheltering sail and disturb the salted provisions. Here was an epitome of the household lares and penates of the Mexican fishers.

About the beach lay dozens of weathered and whitened skulls and shells of turtles and tails of sharks, marking captures of other years, and recalling certain Galapagos landscapes. While we were examining the cache of the Mexicans, Frank waded about in the sargassum and speared four eels, three of which were vicious green morays and the fourth the painted species, brilliant with its row of yellow spots. I found the water colder even than that of five fathoms down beneath the *Zaca*.

We made a circuit of the island, photographing and collecting. It proved to be a mere speck of land raised above the water on the rim of the bay and on the brink of the sheer drop into the depths of the

outer gulf. It was a mile long and a third as wide and its greatest height was all of thirty feet. Yet every moment of our stay was full of discoveries and I longed for a solid week of it, when the lesser struggles for existence and the more perfect adaptations to this small cosmos would begin to be apparent.

The bird life was the most conspicuous. The south end frayed out into a diminutive archipelago of rocks and all the pelicans which could find room to perch had come and done so. The cormorants preferred the opposite end. On the island were five living ospreys, two pairs of them mated, and a sixth dead bird. Seven old nests were deserted although still forming lop-sided but compact piles of rubbish in spite of the blasts of winter storms. Two newly built nests with fresh lining marked the extreme east and west shores, and the owners were much worried about the human intruders and also about a pair of ravens which followed us about everywhere. High in the air frigate-birds and vultures soared, eyeing us hopefully, praying for some miracle of fish or other manna.

The composition of the nests of the fishhawks was almost museum-like—dozens of red and yellow sea-fans, sticks, feathers, skeletons of fish, desiccated bushes, sea-shells, turtle shells, starfish, and finally the dried skin of a grebe which had been turned inside out by some taxidermic ornithologist and then lost. Close to one nest, as if dragged thither, was the

amazingly life-like shape of a young mummified sea-lion.

On the shale just above high water mark yellow-footed gulls had built their careless nests. Two contained a single egg each and three eggs had been deposited in a third. This pair of birds did all they could to drive me away, poising high in air and volplaning with set wings directly at my head, only to veer upward at the last moment. Oyster catchers were breeding and the island also accommodated, at least temporarily, many black-headed gulls, a curlew and a full dozen turnstones.

Several tall candelabra cacti were conspicuous, but aside from them, two lowly weeds, *Atriplex barclayana* and *Amaranthus watsoni*, or in more understandable parlance, species of purslane and pig-weed of sorts, formed all but a fraction of the flora.

On the east side we found insects in uncounted hosts—all of one species, a little, pale brown, flower beetle. Near the shore they covered everything—plants, stranded sargassum, rocks, cacti, one's clothes and face, and hundreds flew uncertainly about in the air and dusted the water for yards. I found they were a most important item in the ecology of Inez Island, forming the chief food of other insects, lizards, crabs, fish, and birds. As a matter of routine I collected a dozen of the beetles, thinking they must belong to some widespread, abundant form. Instead, they proved to be a new species, which all unconsciously

has now been burdened with the name of *Minoxia beebei*!

There were no small birds visible on Inez but their place was taken by active lizards. These could not fly but they made astonishing leaps from rock to rock. The upper parts of their scaly little bodies offered to the ordinary vertical vision of hungry gulls and other lizard-loving enemies a shade of rock-like drab, dusty, olive brown mottled with minute dots. To our more horizontal, less inimical gaze were vouchsafed, now and then, the glories of the side elevation of the little saurians, colours and patterns set off by the pale, grayish white of the under parts. Back of the forelegs the skin was bright pink, the remainder of the sides being brilliant green with two broad, oblique, blue bands. For some reason known only to his Maker, there were in addition two round black spots beneath the tail. Whether of use in cowing his rivals or of real value in attracting and holding the attention, hypnotic or otherwise, of his prospective mate, we could not determine during our brief stay. Confirmed unbelievers in protective colouration should visit Inez Island and try to see a squatting lizard with its elbows and knees drawn in.

The strangest thing about the island was two graves placed on the sky-line with a wooden cross over each. Above the landing beach a stone wall had been built at great expense of energy and care, in the shape of a right angle about forty feet long. It

had no reason to exist that we could see, and the shell of a mighty turtle braced upright at the inner angle did nothing to clarify its use. From this altar or whatever it was a wide lane marked by large, isolated stones led to the two graves. These were three- by ten-foot rectangles of stones ornamented with pearl shells, with nothing to show whether they were of Indian or Mexican origin.

As we left the island there occurred one of those amazing occasional concentrations of life in and above the water. When we pushed off there was nothing unusual to be seen, but suddenly, like the unnoticed onrush of a squall, the whole surface of the gulf near by was churned into a mass of foam and splashing waters. Unbelievable myriads of silver fry leaped in solid sheets and waves, rushing headlong toward us and the shore, pursued and driven into the air by innumerable fish. The air was filled with screaming, fluttering, black-headed gulls, while pelicans and boobies dived in all directions around us, close to the boat like an unending barrage. The sound of the striking and rising birds and the thrashing fish was like the roar of some great rapids or waterfall. We shut off the engine and floated quietly, and the maelstrom approached and passed, the water around and beneath us filled for a time with dark, swift-moving hosts in addition to those leaping forth in a mighty circle around the boat. Within five minutes the last fish and bird had vanished, the former diving

at least to temporary safety, the latter already far away, on their path to nest or roosting place. The gulf was again a mirror, the throb of our engine the only sound.

The flight of birds is as characteristic as the walk of individual human beings. We can often recognize a friend by his mode of walking, at a distance greater than we could know him from stature or features. But flight is of far deeper significance than human progression, being a trenchant character in the distinction of families and even species. To approximate this significance we would have to suppose among human beings that all Germans, men, women, and children, progressed only by means of the goose-step, or all Hottentots went through life solely by hops, skips, and jumps.

I have sometimes been doubted when I have identified a bird by a momentary flash of its wings as it shot past, but even the brief glimpse of migrants crossing the face of the full moon is sufficient to tell warbler from goldfinch or swallow from woodpecker. It would be unthinkable, to our minds, for a hummingbird to soar or a duck to progress by long, dipping loops, yet during our week in Inez Bay I twice observed a flight phenomenon almost as strange and fully as unexpected.

One of the commonest sights from dawn to dusk was the great numbers of cormorants and pelicans.

There were thousands of the former and scores of the latter. As in Magdalena Bay the cormorants passed to and from distant fishing grounds in long straight skeins, sometimes several hundred in a single line, each close behind the bird in front until an oblique view often showed a solid, continuous line of dark bodies. Duck-like, their wings beat in swift constant measure, a steady unvarying vibration, with, however, no attempt at synchronization with the bird in front or behind. The flight of the brown pelicans was radically different from that of the cormorants and in all parts of the world where these great, ungainly birds are found, their flight, to the least detail, is as identical as that of a bird and its shadow. Their favourite formation is in short lines, straight or oblique, consisting usually of about six to twenty individuals, although fewer and more are common sights. The moment the birds leave their roosting places on rocky islets or low bushes, or when, satiated with their catch of fish they start for home, they fall into single file, and at once the leader sets a rhythm which they all follow. The only way I can indicate this in words is flap-flap-flap-gliiiiiiiiide, flap-flap-flap-flap-flap-gliiiiiiiiide. There may be five or seven or even a dozen flaps, while the length of the glide seems dependent on the amount of impetus. With a head-wind there will be more flaps and a shorter glide. Before any appreciable slowing down or loss of elevation there ensues another series of

flaps. If, *en route*, a new birds joins the file, he instantly falls into step, or rather, flap.

The imitative reaction to the leader by the others appears almost instantaneous, especially in the case of a half-dozen pelicans, but in a line of twenty or thirty, a slight individual delay is apparent. This mental drag is multiplied by each bird in succession, becoming so appreciable that there may be two nodes of wing-flapping down the line, just as the delay in sound-carrying of a military band may, to the eye of the observer, as he looks down the distant columns, make successive segments of a long parade seem to be out of step.

The fact of this drag in the flight of pelicans shows conclusively that the tempo and change is taken by each bird in turn from the one in front and not from the leader. The position of this leader is, I believe, sheer accident, and although he must bear the brunt of the full force of any head wind, I have never seen him fall back or change places.

In addition to this regular lock-step flight, pelicans, in spite of their apparent ungainliness, can set their half-closed wings and their beaks in the form of an arrowhead, and dive with terrific speed and effectiveness. Still more surprising they can soar quite as well as vultures or eagles. I will never forget a first visit to Florida with John Burroughs, when our glasses resolved a cloud of slowly revolving motes

high in the heavens over Indian River into several hundred brown pelicans.

But this is aside from the intention of this present theme. One day in a moment of relaxation I was looking idly from the deck of the *Zaca* out over the waters of Inez Bay. A file of a dozen pelicans passed and a distant line of cormorants, recorded automatically by some part of my mind, but not disturbing my meditation. Another small flock of birds approached and my eye wandered idly to it with the instant effect of a strong electric shock. I stood up and knocked over my chair. I instinctively reached for my glasses but did not lift them for the birds were only fifty yards away. The arresting thing was that, of the six birds, three were pelicans and three cormorants, all head to tail, close together in perfect alignment, in the order of pelican, pelican, cormorant, cormorant, pelican, cormorant.

This was strange enough, although these birds associate in most friendly fashion both in their roosting places and when fishing. But the fact which had aroused all my concentrated interest was that the cormorants had *gone pelican* in their flight. In spite of the disparity in size these six birds were all flap-flap-flap-flap-gliiding as if all were pelicans.

To the unornithologically minded this may seem a fact of but slight importance, but to me it was fraught with significance. Throughout all the days, years, and no-one-knows-how-many-centuries and

millenniums these pelicans had slowly evolved their physical characters, together with their specialized flight, and the latter had always seemed to me as unvarying and specific as the voicelessness or the great beak and pouch; on the other hand the swift, unchanging beat of cormorants' wings appeared inseparable from the emerald eye, strong hooked beak and mobile neck. Yet here, for no apparent reason, three cormorants had enlisted in the lock-step squad of brown pelicans, and were flapping and gliding as if from the time of the fossil *nth* great-grandparents of all cormorants they had never flown otherwise. It gave to think furiously and brought the flight of all birds into a renewed appraisal and interest.

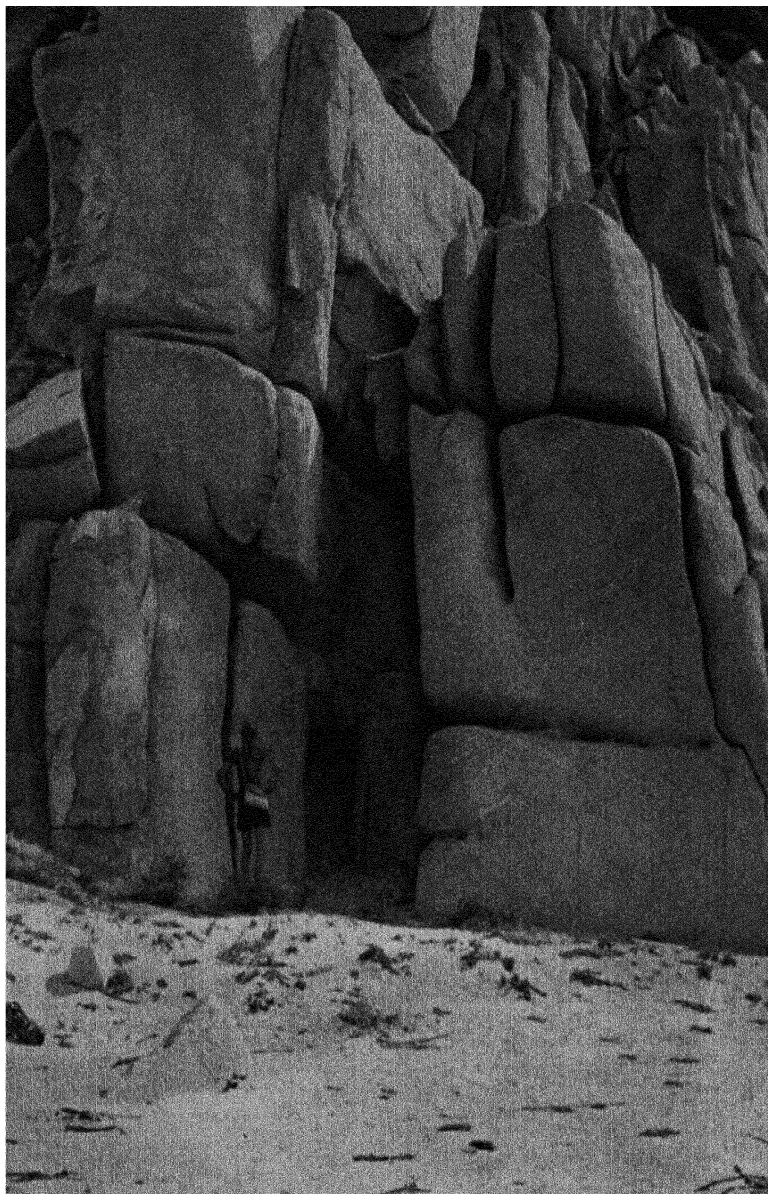
This aroused watchfulness was rewarded within a week when several of us were sorting a dredge haul and my observation was confirmed, this time with the emphasis of simplicity in that only two birds were concerned. A single pelican came along, closely followed head to tail by a single cormorant, and from the time when we first saw them abeam to when they passed beyond the range of our glasses they never ceased to keep perfect pelican rhythm, flap-flap-flap-flap-gliiiiiiiiiide.

Pelicans and cormorants, together with four other diverse groups—the gannets, frigates, tropic-birds, and snake-birds—form six families of a single order, *Pelecaniformes*, but the individuality in action of them

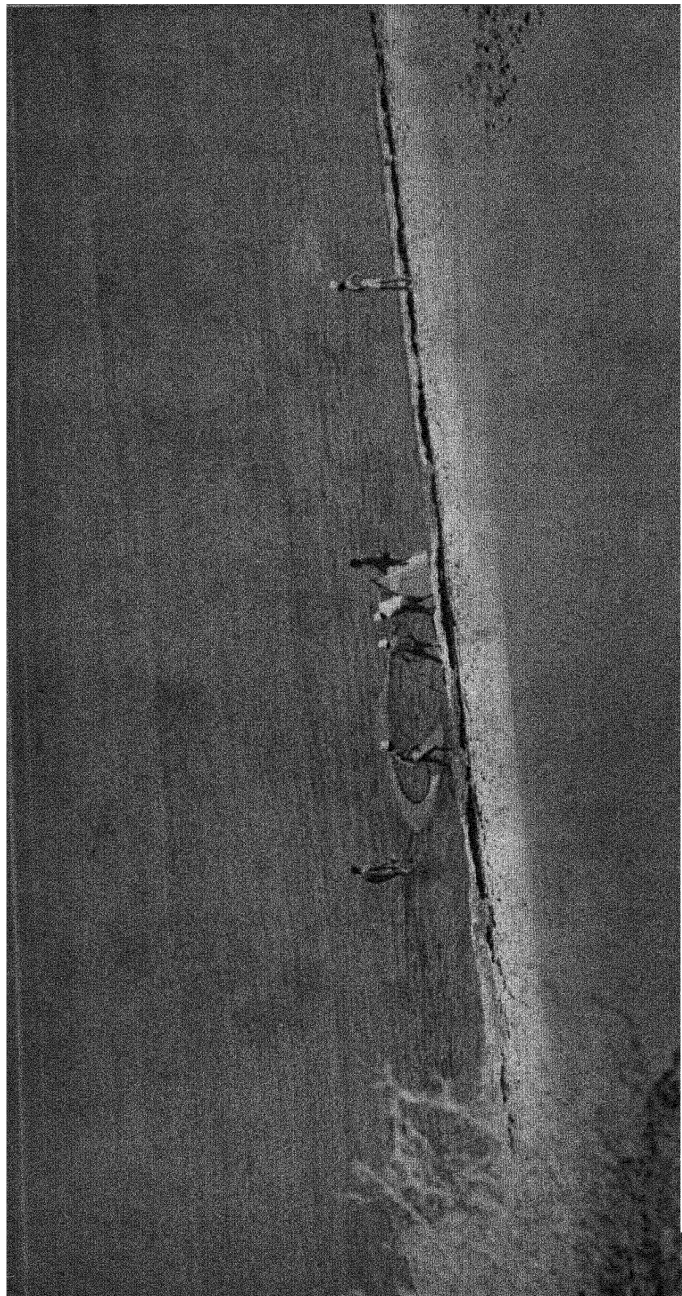
all when on the wing is almost as great as their physical disparity. Twice I have seen a booby and a pelican closely teamed in swift flight, but this is not as surprising as the other association, for both boobies and pelicans have the same make-and-break sequence of progress.

The way of the frigates, or man-o'-war birds, in the air is a slow wonderful flapping with wings so long, so narrow, so angular and under such perfect control that we often forget the narrow body and seem to be looking at an avian caduceus, pure alar harmony. Indeed, slow motion pictures show that the wings may sometimes present actual independence of movement, one pinion acting as a brake while the other controls impetus in a spiral descent.

The shift in flight pattern from cormorant to pelican is remarkable for several reasons; first, from the specific point of view, the relinquishing of an age-old, evolved method of flight for even the temporary adoption of another, more specialized. Second, the heavy, compact, anserine body of the cormorants would seem ill-adapted to the long glide so close to the surface of the water. Third, the adoption, even rarely, of the pelicans' flight hints that there is a very real advantage in the single line formation with its strung temporal beads of flap and glide—perhaps as windbreak and in reduction of air resistance. And while we may say with some assurance that the intermittent glide is a conserva-



GRAY FRIARS—LAND'S END. *Los Frailes—the mighty piles of grey-white granite at the very tip of Lower California have carved themselves into draped figures, tombs, obelisks—all impressive, all beautiful.* (7)



SEINING IN INEZ BAY. The dry sand and lava meet the wet salt water of the bay in a barren line. Animal life is rare on shore but fish abound beneath the surface. (8)

tion of energy, an instant response is to wonder why the pelicans and boobies alone require this economy.

In all save the most obvious things our ignorance concerning the *Whys* of the diversities in flight of birds in the air is almost complete.

Our concern in this country of Santa Inez was chiefly with fish, and only when I took my first walk inland from the shore did I realize the complete and utter divorce between land and water. Behind me, to the horizon, stretched the quiet expanse of the gulf; in front as far as the eye could see there was no pool, lake, brook, stream, or river, nor even cloud. From the dry hot sand at my feet to the distant, crumpled, dusty mountains all was desert, arid and parched. Stepping out of the shallows on to the foreshore of southern Inez I found no lava, but sand alternating with ledges of shale. These were packed with fossil shells and in places recent storms had undercut the cliffs so that great masses had fallen into the gulf, bivalves and univalves of stone returning to their original element, hosts of molluscs which had lived their lives in this water untold thousands of years before.

I climbed a great, upjutting headland topped with a fish-hawk's nest, and for the first time heard commingled the sound of creatures of sea and land. In a small deep bay on the farther side of the cliff a school of porpoises were rolling and sending forth

their liquid sighs, while just above them a pair of ravens were clearing their throats with dusty croaks. On my side of the ridge the only break in the solid, deep blue mirror was a sliver of wood floating near shore far beneath me, three dark specks which might have been sandpipers, and an infinitesimal spider web spread out in a half circle of a few millimeters' diameter—the dory, several of my friends, and an eighty-foot seine. (Fig. 8).

The desert was cut up into steep arroyos, the driest of land moulded by rare cloud-bursts of past years, torrents which must seethe and swirl down these slopes, carrying boulders before them like their slower glacier brethren far to the north. Chesterton would have loved this land, for in every way it was a paradox, not least as water-formed but waterless.

Inland the creases smoothed out and cacti and mesquite found foothold. Besides these weird candelabra and thornbush I came across occasional unreasonable plants. One such was a low, dense, solid semicircle several feet across close to the ground, the leaves very small, sticky, and powerfully spiced, with hundreds upon hundreds of minute, round, perfect daisy blossoms. It seemed as if these rare growths must have had some very special deposition of dew, a nocturnal cloud of their own which precipitated the dampness which was life.

Shapeless little heaps of sand or formless rocks suddenly shot up tall wireless antennae, acquired

monstrous eyes, abruptly took legs to themselves and lolloped out of my path—great desert-coloured jack-rabbits. Their ears looked half as long as their whole bodies, and when they stopped (abruptly, and always in the shade of some bush), unless I was watching carefully, they changed back from rodent to rock and ceased to exist. My glasses invariably showed full profile, giving one eye complete broad-side to inspect me, while the towering ears were slewed around to attend to any hint of danger which sound might give. One hundred feet was their dead-line of permissible approach. A white-tailed pigeon might rise close at hand, shattering with clapping wings the desert's hazy silence, a black-throated humming-bird might whirr from me straight to the rabbit and hum about his head, the shadow of a vulture could draw its dark finger between us, and the rabbit would flicker neither eye nor ear. But let me approach ever so noiselessly and slowly and step across the invisible line separating safety from danger, and the rabbit was off again.

The desert growths, especially, were like the dwarfed trees of Fuji, perfect miniatures of tall, symmetrical trees. I tried an optical photographic trick which proved perfectly successful. I had the camera placed on the ground, and a picture taken of one of these growths. In the finished print it looked at least seventy feet or more high, with a great gnarled boll. By accident a road appeared to run

past and a dark spot some distance away might well be an approaching motor car. Without moving the camera I then stepped forward as close as possible to the heart of the growth and the picture which was then taken was as startling a snapshot of Alice after she had eaten 'a very small cake, on which the words "EAT ME" were beautifully marked in currants.' The highest branch tip was not more than five feet above the ground, and I towered high above this as if I were a human being seventy to eighty feet in height. It was another proof of the fallibility of the human eye—an additional reason for checking carefully every observation in the field.

Desert life manifested itself in extremes—there seemed no average mean of activity. The vultures swung slowly overhead, parasitic even upon the uplifts of heated air which supported their spirals; ravens flew lazily down to the shore and watched for stray fish from our seine; rabbits kept just ahead of us, avoiding danger by the least expenditure of energy and then sitting down. On the other hand, humming birds shot past or hovered in the dead air with all the vigour that they show among the glacier-backed blossoms of Alaska. If I sat down on the hot boulders my eye caught files of big-headed ants, each laden with a dusty seed which might have been a pebble for all the hint of life or nourishment it seemed to promise. Big bronze and gold-armoured tarantula hawks buzzed about on their search for

prey, and twice I found the opened, hinged, silken lids to rifled chambers from which the ferocious but helpless hairy spiders had been dragged and given their knock-out drops.

On one of my inland walks I discovered and crossed the single road in all this land—merely a scratched path where the nicks of burros' hooves, perhaps made years before, stood out clearly. The meanderings of the trail were marked by alternating whitewashed rocks extending along on each side. The weird character of the road was enhanced by the telegraph poles gone quite mad—tall fingers of the cacti, some near the trail, others rushing off on either side, then suddenly a cluster of half a dozen close together as if whispering over the passing messages which they had overheard. (Fig. 9).

As I returned to the launch two creatures tried to recall my mind from this alien region to more familiar scenes. A red butterfly with silver spots beneath its wings alighted on a dead stick and slowly waved its pinions. The memory test was successful and I greeted it with a 'Hello, Argynnis!' Then on my left a woodpecker strove to sound the reveille of northern forests, but succeeded only in producing a prolonged rustling on the muffled, brown paper cactus—proper hardwood rolls were not possible in this country.

Any visitor to the Bay of Santa Inez would be

conscious of a most perfect whole. Whatever came to the eye formed a harmonious quintet—air, water, earth, day, and night, and each was so calm, so without breeze or ripple, moving dust or disturbing change at dawn and evening that the entirety appeared unscamed and inseparable. But the peace and calm of the inorganic was permeated by swift life and swifter death; by ten thousand births every second and an equal number of lives snuffed out for all eternity.

When we looked around we saw bay and land and sky in three dimensions, but the creatures which called these home had established their haunts in half a score as truly dimensional to them as height, breadth, and depth to us.

The air close to the surface of the bay differed in no way, to our eyes, from that high in the heavens, but to the flying fish it was a very special dimension—a temporary but vital sanctuary from onrushing death; likewise the hot atmosphere over and round the desert plants afforded support to the gray humming birds who hung upon nothing for so much of their lives. Not to labour this theme too much, let us quickly ascend, spiralling higher and higher until the bay changed to a tide-pool and the desert's edge to a handful of sand grains. Here, high over the land, swung the vultures, focusing, with telescopic vision from ever-changing circles, upon death or the threat of death. A live jack-rabbit had no interest

A WEEK IN PARADISE

for them, but an ailing bird or a dead grasshopper was worth a descent. Over the bay floated other feathered motes, angular frigate birds who patiently watched for successful fishing boobies, from the same motive which inspires a marauding Arab on the lookout for a richly laden caravan.

When our mind turned landward our eyes picked out the dim, purple outlines of the distant mountains, among which El Puro Ano reared its arid head well over a mile above the sea. Following nearer, lesser ranges with steep cliffs alternating with desert arroyos, we came down to the banks and terraces of the forshore pleated with successive bands of sand and lava. We knew already of the rich harvest of shells covering the upper, storm-washed, sandy beaches. Below these the waterless land was suddenly drowned—so abruptly that no botanical amelioration of mangroves softened the transition.

We roamed at will over the mountains and tablelands without worry save for heat, drought, and thorns, but at the threshold of the water-world our human limitations required delicate readjustments and alterations in order to assure an acquaintance with life beneath the surface. The tide-pools of Inez offered few difficulties; waterglasses smoothed out all ripples aroused by our violent progress, and we reached and gleaned at will. The water-covered stones of Santa Inez offered sanctuary to many creatures, especially uncounted serpent-stars and

occasional living cowries. Sun stars, like fallen constellations, were scattered about, some with as many as thirteen to twenty arms—achieving success in life no better and no worse, as far as I could see, than their more conventional pentagonal cousins.

Through the pools there floated trceries of oblique emerald lines, joined with angles of orange and yellow; they slipped from under stones, mobile, chromatic designs. When captured, these peripatetic patterns proved to be external engravings upon shrimps—and shrimps so transparent that no part but the painted framework cast a shadow. Nudi-branches, the nudists of the snail world, were abundant, with soft flesh flaunting orange, black, turquoise, gold, and orchid hues, apparently proclaiming incredibility. We were not the only tide-pool fishers and we now and then frightened great white herons, great blues and American egrets from their watchful waiting.

At a fathom's depth human impotence demanded a diving helmet and I found this coast a difficult one to navigate and explore. The giant boulders and the fissures in the lava half hidden by draped sargassum weed made it necessary to feel ahead at every step. Although the date was mid-April the warm southern waters had still to make their way up the gulf, and the cold at any considerable depth was cruel. Braced across a mammoth crevice, striving to fight against the rythmic surge and the pull of gravity, I longed

for prehensile toes and a curling tail to help maintain my position.

On this particular day when thus precariously balanced between heaven and the black depths at the outer edge of a submarine lava flow, a rare yellow-bellied blenny came suddenly from nowhere and peered into my helmet glass. By superhuman exertions I frightened him far enough away to line up and explode my bang-bang. An unexpected rush of waters threw me back and downward and I had to bring into play all my arms, legs, and shoulders to keep from drifting out and far down. Then my net washed loose, sank to the deepest angle of my rocky fissure, and required five minutes of searching about with my feet before I retrieved it. Half clambering and half being rolled over the nearest ledge I looked down and saw my stunned blenny disappearing into the mouth of a golden grouper, who was far too canny to come near enough to be shot in turn. These lovely fish were not rare in Santa Inez—I saw three at one time. Like black leopards they are sports or colour variations of their more common mottled brethren—leopard groupers. Never to be forgotten is the apparition of one of these fish—sheer gold, seemingly self-luminous among the dark weed and black rocks. The sight of surgeons and yellow-banded angel-fish alleviated my physical pains, and the foreground was always inhabited by strange little blennies, sergeant majors and girellas or opaleyes.

When I came to the surface after this dive I was some distance from the boat and found myself balancing on a rock with only my helmet glass projecting above the surface. Looking along the level water I had a perfect flying-fish's-eye view of the world of air, and I realized how, to them, it must mean only a slight extension of a new cosmos of dangers. Cormorants were hurtling past and a pelican dropped like a meteor not far away, surf scoters paddled about watching me suspiciously; groups of small bonaparte gulls shrieked at each other and a large western gull was hot fighting it after an osprey: all fish-eating birds these, ready with keen eyes and eager wings for the first glimpse of fin or scale.

When I left behind my laboratory in Bermuda for a season in the Pacific, I fully expected to see the last of sargassum weed and to be able to study the life of the great kelp beds of the western ocean. All down the west coast of Lower California I had rejoiced in this kelp, and when we entered Inez Bay I looked for similar beds. But not a single frond or stem or holdfast showed itself. Instead there was sargassum weed everywhere, floating and also growing in great masses on the rocks near shore. Here was more weed than I had ever seen in Bermuda, much of it with finer fronds and smaller berries, but also other species indistinguishable to me from those in the Atlantic. Every large cove along shore, especially along the northern side, contained

groves of sargassum, some of it starting fifteen feet down.

Frank Taiga, the Samoan, in his gentle, insistent way, kept hinting that spearing fish at night by electric light was exciting and would yield rare specimens. So one evening three of us started out in the dory and were towed to the nearest shore on the west side of the bay. The water was smooth as silk and the afterglow was dying down into the brief twilight of this temperate tropic zone. Before we reached shallow water the light of day had gone and the stars were out in full strength. There was not a breath of wind and the temperature was so perfect that it never occurred to us to think whether we were hot or cold.

We had two acetylene lamps and two strong flashlights and after experimenting I hooked one of the former over the bow and curled up into a ball close behind it, while Frank took up his position directly over me. No box or front row centre ever afforded a better view than this. The light suspended below me gave a good general illumination, and when necessary I swung round the giant flash to light up some particular spot. The boat seemed to be floating upon air or rather midway *in* the air; to our eyes the water simply did not exist. From the sand, with roots hidden and anchored on some concealed rock or great shell, rose the long strands of the sargassum weed. Sometimes we passed through

great masses, the last upper foot or yard of the stems floating upon the surface. The foliage was delicate and the berries inconspicuous.

A faint white circle now and then moved gently over the sand, whereupon Frank would make a beautiful throw and bring up a little sting ray, perhaps pale creamy white with a dozen black spots on the back, or again one which had concentric lines of dark colour around the rim of the disc. Once a huge long-tailed ray flew past and we missed, but later a smaller one was harpooned. Large girellas or opaleyes clung to the edges of overhanging rocks, and we had to wait and catch them when they showed for a moment. They appeared dark green in the flashlight with four conspicuous light spots along the back near the dorsal fin. Now and then I caught a glimpse of a sand-white wrasse, or gars half a yard long shot past. Half-beaks occasionally bothered us by skittering and leaping at my light and thus shattering the mirror of the waters and making it difficult to see the bottom. But for the most part even the sand grains and the minute details of the rock ledges were distinct.

Once while my attention was directed to the left, Frank struck to the right and immediately a great flood of jet black ink diffused through the water. The pole was almost wrenched out of his hand, and steadying it, Frank leaped overboard in about eight feet of water. Working down the pole he

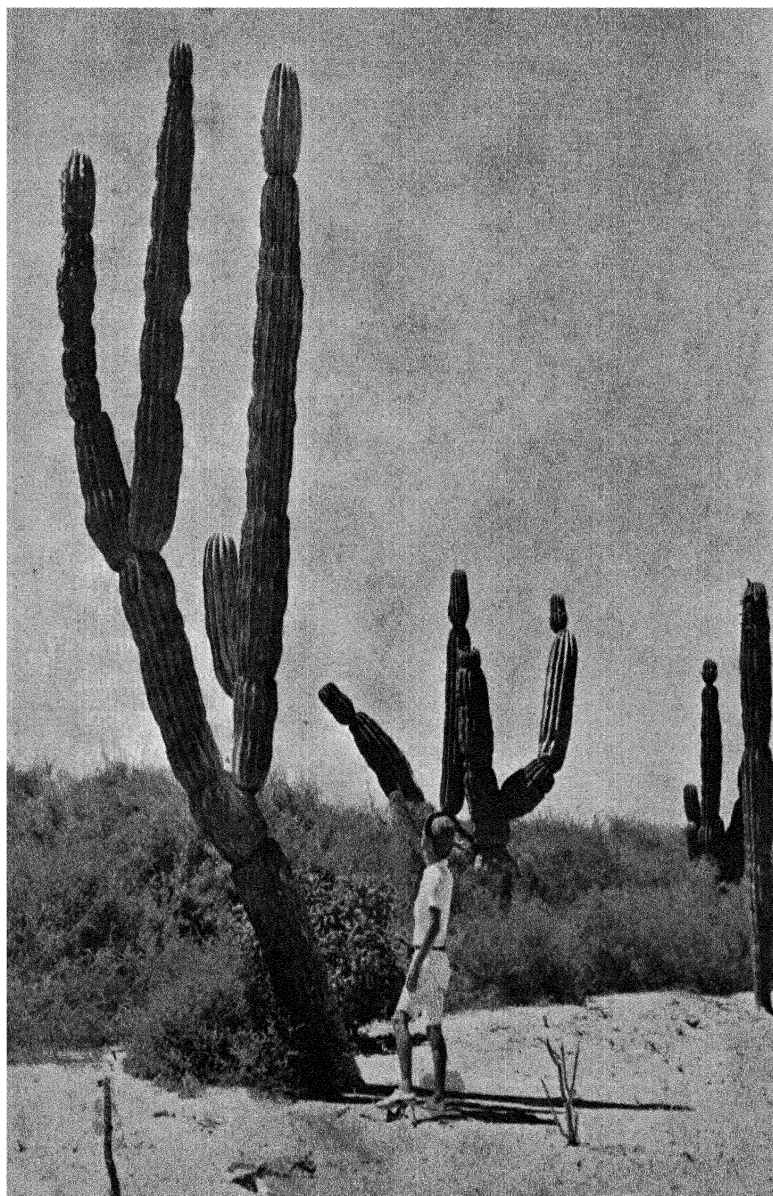
struggled blindly at the rock and beneath it. Twice he had to climb up and twist his head out for air, but after a single gasp he went down again. Three times he submerged, the last period seeming to run into minutes. I was quite out of breath in sympathy when he came up at last with a great octopus twisting around his arm. It was a beautiful deep shade of green, but shifted colour to a creamy white almost as rapidly as it changed holds. It was flicked off the barbs with great difficulty and fled up the side of the pail and found final lodgment in the water beneath the floor boards of the dory. Once during the evening an upright thread of silver resolved, as the fish turned sideways, into a full moon of shining metal—a moonfish, the only one we saw on the entire trip.

The most interesting thing of the whole evening was the sleeping postures of the fish. Some of the groupers rested flat on the sand, on even keel or listing to port, but absolutely quiet even when the light struck full upon them. Several rock fish, one of which we speared, were leaning against rocks or lying on their sides fast asleep. Most amusing of all were the puffers. We harpooned one by mistake early in the evening and had great trouble getting it off the prongs. Several times we met single ones near the surface drifting slowly along, paying no attention to the flash and apparently asleep on their fins. These somnolent drifters were mostly brilliantly coloured—the circles and bands bright yellow and

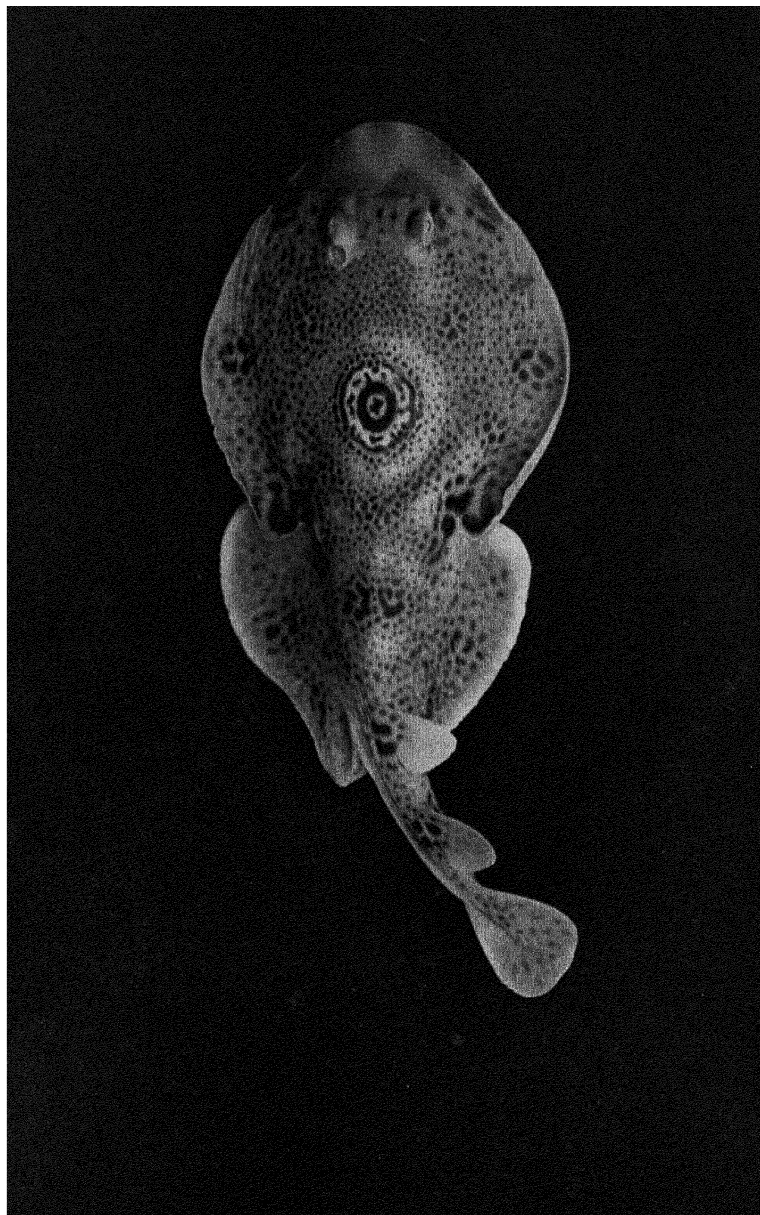
the background jet black. On the sand in the shallows near shore we passed over hundreds upon hundreds of puffers clustered close together. Two or three were piled half over one another, while five or six would sometimes be lying head to tail or side by side. At one place we counted sixty within range of the light. They were sleeping right side up, not buried but nearly all with a thin coating of sand thrown over their backs. This in no way disguised them, and from their conspicuousness and fearlessness they seemed to have little dread of attack. Once when we frightened a good-sized sting ray it swam swiftly over the sleeping fish close to the sand, and twenty or thirty startled puffers woke up and rushed about in all directions, banging blindly into the rocks and weed.

One reason for the slumber of the puffers and the wakefulness of the rays was to be found in their respective diets. The former were feeding almost exclusively on molluscs, whose shells they crushed, thus swallowing both animal and shell. This food was found and secured in the daytime, but the rays and skates had to search through the night for their amazing diet of polychaete worms, chiefly those with sharp, stinging spicules—creatures which never dared to leave their hiding places in the light of day.

Almost the last fish to be caught on our night-spearing expedition was a large brown eel, and when, on the deck of the *Zaca*, we examined its food we



CACTUS. Green, leafless, thorny—these weird plants grow slowly through the years, pushing up their thick stems which, even in this parched, barren land, are three-fourths water. (9)



ELECTRIC RAY. *This small flattened fish is distinguished by a brilliant pattern and colouration, and a pair of electric organs which can give a fairly strong shock. (10)*

A WEEK IN PARADISE

found that the immunity of the puffers was not as complete as we had thought, for the eel had swallowed one of these fish, eight inches in length and quite whole.

In the same sandy locality we saw small lizard-fish, quiet on the bottom but so far from being asleep that every one escaped the prongs before it was touched. A large dark-coloured eel slithered beneath a ledge of rock but we saw no other. Porcupine fish swam through the fronds and we got one without recognizing it or wanting it. A second octopus hunched along in the open and was secured easily.

A second and a third evening of night spearing were as absorbing and profitable as the first. A handsome little electric ray was taken while swimming slowly along two feet below the surface. It gave three shocks in succession, not nearly as powerful as those from an electric eel but sufficient, when unexpected, to make us drop the fish. The stimulus was gentle pressure on the body on each side of the central ocellus. (Fig. 10.)

We found an excellent place over eight to twelve feet of water, with rocks, sand, and weed all within range. Rays were abundant, passing both along the bottom and through midwater. A big snapper came, was seen and caught, and made species number ninety-nine on our Inez list. We watched the small folk gather about the light: little red worms and infant crabs and a mist of life to be resolved into

recognition only under a microscope lens. Several flat glass threads wriggled into view—the strange larvae of bone-fish.

I exploded a dynamite cap and stunned a fish in eight feet of water, but a passing grouper got it before we could. Another, however, which I fired at in one fathom, we retrieved safely with the net; it proved to be a young grunt new to us, with amber fins and black tail blotch, and brought the Inez list to one hundred. The concussion woke up and annoyed a fussy old porcupine fish which half inflated and swam about, banging our boat until it recovered full consciousness and sculled off into the night. The bang-bang continued to work well and we secured a number of rare cardinal fish.

We had worked in near shore and insects began to drift to the light from the desert—beautiful black-and-white moths and a large tarantula-hawk wasp with metallic blue body and orange legs. I collected a green and yellow grasshopper from a tattoo mark on Frank's leg. (On the side of his left forearm was printed, directory fashion, *T. Frank*, put there, as he told us, so that he would not forget his name). At two o'clock we had a full load of interesting fish and returned to the *Zaca*.

Still farther out in the bay, we depended, except for sporadic helmet dives, on small dredge hauls. Their diversity showed what a varied landscape there

must be fathoms down, to support the creatures which lived and swam over this submerged land. The *Zaca* was now anchored in thirteen fathoms, and this was just beyond my self-set safety limit of diving. So we drew many dredges and found that tall sea-pens were growing here, accompanied by great orange starfish and flounders with varying patterns.

A wire trap lowered to the sand and baited with decidedly unfresh fish yielded a harvest of great beauty. The scent must have drifted far along the bottom, eighty feet down, and up current had come a company of starfish and lovely murex snails. The spiny shells of the latter with their entrances of exquisite deep rose enamel filled the trap—a score or more. Many gray and carmine stars had squeezed and wedged themselves through the narrow entrance funnels to feed with eagerness on the decayed fish. We had to take the trap apart to get them out. Small puffers revealed vulturine propensities and six had pushed in with the starfish and the elegant scavenger snails.

When least expected, a vision would be thrust upon us of the superabundance of life in these waters. We drew a small dredge, on April 13th, for a few minutes in thirty fathoms. This haul was known officially as Inez Station Number 143, Dredge Number 1, and it was located halfway between Inez Island and the shore, about four miles from each. The contents were typical of many dredges pulled

hereabouts, and afforded a reasonably accurate cross-section of the population of Incz small folk living out their lives one hundred and eighty feet down.

There were 28 echinoderms of 6 species, including brittle stars, urchins, and sand dollars; of crustaceans we counted 70, also of 6 species, half of the total number being flat, long-legged spider crabs. The catch of fish was meagre, there being only 21 of 4 species. Two of these and 17 individuals were flounders, besides several dwarf gurnards and a harlequin rock-fish.

Molluscs, as usual, were dominant in numbers. We found we had taken 30 species and 125 individuals. Four, including crown and screw shells, were very numerous.

All of these 250 creatures were half or wholly buried in a mass of fine, shelly mud at the bottom of the dredge, this material forming the bottom of the bay here and in neighbouring areas. Instead of flushing this overboard with the hose from the large sieve boxes as we usually did I yielded to an impulse and scooped up some of it into a quart preserve jar, labelled and packed it away. In the course of time it went to the conchologists who named all our shell collections.

We were amazed a few months later to read the report on this bottom material and find that careful examination of it with a hand lens had yielded 129 species of molluscs, 8 of which were new to

science. A few were the young of large species which inhabited this locality, but most proved to be full-grown, microscopic forms, living in this deep water, species which would never be found in any hasty, macroscopic collecting.

Of this diminutive snail world it is interesting to know that 14 species of the 129 consisted of 150 to 360 individuals each, and comprised 3,065 shells. The remainder brought up the total to 4,370 individuals, all living in this small sample of the bottom of the bay.

In order to include in our study every type of area in the bay, on the third day of our stay we weighed anchor and made four dredge hauls in thirty to fifty fathoms to the north of Inez Island on the verge of the outer deep. Every haul was different. One was heavy with black gravel, almost lava sand, and contained shells in large numbers, mostly empty of original owners but full of active hermit crabs. In another dredge were seventy-seven great, yellow-green sea cucumbers with a double row of black ventral spots. We set aside several for preservation and found they were a new species which was later named *Holothuria zaca*.

With a sharp knife Frank went through the remainder with true Samoan patience, slitting each one and searching for possible guests. None was found until from almost the last individual a silvery form slipped out and we had our first pearl-fish.

This was an elongate, slender, eel-like being of whose life we know little except that it seems to spend most of its days and nights in the black interior of these sea cucumbers or, what would seem more pleasant accommodations, within the shells of pearl oysters. Some of the characters of pearl-fish seemed reasonably connected with their peculiar living quarters, such as the thin, papery skulls—heavy bones being useless; also transparent skin through which the backbone and blood-vessels show plainly. The pectoral fins were fleshy, more serviceable in pushing about among the various internal organs of their hosts than in swimming in the open sea. But it was difficult to explain why the lips and the interior of the mouth should be jet black and the body cavity silvery; or why the eyes on the flattened head were so arranged that their normal gaze was upward. In full sunlight the colour of the fish was a blazing intermingling of iridescent silver, bronze, and blue, obviously a by-product and a complete antithesis to their dark abode. It is this superficial glory which has given them the name of *Fierasfer*.

The commonest habit of sea cucumbers when annoyed is to discard practically all their internal organs, then to wait patiently until time has regenerated a new set, so that they may again eat, drink, and bring about whatever a holothurian can in the way of merriment. It must be bad enough, in our biased opinion, to have to spend one's life under

such depressing surroundings, in such a completely unattractive environment, but think of the added dismay and humiliation to a pearl-fish of being dispossessed at the whim of a landlord, and finding oneself homeless in some street of the deep sea!

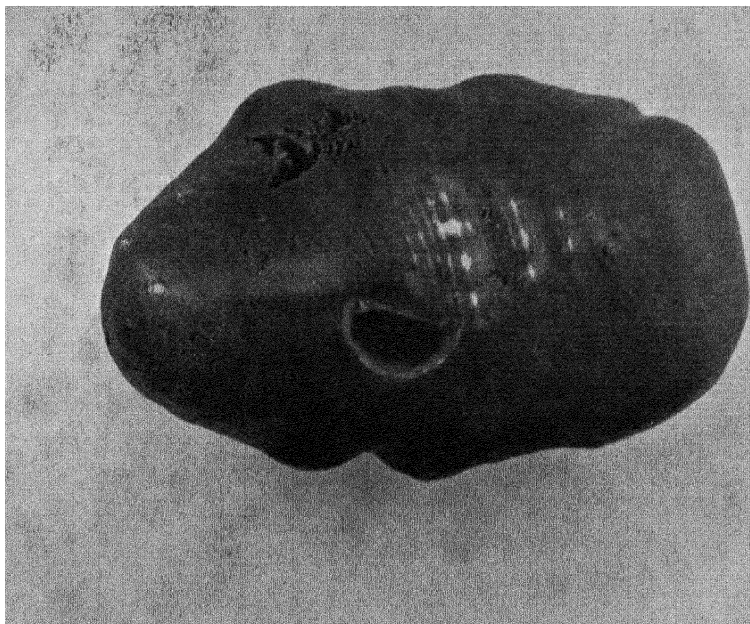
One of the most beautiful objects I have ever seen was washed out of black mud by the gentle stream of water from the hose—an oval bit of orange sponge, a broad spindle about three inches in length. I turned it over and reason for its shape was revealed. Incased within was an exquisite sculptured, long-spined murex shell, well below the surface but clearly visible through the translucent, delicate tint of shallow sponge tissue. It was like a dainty cameo brought to view by a lapidary's craftsmanship, a butterfly in amber, a marvellously coloured living fossil in the making. At the mouth of the shell there was an opening to the surface, and as I held the sponge in my hand I saw a movement deep within and a pair of stalked eyes like turquoise-topped matchsticks peered out at me. This little hermit crab had a home fulfilling all requirements, for himself it was safe, a shelter in a hard marble cavern, which was in turn encased in a complete, inedible, spicule-filled skin of living sponge. And to me and my friends it afforded a satisfying emotion of wholly unexpected and harmonious beauty. Six more of these sponge-covered shells came up, every shell different, but all equal in loveliness. The hermits could keep their

sponge vines trimmed about their doorstep, but it would seem certain that in the course of time the amount and weight of growth at the sides and over the roof would finally clog and hamper the movements of the little guest and force his removal to a new home adorned with less lush animal shrubbery. (Fig. 11.)

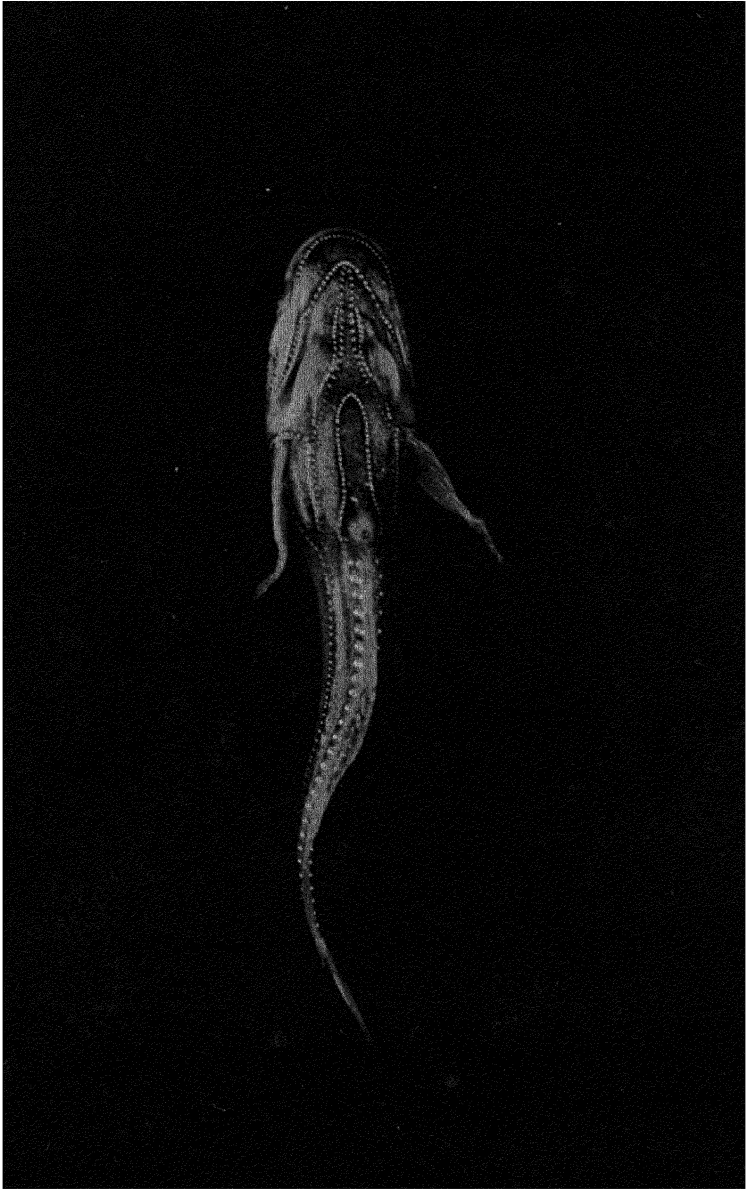
In one dredge were twenty great spindle shells, eighteen manned with the rightful owners and two with pirate hermit crabs. Neither of these last had any signs of spongy ectoplasm, but on each shell, on the side opposite the mouth, was a large, solitary, dark, wine-coloured anemone, rising from the surface of the shell in a graceful cone like Fugi from the plains of Hakone.

In the water, as the crab hitched along his great, ornate spire, the elongated tentacles of the anemone waved and jerked about like the unsteady stance of Ceres and other goddesses of early spring wheat on the wobbly float of a village pageant. It was interesting to discover that this anemone lacked all the sensitiveness of the rock-loving forms which withdraw their tentacles at the slightest touch. The constant bumping and banging to which it was subjected as the crab crawled along, over and around obstacles, had inured it to any amount of casual tactile irritation.

Having dredged from one to fifty fathoms in the bay we worked slowly outward toward the abrupt descent to the bottom of the gulf itself, which,



SPONGE CAMEO. *A shell inhabited by a hermit crab has become encase growth of scarlet sponge, leaving exposed only the entrance. (11)*



THE SINGING FISH—PORICHTHYS. *Looking like a grown-up tadpole, this fish can hum aloud, and from its numerous silvery pores can send forth mucus or a dim yellow light. (12)*

despite its relatively narrow width reaches a depth of a full mile in the centre. The first dredge, on the rim of the drop, was made in only thirty-five fathoms and amid the bottom mass were several shells for which we had been searching ever since we started on the expedition. They were handsome brownish-black mitres, the namesake of our yacht—*Mitra zacae*—which until now had been taken only off Acapulco, a thousand miles to the south. I examined a handful of the bottom detritus which looked like sand filled with numerous muddy matchsticks. Under the lens these resolved into worm tubes of many kinds; some were horny, others in consistency like thin, pliant canvas, or again a mosaic of bits of shells which, under higher magnification, became walls of great, many-coloured boulders. A second sieving left a fine residue of minute, perfect shells and sand grains, while here and there were the sculptured otoliths or ear-bones of fishes and tiny brown teeth of sharks. These recalled the ear-bones of whales and the huge sharks' teeth which the dredge brings up from three and four miles in the open ocean—the only objects which resist the dissolving chemical agents of these abysses.

As we steamed out into the gulf, large surface-swimming sharks became numerous, and we counted many within an hour's time, six of which were in closely associated pairs. The deep water we found disappointing in its life, or perhaps we had been

spoiled by the superabundance near shore. Many of the creatures went in schools and in one net we took one hundred and seven Mexican lantern-fish and a swarm of large scarlet shrimps. The cold water of the outer ocean becomes tempered as it enters the gulf and this is something that few inhabitants of the oceanic deeps can withstand.

The plankton or lesser floating life was abundant in mass but meagre in species. But at night, under the microscope, I found the microplankton fulfilling all expectations. The diatoms alone were a reward in full—circles, wheels, spheres, cubes, covered boxes, spindles, and rods, all reflecting gorgeous hues and tints. Fire opals make the only adequate simile. As I looked and manipulated the microscope lenses and lights I remembered that all these kaleidoscopic glories were not inherent pigments or colours but structural—superficial. After all, the eye of a peacock's covert is dull brown when held against the light, but why hold it against the light!

Now and then a string of ten to twenty Dinoflagellates drifted into view, looking for all the world like a locked-flight of motionless terns. These one-celled creatures are known as *Ceratium* and there is no ocean on the planet where I have not found them. When the long skeins separate into individuals we see each as a little, irregularly rounded body from which project three spines, one extending backward and the others curving around until they

too point in the same direction. The surface is delicately curved and there are two whip-like flagella, one of which rests in a groove. The external armour is a kind of cellulose which brands the organism as a plant of sorts. But it can digest organic food which in turn puts it on the animal side. On the whole it is well over 50 per cent plus animal, but this uncertainty, this tendency toward *halfway*, makes it of unusual evolutionary interest.

In a work on life in the ocean I found the following dictum: 'A monotonous environment may permit many individuals to exist but limits the number of types; whereas a changing environment is associated with variety and the evolution of new types.' This may be justified in the evolution of creatures of a tropical jungle, but it is certainly not true of abyssal oceanic life. Whether we consider fish, squid, crustaceans or any of the lower forms of sea life, it is inexplicable why, in the static darkness, eternal cold, and never-varying pressure of great depths, such extreme developments of structure, such strange and numerous forms, should have evolved, more bizarre than any of their relations at the surface or wherever else there is infinitely more variety in movement, light, and temperature.

In one of the nets came up several *Gigantocypris* (nameless otherwise), unbelievable cousins of the common *Daphnia* or water flea of our country ponds. Only this creature was a whole inch across, quite

round, with a humanly comic facial arrangement of organs on one side—an abyssal crustacean Tweedledum—the only break on the equatorial horizon of itself being a tuft of feathery appendages. These were its sole movable connections with the outside world, as if an armadillo should become fixed when it was rolled up into a tight ball and lose contact with the external cosmos except through its extended paws. In the same net was a bewildering contrast—a small scarlet shrimp sharing the same stratum as the round living ball, but in this case the focus of a maze of appendages all long and slender, some for swimming, some for catching and holding food or perhaps a mate, others for driving a current of water across the gills, while in front was a pair of scarlet antennal threads, several times as long as the entire animal. These filaments were of multiple use—feelers to reach out into the icy darkness, to sense approaching danger and signal flight, or to detect the proximity of a mate and telegraph an advance, or finally perhaps to scent out food and by some complex of neural messages to prepare and correlate the whole shrimp for its seizure.

Our captures were beyond number: our understanding of their lives humiliatingly meagre.

On the evening of April 16th, our last in Inez Bay, I sat in a deck chair and watched the spreading glory of the sunset cool itself on the distant purple

mountains. The darkness was not so much an active shutting down as we usually think of it, as it was a withdrawing of light. And in Inez Bay such fine distinctions are important, even if born of mental rather than physical stimulus.

I thought over our memorable week, and the aspect of humanlessness came first to mind. Twice only had we seen any signs of mankind, once when four Indians floated past in their canoe, watching us, and again when we had brief intercourse with the Mexican turtlers. In both cases no one seemed to have watched them go. The Indians had sent a bloodcurdling yell at us and paddled northward with all their might; the Mexicans, with a gentle '*Adios Señores*,' pushed off from the *Zaca's* side. But after that no one saw them again. It was part of the magic of Inez; they had appeared from nowhere and then simply dematerialized like fish at a distance to a diver's eye—they vanished down no road, by no compass.

In the evening a dim speck of light winked at us from afar, much more like a low-hung, lesser-magnitude star than a shiftless man-made beacon on the distant shore. And once in the desert I had come upon a ghost trail with whitened stone markers, and cactus pretending to be telegraph poles. It was said to go on until it came to a place called Mulege, where the coast pilot absurdly located people—dozens of them—and sweet-water springs and such

long-forgotten objects as palms, oranges, and bananas. We knew that such things had no substance near Inez; we were the only beings left in the world. We even read of a date, 1705, when a mission was established at this mythical town. But while we mouthed some such statement as that we had been here for eight days, yet it had no real significance; time, like the days and nights, was for us at Inez a scarcely observable illusion.

Another characteristic making for this unreality was the silence of the bay, combined with an unbelievable sensitiveness to sound. As I sat on deck the darkness brought nothing to my ears but an occasional sigh from porpoise or dolphin—schools of both coming sometimes at night to have a look at us. On other evenings the excited shouts and calls of the harpooning party over some capture came clearly from a mile away and as instantly died out. In the desert the songs of birds had attentively to be listened for, to separate them from the all-pervading quiet; the wings of a humming bird made a very audible whirlpool of sound in the hot air.

Throughout our stay there had not been enough breeze for the least sough of foliage, nor sufficient restlessness of water for the sound of lapping. The gentle movement of the surface, the shifting haze on the distant mountains, the heavy dew at night, all came and passed in silence.

After the tearing dust storms and raging waves at Guaymas, the Inez region left us feeling that we had spent the present part of our lives in a great room. Our Zacian life, troubled with so few clothes, our eating and working on deck, contributed to this. Sleep had been so sound that our cabins came to mean little more than a larger darkness than that enclosed beneath our eyelids. The sky was always clear, wholly free from clouds, or with only those mists which materialized like the Indians, casting no definite shadows, and for lack of even a breath of air failing to attract any attention from movement. The only shadows from the heavens were those of vultures and frigate-birds, or the black arrow of a diving pelican rushing headlong to meet its substance at the surface. The light, while strong and brilliant, had never disturbed our eyes. No one used dark glasses, and only the glory of the morning and the evening of the Earth's quiet revolutions made us conscious of the sun. The sky was the domed ceiling of our room at Inez, reaching down to the peaks and islands, which in turn formed a rose and buff moulding in the distance, rising high into walls above our heads when we came close to them. The quietness and solidity of the water of the bay made a boat seem needless; often it would have required only a very slight accretion of Faith to have made of me a successful St. Peter. And in the centre of it all the *Zaca* was a focus of comfort, providing laboratory,

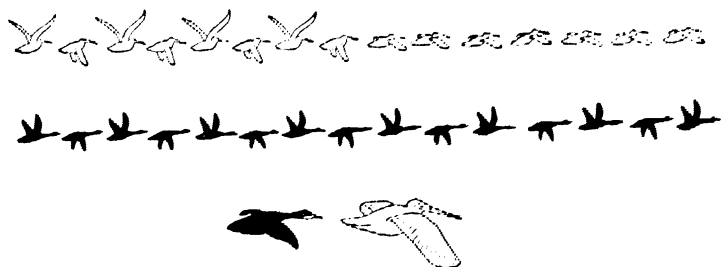
library, bed, food, drink, conversation—a perfect, thoughtful place. (Fig. 3.)

To any of the gods looking down from high overhead we must have presented an amusing sight. Creeping forth like ants at the tinkling of seven bells, clambering into tiny affairs of hollowed wood and scurrying over the face of the waters in all directions, some of us to cast out a long length of coarse fabric, draw it in to shore and eagerly gather minute silvery motes entangled therein; others to incase their heads in a queer metal contrivance and sink for a short space of time beneath the surface, there to produce a sharp sound and come up, grasping one or more shining specks. Various threads dangled from the edge of the central Aquatic Nest or Hive and now and then these were pulled up with wriggling beings at the ends. After dark large dark men fiercely thrust slivers of steel beneath the water in the path of a small light and impaled still more submarine creatures. And so throughout the days and on far into every night.

Strangely enough we were almost satisfied with the scientific work we had accomplished—work of no immediate use to mankind, of no political or cash value—but as far as it went, a thorough and accurate study of the lives of some of the inhabitants of Inez—creatures who had been living here, not for the pitiful two centuries of a mythical Mulege, but whose residence went far back of the lava flows

A WEEK IN PARADISE

to be reckoned in millions of years. These 'oldest inhabitants' had filled our week with the vital interest which only Naturalists know.



FLIGHT RHYTHM OF PELICANS, OF CORMORANTS, AND OF THE TWO WHEN
FLYING TOGETHER

V

THE MAGIC BANKS

ON April 18th the *Zaca* steamed out into the gulf, out of sight of Inez the Perfect, and turned southwards. We relaxed on the deck, prepared for a quiet day between stations in which to discuss our week's experiences. But our most indefatigable fisherman was at the wheel and to the rail at his side he had tied his pet line and feather jig. Our contemplative reverie was rudely shattered by the sudden leap of a fish and in came a magnificent yellow-fin tuna. A few minutes later another was taken, and I cast aside all thought of rest and concentrated on the fish from the moment they appeared in the *Zaca's* wake until death ended their colour changes.

The observations gave further proof of the utter inadequacy of present human scientific descriptions. And when we come to think of it, our conventional diagnoses exclude not only the changes due to the emotions of fish, but a further 50 per cent must be deducted because of our laziness and diurnal habits. These human attributes have allowed us to take into consideration only the patterns and colours found

during the twelve hours of daylight, leaving fully unknown and undescribed the appearance of fish throughout a full half of their entire lives. Pattern and colour are primary elements of art and beauty as well as important ichthyological characters. So the following detailed account (like the corresponding one of the bonito on an earlier page), dealing with the astonishing changes in this Pacific tuna, carries more than one appeal.

When the tuna was first taken out of the water it was bluish black above and this colour merged by degrees into the dusky of the lower parts, through iridescent steel blue, then bronze, then slaty brown. A series of about twenty upright, bluish white bands extended along the whole body, from the lowest profile of the abdomen up to the edge of the dorsal black, over three-quarters of the entire depth of the fish. There were eleven of these bands in front of the tip of the pectoral fin, and between each was a second series, fainter, and broken up into successive spots.

As we watched the new-caught fish, within a period of three minutes a solid broad band of blazing gold appeared, so solid that it obliterated every pattern and colour in its path. It began strongly at the snout, and widened immediately until it encompassed the whole eye. It then swept back over the upper third of the cheek, covered the whole of the outer side of the pectoral fin and continued over the entire

length of the body, narrowing gradually until it died out at the lateral tail keel.

One of the miracles of this pattern went far back of the present into pigment distribution in the embryo. The pectoral fin, like our arm, is a structure quite apart from the scales or skin on the surface of the body, its tissues having no direct contact with the superficial body tissues. Yet while usually the colour of the part of the fin over which the gold extended is the same as the whitish of the under parts, when for some as yet unknown reason the great gold band appears, this pigment flux rushes far out on to the extraneous tip of the fin, so that when it is folded back against the side, its colour will carry out the symmetry of the definite band pattern and not result in a fin's outline breaking into and destroying the evenness of the auriferous beauty. We may be sure that the evolution of the gold band had nothing to do with beauty, and while we can assign no reason adequate for its appearance in this swift, defenceful fish, yet we may at least be certain that it was not designed to be developed only at approaching death. As for the beauty of this swift change, the only worthy simile is a sunset: not all sunsets either, but one of surpassing colours and with an exceptional afterglow.

The first fish fought with all its strength until it lay on the deck, when it quivered once or twice and never moved again. After ten minutes the gold band

began to fade and by the time we had it on the measuring table the first white-marked duskiness had returned, while the gold was now oxidized and had become only a casual iridescence. Both fish were males but not breeding, so there was nothing of nuptial reason for all this transitory glory.

In the stomach of one of the tunas were seven of the little robins or cigar-fish which came so frequently to our submarine lights. In one of these in turn I found a tiny white larval blenny dotted with white, but since *his* stomach was empty the chain of life ceased. The flesh of the tuna was saved for sail-fish lure, so further links may be forged at the opposite end.

The closeness of relationship of the tuna of the Atlantic and the Pacific re-emphasized a scientific problem with which we were much concerned on this expedition. Some genius of the future will make a detailed comparison between the tropical marine life of the eastern and western oceans. This will be one of the most interesting and important contributions to ecology and evolution ever produced. At present we lack sufficient facts for even a superficial attempt.

We know that the marine life on either side of the waistline of the Americas has developed independently for many millions of years. The tropical area from Bermuda south through the West Indies, Gulf of Mexico, and Caribbean Sea, and the correspond-

ing latitudes from Lower California to Panama are the two zones of vital comparison. Any mingling of fish and other creatures through the cutting of the Panama Canal is completely negligible. But once, when the face of the earth was different, there was a far wider gap linking the two oceans across what is now southern Nicaragua, Costa Rica, and Panama. These present-day lands are uplifted ocean bottoms and have nothing in common with the remaining structural parts of North and South America. Fossil shells and other marine forms show that this link between the oceans existed throughout all except the latest Tertiary.

Still more interesting is the fact that the Gulf of California was formed even later, and when the water partly retreated, leaving exposed the Colorado deserts, the stranded shells and corals showed many Antillean relationships, so that a later and last connection between the two oceans must have existed across the Isthmus of Tehuantepec. A conservative estimate of the intervening time is twenty-five million years. So at present, when we look at two fish such as our snipe-fish, or tuna or sail-fish, or shells or other organisms, one Atlantic and the other Pacific, whether they appear identical or show trenchant differences, we realize that they have been separated from any common ancestor for at least the above length of time. And in every case where, to superficial examination, they seem to be indis-

tinguishable, comparison of the skeleton and all other important internal characters should be made before any final decision is reached.

At nine o'clock in the evening of this our first day away from Inez, the *Zaca's* engines were stopped and after headway was lost the light was put down from the end of the boom-walk and a little local whirlpool of life created in the midst of the dark waters of the gulf. The slight breeze kept the ship moving ever so slightly so the simile was not wholly fanciful, for all the time creatures kept coming in and passing on, after being affected not at all or else stirred to the very core of their beings by the sudden illumination. Just as night after night at Inez we unconsciously searched for and found the diminutive Mexican beam of light on the distant shore, so these aquatic organisms, undisturbed by the general illumination of the sun in the daytime, were drawn irresistibly to execution against the glass, or spiralled about by some induced whirlpool within their thin tissues.

Hardly had the light been turned on when a school of twelve- or fifteen-inch squids appeared. These aristocrats of the molluscs had nerves far too well developed to yield in any helpless way to the glaring shaft of light, and their clever ganglial brains instinctively used it to the utmost advantage. They had never seen such a thing before and never would

again but, as if it were a nightly occurrence, they remained the whole time circling swiftly a fathom below the surface, safe from us and garnering all the fish of worthy size which were helplessly yielding to their positively phototropic destinies.

The very instant the light was flashed on, the water in front of it was thick with organisms, and as I lay flat on the boom boards I could distinguish many of the components of the milling swarm. Ctenophore jellyfish, like watery beads an inch across, trailed two long threads after them, and ciliated themselves with remarkable rapidity back and forth before passing on into the darkness. Now and then the light showed where eel larvae—slender, wriggling wisps of barely organized water—were swimming about, wholly at the mercy of the light. Oblong blobs of reddishness indicated minute relations of the great marauding squids patrolling the outer radiance of the luminous circle. I do not know why the diminutive squids in their comic staring qualities always reminded me of pelicans, but they did. Large jellies swept past deeper down, like the giants we always saw when we drew in the deep nets. I caught one, six inches across; others must have measured three feet across the disc.

Bits of sargassum weed floated past and the least shred almost always sheltered one or more small fish. We learned not to neglect even a single strand. In the pans on the laboratory table appeared a steady

stream of forms of life, as Frank and Ben ladled in net after netful. The weed was covered with almost a solid coating of flat worms, self-coloured with their host plant, about a fifth of an inch long, and some of them in the process of dividing longitudinally into two. It was practically twins-while-you-wait with these lowly forms of life. They could swim with graceful waves, or crawl upside down beneath the surface film, and were at home on the weed itself.

Unseen from the boom because of size and colour were hosts of porpita, elegant relations of Portuguese men-o'-war. The largest were only slightly over an eighth of an inch in length but ultramarine of the deepest. Under low power they looked like concentrically ringed little sapphires, until twenty or more pale tentacles protruded from beneath the disc, extending in extent in oceanic space to a full quarter inch. There were scores if not hundreds, most of them mere pinheads of blue, but all perfect to every detail, never to delight the eye of man unless I selected one from among the host and placed it on the microscope stage.

By far the most delightful visitor this evening was a small black petrel. It fluttered toward the light and fell into the water in utter bewilderment. I made futile lunges at it, but it escaped. A half-hour passed and I forgot all about it until I looked down and under the armpit of my sweater was a tiny, black,

bat-like thing looking at me with quiet unconcern. I took it out and gave it to someone to hold. Later, identification proved it to be the smallest storm petrel in the world, *Halocyptena microsoma*. Its full length was five and a half inches, so its name as here printed is more than one-quarter of that. It was an ordinary petrel looked at through the large end of an open glass, quite as exciting from its small size as would be a petrel as large as a horse. I wanted it for many reasons—its unusual size, its rarity, its skeleton. If I had caught it in the net, dragging it out of the water, a wet, bedraggled, flapping thing, if it had pecked me or struggled or called loudly I would have hardened my heart, gently but firmly chloroformed and skinned it. But what could one do with this atom of a storm petrel which had flown directly under my arm, the psychological place for protection of weaker things, and which sat quietly in a glass jar until I examined it; which permitted itself to be handled, its beak, wings, tail to be measured; and then while I was looking up its name, sat self-possessedly in my hand, watching me with what seemed embarrassing composure and confidence? What was there to do but take it on deck and toss it gently into the air? It had to be tossed, for it still sat quietly after the restraining fingers had opened.

John Xantus, that famous old explorer, shot the first least petrel one hundred and fifty miles south

of this spot during the time of the Civil War in 1861; Elliott Coues with creditable imagination not common in ornithological taxonomy, called it the tiny-bodied sea-swallow, and now (at least for to-night) I completed human contact with the small being by setting it free.

Four hundred years ago Lower California was discovered by Cortez; for several thousands earlier the pitiful Guaicuru Indians inhabited the land, and to-day we find Mexicans almost as primitive in this region—thus summing up human successions. The lineage of my diminutive petrel stretched back, even to our imperfect knowledge, some fifty millions of years.

A pleasant haze of religion enveloped the fluff of feathers, for I captured it not far from the island of Santa Cruz; its nests are in burrows on San Luis; I set it free on the day of Saint Eleutherius, and it walks on the water like its namesake St. Peter. *Halocptena, pax vobiscum.*

Just within the mouth of the great gulf, on the inner tip of Lower California, well sheltered from the strong north-west winds by Los Frailes and Cape San Lucas, is an elongated, submerged bank about a mile and a half offshore, extending from Arena Point to south of Cape Pulmo. In the course of our expedition we visited it four times and established it as Station 136. In addition to net hauls at the

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surface and many collections made at night lights, we drew thirty-three dredges along the bottom.

Twenty-five miles farther south, about halfway to Cape San Lucas, is a second bank, this one rounded, located about five miles offshore and measuring two miles across. On this, which is known as Gorda, and which we identified as Station 150, we made twenty-six dredge hauls. When we finally classified all of the hauls, we found that nineteen from Arena formed a typical group drawn over a relatively small, compact area, and sixteen from Gorda comprised a corresponding representation.

In years past soundings had been made in these two areas by the United States Coast Survey, but as far as we knew no living creature had ever been taken from the floor of either bank. So we began work in absolute ignorance of the bottom and the animal life which lived there. Our knowledge of adjacent bottoms was the meagre observations made when I had walked about in a helmet far to the south, and a few yards from the feet of the Gray Friars had seen the sand and rocks slope abruptly down and out into black depths. I had also hauled small dredges in San Lucas Bay close to shore and found a surprising abundance of organisms of nursery age.

Here the sounding line told us that the bottom of these banks was rolling, sloping more or less regularly outward. Our dredge hauls were made with as even

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a pattern as possible, weaving back and forth over the bottom so that a reasonably accurate knowledge could be obtained of the entire banks. This was insured by using landmarks to guide and check our exact positions.

The technique of dredging is different from anything else in the world and combines the most exciting qualities of exploring an absolutely unknown field with all the essence of gambling. The yacht is stopped and a sounding made to give the approximate depth. The great iron frame, two feet by four, with a strong net dangling from the rim is then slipped over the stern and the thirty-five-pound weight cleared of the sheave. Then come two signals on the electric buzzer and the wire begins to reel out. The drum is amidships, and from here the wire is led a short distance aft to the winch. Here it is given five turns around the revolving drum of the winch and from thence up and along beneath the great horizontal boom of the mainmast, over the sheave and overboard. The strain is taken up by the five turns on the winch drum, but the man at the handle of the reeling drum must be strong and ready to stop any sudden run until he can put on the brake. A second man has a bent hand-guide to spool the wire roughly. At last, from the 'feel' of the wire it is certain that the dredge is on the bottom. Then more wire is run off and finally, with a single engine at 'slow,' the haul is made.

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All of this part of the programme is carried on quietly by two or three men while the rest of us are about our various occupations. During the actual dredging, however, the captain never releases the wire from his bill-hook instrument, telling from the pull whether the dredge is sliding smoothly along, or from a sudden strain that it has encountered a more or less serious obstacle. Occasionally the dredge hangs up on a ledge or boulder and when this happens we go full speed astern until the wire is straight up and down, when the dredge can usually be freed and drawn to the surface. Sometimes the net is torn away or the frame is badly bent but fortunately these accidents are rare.

The *Zaca* has to be jockeyed a bit while the dredging is going on, for the slowest speed of one of the Diesel engines is about three or four knots and any favouring wind must be taken into consideration; sometimes the engines are shut off altogether and the speed made by the wind alone. If the speed is too great, and the feel of the wire shows no jerks or jars, the dredge is probably off the bottom and more wire must be paid out.

After five or ten minutes three buzzes electrify everyone on board. Whether we are down in our cabins, or in the laboratory, forward or aft, or mayhap up the rigging looking for whatever is important to look for at that moment in our lives, wherever we are those three sharp signals act like the

similar-sounding notes of an angry and outraged hornet, snapping us all to attention. We climb down or climb up, and find all the men at their stations. The *Zaca* was built for racing and for comfort, not at all for this kind of work, and yet I have never been on any oceanographic vessel fashioned especially for the purpose where the work was accomplished more easily or with greater facility and accuracy.

A single buzz starts up the winch, and the whining wail announces that the wire has begun to come in. As the meter wheel shows that the net is nearing the surface we all watch eagerly for the first indication of the weight on the wire or the ghostly white appearance of the net of the dredge itself. At sight of either, again sound the warning three buzzes, and as the leaden ball comes within a foot of the sheave, a sharp single buzz stops it before any damage is done. A rope run over a pulley high up the mast is then hooked on, to take the strain from the dredging wire, and slowly the dredge, now at the surface, is urged around the stern and along the rail. As it goes it usually leaves a wide muddy wake in its course, and sometimes fish, at other times birds or even sea-lions, are attracted by this unusual sight or smell or whatever it is which appeals to their senses. (Fig. 13.)

Amidships a vocal signal halts the net. If the dredge load is heavy, with the net half-full of mud, the engines are turned over very slowly, and while the net is still partly submerged it is gently dragged

alongside, the slight wash churning out hundreds of pounds of useless mud. We peer over and see the arms of starfish and the heads or tails of fishes protruding from the meshes.

'Heave away!' brings the net slowly up. We all watch anxiously as the still great weight at the bulging end comes into view, and the long-suffering meshes strain and elongate until it seems as if they must give way. Over the rail it comes and is allowed to settle gently, spreading out like some huge, bloated octopus into great box sieves. The latter are the simple but exceedingly ingenious devices planned by Mr. Crocker for extracting rapidly and thoroughly all the desired beasts from the catch. Two large, shallow, wire-floored boxes fit partly into each other, the lower supported on short legs. The wire in the upper is much coarser than that on the floor of the nether box.

The bottom of the net is tied, and although it is a most canny knot, which comes loose at a single pull, it is sometimes a question of minutes, and of mighty lifts and shoves by the captain and crew, before the rope is found and freed. Then the pulley-line is again tightened, the dredge lifts, and out of the slimy meshes the catch flows into the confining box. The net is slowly raised and taken aft for another haul, and we gather about the catch with the same enthusiasm which inspires an astronomer at the sight of a new comet.

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One of us takes the gently flowing hose and plays a slow trickle over the surface and into the corners, displacing the mud and revealing the living creatures, which we lift carefully into glass dishes and enamel trays. The treasure hunt is on.

Fortunately, in these bank hauls, there were no needle-spined urchins or other animals dangerous to our hands, and we could dig and scoop at will, a nip from the claw of some buried crab being the worst we might expect. The mud was greenish black, of a slightly clayey consistency, moulding into firm shape when squeezed free of water. It had no odour and washed off without stain or residue. Waving legs indicated where bogged crabs were striving to free themselves; protruding blunt spines showed the presence of club-spined urchins. When an oval bit of mud itself took on a slight wriggling, a little sole was probably responsible. A flash of scarlet was a triglid fish and a gleam of iridescent copper was *Porichthys*, or singing fish.

Most of the hauls were rich in fish and in various groups of invertebrates. The bare list of these and the new species discovered, together with what we could learn of their colours, food, and habits, while of vital importance from a scientific point of view and all to be published in their appropriate place, would make dull reading in an account like the present. I will give only a few comments on the comparison of the two banks—Arena and Gorda—each relatively

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so tiny, so close together, and yet so wholly individualistic.

The average depth of the nineteen typical Arena hauls was two hundred and seventy-five feet, while the corresponding sixteen dredges on Gorda were considerably deeper, around four hundred feet. These depths were far beyond all possible range of helmet diving. So only by the vague and chance gropings of the dredges drawn steadily for five to ten minutes at a time, along the bottom, could we learn of whatever lives and moves and has its being in the dim twilight of these waters.

The most important fact in regard to these two banks was that Arena, slightly to the north and somewhat within the lip of the gulf, had a floor which was essentially muddy; while Gorda, facing more to the open Pacific, showed much more sand in the composition of its bottom. We expected this to have some effect on the creatures which lived out their lives far down on the two banks, but we were wholly unprepared for the radical distinction of species which we found. The two banks might well have been a thousand miles apart instead of the short distance which separated them along the coast. For example, of thirty-eight species of fish which came up in dredges, only two were found on both banks, and even in these cases the separation was almost complete. These two species, both of which were small flounders, were essentially Arena forms

where they were abundant, being represented on Gorda only by two and one individuals respectively.

A strange, toad-like fish, *Porichthys*, lived both in sand and mud, its skin giving out brilliant coppery and brass reflections which could have had absolutely no value in the dark, watery depths of its home. Over the thin skin there extended long lines of pores, usually filled with mucus but which on occasion could produce a dull luminescence. The reason for its name of *Porichthys*, or pore-fish, is at once apparent, and it is also known as midshipman from the resemblance of the long lines of shining organs to the multitude of buttons on the jackets of these marine bellboys. Still another title is singing fish from the low humming sound which results from the vibration of its swim bladder.

When we came to examine these fish more carefully we found that they were not a conspicuous exception to the rule of differentiation of species on the two banks, but that Arena and Gorda formed the exact line of demarcation between two species of *Porichthys*, distinguished by differences in the lines of pores as well as other characters. From far north in Puget Sound down to the very tip of Lower California there lives the so-called spotted midshipman. Off the shores of northern South America a second species has been named the pearl-bearer. Although this was twenty-five hundred miles to the south, yet we found that while from Gorda we had obtained

more than one hundred and thirty of the spotted northern species, yet Arena, hardly twenty-five miles away, yielded twenty-six midshipmen, all of the pearl-bearing southern form. (Fig. 12.) Careful study will probably reveal additional forms.

We never could anticipate the surprises which dredge after dredge held for us. When we had finished with Gorda and had completed the census, we discovered that almost half of all the number of fish taken belonged to a single new species of flounder, which we named *gordae*.

The differences of bottom fauna extended to many groups of invertebrates. At Gorda thousands of long-armed, scarlet little lobsters came up, but not a single one from Arena. On the other hand a shrimp with a pair of vividly marked, keen but false eyes on its carapace was abundant on Arena and wholly absent from Gorda.

On all of my optical under-water observations, whether with waterglass, helmet, or bathysphere, one thing has always seemed consistent, a general distribution of the great variety of organisms. Species of seaweeds succeed one another at frequent intervals, while starfish, urchins, fish, shrimps, and crabs are all intermingled like their relatives in shallow water. Yet a surprising number of dredges came up with almost a pure culture of one or another single form of life. In Arena dredge number seventeen were more than forty large bubbleshells, but not a single one in

any other haul. Yet when found in shallow water near shore these snails are solitary, wandering alone on their molluscan way.

They were very beautiful, nearly as delicate and inflated as their namesakes. The owners of the bubbles were of large size and almost enveloped their shells. In fact, these creatures are on their way to the condition of their relatives, the sea-slugs, whose shells are reduced to an internal horny plate. These were Gould's bubbles, as thin as the thinnest of egg-shells and most beautifully coloured. Over a background of palest lavender were scattered many upright objects of various shapes; grains of sand, minute pebbles, V's, W's, and even words of unknown meanings. All these articles, scattered at random, were pearly white, and all were lighted strongly and very obliquely as in late evening, so that they cast long, black shadows far behind them: such was the exact impression, illusions in three dimensions, conveyed to the eye by the exquisitely shaded and clouded markings on the perfectly *smooth* surface of the shells. Yet in the process of making, and throughout the life of these shells, all this was covered by the thick flesh of the snail itself, while after death my bubbles would have been buried in the black, slimy mud, five and forty times our human height beneath the surface. Further, the shells were all perfect. I could crush them without effort between thumb and forefinger, yet in some way they had withstood the terrific pressure of the

mud in the net for the considerable time while the dredge had dangled in mid-air.

A few hundred yards away, from the same depth of two hundred and seventy feet, a dredge brought up (for the first and last time on Arena) a great pile of rare collector shells—ninety-seven of them. In general form they are like flattened tops but unlike their near relatives, the sun-dial shells, they are not satisfied with their unadorned beauty. In some mysterious way they solder to their shells those of other molluscs, until, from above, they look like casual clumps of heterogeneous shell-heaps.

In the make-up of these snails I found no special development to explain the method of this seizing of foreign shells and attaching them to their own ample whorls. No matter how diverse and angular the assembled specimens, no sharp edge or extended tip was ever allowed to protrude below and so hamper the movements of the collector itself. Any shell such as a clam or scallop was always fastened with the convex side down, like the runners of a sled or the bow of a boat.

Some of the dredged collectors had sun-dial shells, their very own kin, attached by one rim, for ever afterwards to be held upside-down horizontally, with the original owner, alive and still inside, twisting helplessly around whenever he emerged. Or some slender turreted shell held only by the point would show a hermit crab peering forth, kicking its heels

in midwater and travelling along faster and farther than it could ever have done with its own scrambling. The hermit, in the course of time, could of necessity leave its adopted shell and clamber along the rim of its kidnapper looking for a bigger and better home, or, taking a terrible risk, have dropped to the ground and raced with omnipresent death against the finding of another shelter. Waving about in mid-water it would be hard put to it for food. But the mollusc, the sun-dial, had no such choice. It might keep adding to the circle of its little wheel of life, until it met the great limestone rim of the collector. Two tethered sun-dials which I examined were offered no possibility of ultimate continued life, or of escape; they could not turn or bend above or below; all building and life must soon cease.

The concentration of single species carried on through many groups—four hundred box crabs in one haul, thousands of small lobsters in another. But the climax came when dredge number eighteen on Gorda rose to the surface. We thought, at first glance, that we had torn up vast quantities of some fluffy kind of seaweed. Festooned over the frame were trailing strands and great masses of orange substance, of which, as the dredge approached the stern, large quantities were constantly washed away and sank.

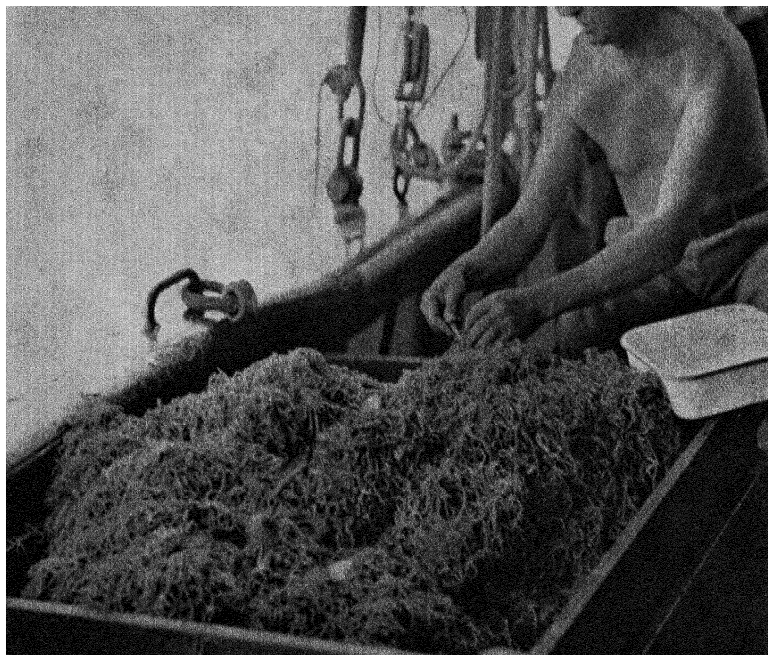
When we had the catch on board the substance materialized into enormous numbers of living, orange, brittle serpent-stars inextricably tangled.

They were impossible to count in the usual way, so we found that there were about two hundred and fifty in a pound. We then frayed out handfuls into pails and weighed these, one after the other, and discovered that there were exactly one hundred pounds of starfish still left in the catch, while uncounted thousands more had escaped from the net after it was in sight. Our total catch in hand numbered at least twenty-five thousand. (Figs. 14 and 15.)

I examined one out of the lot carefully, and the higher the power of my lens the greater beauty was revealed. The central disc showed star pattern within stars, a lovely purplish blue spotted with red, and thence the long, pale orange arms led out into the rayed activity, each with a double line of dark, oblong spots along the upper surface. On one arm I counted sixty symmetrical tubercles along each side, from each of which sprang sometimes three, but usually two, long, glassy, sharp spines, finely barbed along each side. Here were two hundred and forty spines on each of the arms; twelve hundred spines on each starfish; thirty million, eight hundred and forty thousand spines in the pile before me. My head buzzed at these astronomical figures, and I smiled at the conceit of our grandfathers who believed that beauty and perfection in nature were for man's delectation alone!



AN INCOMING DREDGE. *From the cross-trees we look down upon the dredge coming up from two hundred and forty feet on Gorda Bank, overflowing with bright-coloured serpent stars. (13)*



TWENTY-FIVE THOUSAND SERPENT STARS. *These are related to the common starfish but their slender arms twist actively about and are thrown off if handled roughly. (14)*



SERPENT STAR INDIVIDUALS. *OPHIOTHRIX GALAPAGENSIS, or the pink-armed serpent star, composed this great host brought up in a single ten-minute dredge. (15)*

VI

WHALE-SHARKING

EXCEPT when we went after game fish in the launch, all our work at sea in the vicinity of Cape San Lucas and the banks was carried on from the deck of the *Zaca* itself, but there came a day toward the end of our stay in these waters when we entered more intimately into the life of the ocean. For days we had been seeing very large fins of sharks, placed far apart, cutting the surface here and there. We had put them down as giant blue sharks or hammerheads, or perhaps marlin larger than any that had ever been caught.

On the second day of May, when we had pulled up the last dredge on Arena and were headed south toward Gorda, we once again sighted an immense fin, off the port bow, with a second fin so far behind that it seemed as if two or even three sharks must intervene. It must be realized that it is exceedingly difficult to judge the size of an object isolated at sea, as there is nothing with which to compare it, but in this case there was no doubt of the extraordinary size of the fin.

The *Zaca* held on her course but the wandering

fins gained, finally turned toward us and passed close. I happened to be some distance up the ratlines and as I looked down I saw the water suddenly filled with a multitudinous pattern of white spots: a single giant whale-shark, largest of all living fish and one of the rarest of sharks, was swimming slowly past.

The fish was visible until we lowered the launch and started out. For ten minutes thereafter no sign was seen of him, then the fins appeared a hundred yards away and we headed toward them at full speed. Ben was at the engine and Frank and Pemasa had a great harpoon fastened by a long rope to an empty gasoline drum.

When we came alongside the fish was only about three feet below the surface. We waited until he was almost awash, when both men made a beautiful pole-vaulting dive, with the harpoon between them. They struck hard and then leaped into the air and let their whole weight bear down, driving the harpoon home. At the same moment I fired a revolver straight down into the creature's head, making at least two direct hits. The drum was thrown overboard and vanished.

After fifteen minutes, excited yells came from the crew on the yacht. They directed our attention to the farther side, and there, three hundred yards away, was the float. We found it completely crumpled in the middle like a huge hour-glass, evidence of the pressure at the great depth to which it must have been

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dragged. It was moving slowly and steadily along. We soon caught up with it and for the next hour had the excitement of our lives. The great shark was never more than fifteen feet down and usually was swimming within a yard of the surface.

Twice we returned to the yacht for additional harpoons, but in spite of the greatest efforts of the Samoans the instruments bent as if they had struck steel. Pe said this often happened in the case of large sharks of more common species. The first harpoon enters easily, but after that some sort of tightening of the dermal muscles makes it impossible to drive through. We tried to slip a cable over the drum and around the tail, but the speed, slow though it was, prevented us. I watched the shark for an hour or more, trying to memorize the spots and patterns.

There seemed to be no end in sight, for we had no harpoon gun, and we were only helpless midgets in our inability to do further harm to this giant. His steady progress seemed to indicate that he could go on like this for days and weeks. Finally we tightened the noose around the drum and led the cable back to the *Zaca* where it was made fast, whereupon the whale shark headed readily alongside. But the moment he felt the pull of the yacht he tore out the harpoon as if it had been a pin, and was off, without any undue haste, for the open Pacific. I estimated his length at thirty-five feet, but the splendid photographs which John Tee-Van took from the cross-trees permitted

direct comparison with the known length of the launch, and proved the shark to be forty-two feet from head to tail tip. (Fig. 16.)

We found in this fisherman's paradise that these sharks were actually common, and the Japanese captain of a tunaboat told me that he often saw ten in a day. This abundance is seen in its true importance when we recall that only eighty or eighty-five individual whale-sharks have ever been recorded in the annals of science.

This man was well informed and thoughtful and conservative in all his replies to my questions. He had been tuna fishing throughout seven seasons and had almost never gone out from San Lucas on one or more days' fishing without sighting a whale-shark. The first may appear in March but more usually in early April, and the last sharks are seen in September or rarely early October. No one knows where they go and no young ones have ever been seen. Arena and Gorda seem to be the centre of distribution and the captain had never noticed them beyond La Paz up the gulf, or Turtle Bay on the west coast of the peninsula.

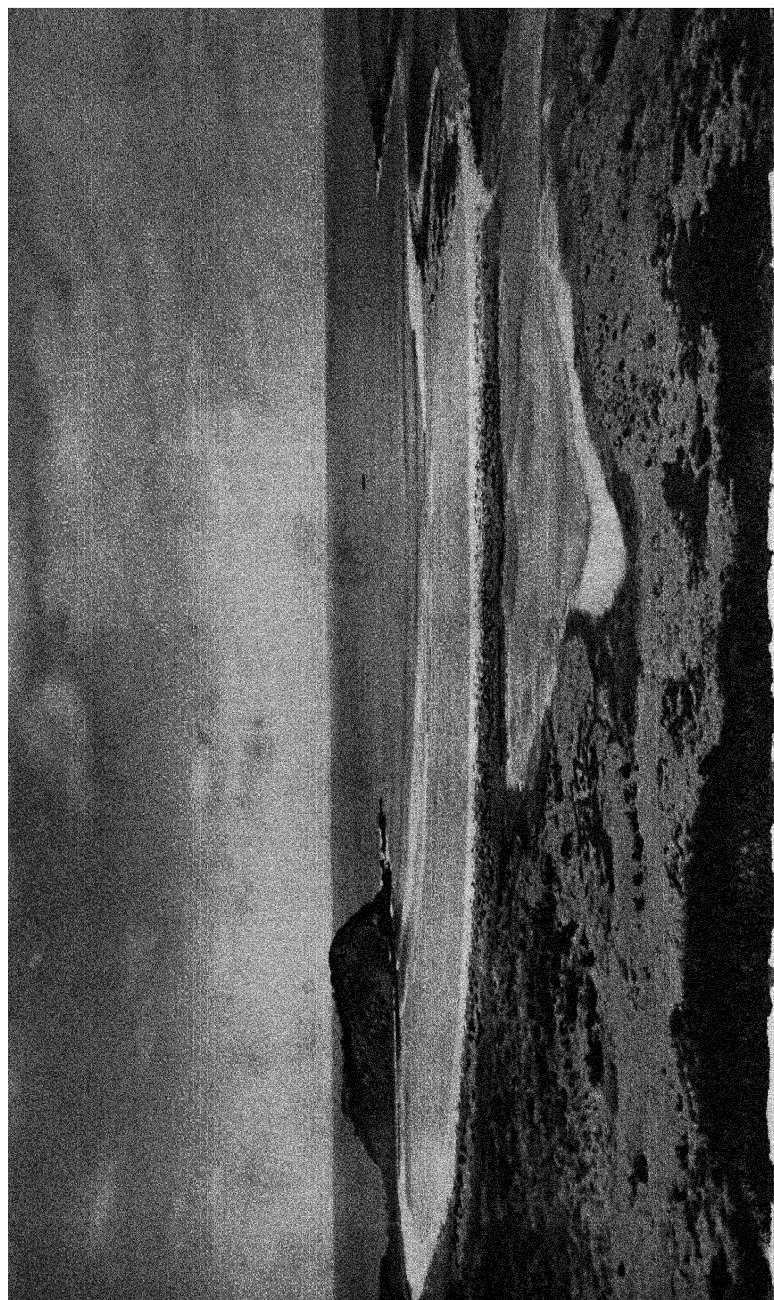
The largest he had ever seen was at least two fathoms longer than his tunaboat, which measured fifty-five feet. The smallest were not less than three or four fathoms. They never attack, but are very troublesome when, by accident, they get entangled in the fish nets. This man had seen them as far west



WHALE SHARK. Our forty-two-foot whale shark swims quietly along the surface after being harpooned. (16)

[Overleaf,

CLARION ISLAND. The only landing place around the whole of the island is between the two headlands on the far right. (17)



WHALE-SHARKING

in the Pacific as Nagoya. off southern Japan. The Japanese call them Babaa, meaning Old Woman, because they appear to have no teeth. The tuna fishermen dislike steaming through these waters at night because of the danger of running into a whale shark and losing a propeller or a rudder from a single flick of the gigantic tail.

We counted ten distinct whale-sharks during the course of the three days following our first identification. Sometimes we sighted the same individual several times, and in four or five cases we could recognize a shark seen an hour or a day before by some unusual visible character. One had the first dorsal scooped irregularly out behind; another had both fins notched at the tips; and one which we followed and photographed for two hours had, as a recognizable brand, a two-inch hole straight through the tail fin near the tip.

On the third of May, John Tee-Van, Jocelyn Crane, and I followed this last specimen for two hours, most of the time just overhead or close alongside. By racing our engines suddenly we were able to disturb him just sufficiently to make him turn slightly to one side or the other, and were thus able to herd him into patches of slick calm, where we could photograph and observe as through clear air. We watched shark suckers, some more than two feet in length, slither over his great body, their favourite place being near the base of the pectoral fins. Several months later I

took this whole series of photographs to the British Museum of Natural History, where they were of use in helping with the construction of a whale-shark model, and later the same thing occurred in our American Museum in New York.

The upper half of the pectoral fins and the whole head from these fins forward were very thickly covered with two-inch, white, or creamy-white spots in dense, irregular order. From here aft the spots became abruptly larger and farther apart, in regular rows separated by white vertical lines, as far as the second dorsal fin, where they gradually disappeared. There was no sign of the horizontal white lines which are usually accredited to the pattern of this shark, nor of more than one lateral dermal ridge. From every aspect the entire surface appeared perfectly smooth. The head was exceedingly blunt and broad, with a mouth fully six feet across. The teeth in the huge maw (as I knew from examination of a museum specimen) were arranged in great sheets, consisting of thousands upon thousands of denticles each about an eighth of an inch in length. The tail fin was enormous and swept regularly back and forth like some part of a mighty engine, its tip swinging from one side to the other in three seconds through a space of ten feet.

The strangest thing about the whole apparition was the result of the identity of the shark's general background colour with that of the seawater. Whenever we first came within sight of one of these beings, the

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outline was so indistinct that, as I have already said, the effect was of the water being suddenly filled with a vast number of unconnected, drifting spots of white.

The five great gills showed not the slightest movement. They were slightly open and remained so. The lower portion of the last gill opening was distended, and opened and closed regularly all the time. This characteristic recalled an identical condition in the nurse shark, a shark of similar activity and general habits which, perhaps, needs only the functioning of part of the last gill to allow a sufficient flow of water over the gills.

The first record of a whale-shark seen by man was of a fifteen-foot specimen in the waters of Table Bay, Cape of Good Hope, on an April day one hundred and eight years ago. Some fishermen harpooned this white-spotted shark and towed it ashore, where fortunately it came into the possession of a scientist, Dr. Andrew Smith, who dissected it, gave it a name, and twenty years later published in full a very complete account, together with a hand-coloured illustration.

Since then less than a hundred others have been reported from various parts of the world. The greatest number have been seen near the Philippines, while the second area of abundance is off this western coast of Mexico. Sixty-five feet seems to be an authentic estimate of the largest, which puts it well at the head

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of all the fish in the world for actual length and body weight.

It has much in common with the nurse shark as regards gentleness and inoffensiveness. While it is almost without fear, yet even after being harpooned it has never been known to attack or turn on man or boat. With a harpoon deep within its body it swims or dives deliberately, making haste but slowly and dying quietly and with decorum.

Its thousands of minute teeth, arranged file-wise around its jaws, function only in hindering the escape of more active small fish. The method of feeding is apparently to swim slowly along the surface, as our fish were doing, and to strain out through its gills the slower-swimming shrimp and fish, together with the host of lesser floating life. It is perhaps significant that the other dominant form of oceanic creatures with identical feeding habits—the whale-bone whales—also challenge and exceed this great shark in size. In connection with its blind methods of feeding we find the eyes small, as being of little use, the mouth enormous and placed at the very front of the head somewhat like the opening of a trawling net, the gills developed into deep horny sieves, and the teeth reduced to minute denticles.

The courtship of the whale shark, if any, its mating, migrations, and its young, are all mysteries. We do not know whether the young are hatched from eggs or are born alive. Dr. Gudger, who has

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spent many years in researches on these creatures, considers the latter method as almost certain.

After we had seen the last of our harpooned shark, in the final dredge drawn up from the Lucas Banks I found four *Amphioxus*—inchling relics of the very origin of fish life on our planet. A few hours before we were struggling impotently with at least eight tons of the most specialized shark living to-day. A greater contrast would be difficult to imagine.

VII

SAN LUCAS: LAND'S END

ONE morning the Japanese captain of a tunaboat steamed past us into San Lucas Bay and reported having seen two large whale-sharks not far offshore. We put out in the *Zaca* and cruised slowly about or lay quietly rolling in the swells. The most intensive observation both from pulpit, boom-walk, and cross-trees failed to reveal a sign of the great beasts, but, as usual, compensation piled in from all directions. Two swordfish appeared again and again, always swimming close together, turning as one fish, one slightly behind the other, both equal in size. An eight-foot hammerhead shark hung about beneath the pulpit apparently hoping something or somebody would fall out. Once the three fish were in sight at once—violent extremes in evolution of heads, extremes which make us realize our pitiful ignorance in accounting for or explaining a host of structures. Swordfish? Yes: with such a weapon defence is easily visualized, pot-hunting with broad-sword cuts to left and right in a school of potential food. And when full speed ahead is required, the sword becomes

a cut-water prow continuing the perfect streamlining of all the rest.

If the fashioning of the first shark had been left to me, I should never have placed its mouth so far back on the under side. This idea of awkwardness is reflected in the popular fallacy that a shark has to turn upside down in order to bite or feed. Yet with the comparatively narrow, rounded head, the configuration serves its purpose. Through all the ages sharks have lived and lived well, provided with this type of cephalic architecture. But now I look down from my pulpit and see the great hammerhead living and having his being with an apparatus as unlike that of a swordfish as the muzzle of a King Charles spaniel differs from that of a greyhound. Abnormal, monstrous, fantastic, bizarre, grotesque—every epithet is applicable. If only one traveller had reported such a creature we should have been certain that the truth was not in him. In a mediaeval map where inaccuracy of coast-line was compensated by the distracting assembly of impossible beasts popping forth from adjacent seas, a hammerhead might lawfully take its place between mermaids and flame-breathing dragons.

It would seem that the great lateral lobes of this shark must hinder speed and quick turning; the wide-spread eyes achieve no stereoscopic effect because they are monocular in function. From the vantage point of opaque human ignorance we looked down

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and heartily condemned this structure, while the hammerhead swam quietly on, and more successfully than any other shark in these waters avoided its native enemies, secured its food, and propagated its race. The proof of its triumph was manifest in the proportionate numbers found in a shark-hunters' camp near San Lucas, where were the remains of eight bay sharks, a dozen nurse, and two hundred hammerheads.

Having humbled sufficiently my mental conceit the hammerhead passed from sight. I glanced back toward shore only to be confronted with more evidence of the narrow earthly boundaries within which we human beings live and exercise our senses. If my eyes told truth, no *conquistadores*, no mediaeval English captains would ever have put in at San Lucas Bay. If at first we had seen the shore as I now saw it, the *Zaca* would have sailed swiftly past with never a thought of stopping.

It was mid-morning with no indication of haze or fog except far out on the waters of the Pacific. Yet the neighbouring shore showed as a perfect example of an inverted mirage, which extended around two-thirds of the horizon. Along shore as far as we could see in both directions the beaches, as beaches, had vanished. They were repeated, duplicated, inverted, so that all sense of the slope was lost, and the entire front presented steep, almost precipitous, cliffs. Had we wished to go seining and saw this coast for the

first time, we should never even have tried to land, for the shore rose steeply from the water to a height of fifty or a hundred feet. Through my Number Twelves I saw each bush repeated and all the slopes turned into straight lines. From the north four tuna-boats were approaching, and while they were all clearly visible on the water, from the tip of each mast was balanced the tip of the mast of its reversed image. Above this appeared the duplicate boats, inverted, keel-up, also perfect in every detail, with a narrow line of water upon which to float upside down. It was miraculous, even through the high-power glasses, to see nothing to deceive the eye. The day was bright with the sun shining clearly, and only, as I have said, a slight haze along the distant oceanic horizon, not noticeable except when searched for.

While we were on the look-out for whale-sharks, a baby sea-lion not long weaned appeared from nowhere and for half an hour paddled up and down alongside the *Zaca*, apparently hoping for a bit of food, flipping itself upright, mermaid-like, and watching us with interest. We had not a scrap of fish to offer it. When we squawked or roared in feeble imitation of a sea-lion, the pup swam opposite the performer and stood as high as possible out of water. The Mexicans must feed these youngsters now and then for them to be so fearless. Its trustfulness was a breath of Galapagos life.

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On the return trip to shore Jocelyn Crane and I dropped off into the fishing boat and trolled in the rough water outside the Frailes. We started trolling past the outer pulpit rock and found the seat of honour occupied by a dignified old pelican perched upon the summit sound asleep. Close below him, arranged on the series of steps or pews, were six cormorants looking bright and attentive in contrast to their visiting pastor. To-day the sloping seal rock was covered by a very large male sea-lion and a harem of seven, all buried in slumber, with no sign of life except when a sleepy flipper would wave back and forth, languidly brushing away a swarm of flies.

As fast as we could throw out jigs and pull them in we caught forty-eight grand sierra mackerel, their sides of sheet silver gleaming with the gold pieces scattered at random from head to tail. Almost all were caught through the thin tissue beneath the upper jaw and quite unhurt, so we threw four-and-thirty back. I nicked the tail of several, four to be exact, and within a few minutes we had recaptured three.

The sierras began biting as soon as we got well outside the first Fraile. When we ran on a quarter of a mile farther out to sea not a fish took our lures; yet when we turned and steered westward the fish bit ravenously again, often striking simultaneously on both lines. I began trailing the jig ten feet behind the boat, watched for the fish, and jerked the lure away from them. In this way I learned that their

attack was by a terrifically fast dash from first one side and then the other, never by a direct following up from behind. So exactly did they gauge the distance that if I pulled the hook only a foot ahead they would miss it completely. Each time they missed they seemed to get more angry and the next attack would be still more vicious. When at last they struck full force the impetus often carried them fairly out of water. The boat was unsteady, the floor boards were slippery with blood, we continually shrieked for the motor to stop as both feathers would be taken at once—and it was altogether an exciting experience.

In order to gain any thorough insight into the lives of wild creatures, the detective work must seize upon every little clue. An example was the food of these larger game fish. Most of the sierra mackerel had nothing in their stomachs, showing that they feed at some other of the twenty-four hours. The food of three skip-jacks revealed the following facts; one had eaten nothing but sardines, about four inches in length. These small fish run in schools at the surface, they swim with considerable rapidity, and have the ability of leaping into the air when hard pressed. So the skip-jack at times gleans its food at the surface, can cope with more than average speed and escape-attempts by leaping. A second fish had two hundred and six euphausiids in its stomach and nothing else. These particular little cousins of the shrimps have brilliant luminous organs and live well beneath the

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surface; they are about half an inch in length and pre-eminently solitary. In early mornings I have seen dead ones floating past and never two anywhere together. So from this diet we learn that skip-jacks, like bees visiting the same coloured flowers, are selective to a high degree. It is hardly possible, in searching for these cuphausiids, that other organisms, such as small fishes, would not be encountered by the fish. It is also evident that vision in these fishes is well adapted to seeing not only small fishes but much smaller invertebrates. The luminous shrimps were swallowed whole so that for a time during this meal the interior of the fish's stomach must have been a blaze of glory.

To return for a moment to the luminous shrimps. We learned much of them on the evening when the full moon came up out of the sea well beyond the Frailes, appearing at first red and misshapen, then orange, and finally cold and round. Toshio spoke of the Japanese rabbit in the moon, grinding rice, and when we could put out of mind our own Old Man and the Gibson girl we could see the little rodent plainly, more distinctly, in fact, with the naked eye than with glasses.

Although it seemed useless on such an evening, we turned on the night submarine light and even Frank with all his skill and patience could net only two small fishes. The strange effect exerted by the full moon kept all the others from their usual hypnotic help-

lessness. But their place in the silver radiance of the evening was taken by unnumbered masses of the luminous shrimps. With several sweeps of the net a tumblerful could be scooped up, which when dumped into an enamelled tray would give off the most intense, pale green illumination, brilliant even in the moonlight.

With a hand lens it was easy to distinguish the posterior four median lights on the abdomen, then two pairs of larger lights on the thorax, and finally the largest pair of all on the head. In water the illumination was less persistent and bright, as if some vague hint of the relation of water and fire were adumbrated in these lowly luminants.

In a dish with water under the microscope the little crustaceans appeared remarkably delicate and beautiful. They were made of glass with all organs showing through, patterned unreasonably with various colours, pink, scarlet, and pale green. The eyes stood out as of burnished jet. The joints of the legs were scarlet and the light organs burning red. The lacy gills were transparent as were all the swimming and head appendages, all more evident by their shadows than by themselves. In either the full glow of the microscopic lamp or with the diaphragm cut down to a finest slit, they were uniformly negatively phototropic, which is the hardest way of saying that they instinctively exerted every effort to get as far away as possible from the source of light. In the ocean over-

side they were utterly helpless in resisting the attraction of the submarine lamp. Now something had clicked, their sensory reactions had been thrown into reverse gear, and with all their little might they desired nothing but to get as far as possible into the deepest darkness. In spite of their having come in myriads to the electric beam they now crowded to the side farthest from the source of light.

Most of them had their own illumination going full strength and when looked at upside down with the lights between the abdominal legs facing upward, it could be seen that the centre of the upper aspect alone was green, all the rest blazing scarlet. It was like looking down through a lens into the depths of the small round jewel, and in fact that is probably somewhat like what I was seeing.

I gently pressed the body of the shrimp and the lights flared up with renewed brilliance and then faded, whereupon the thorax lights shone with full strength. When I again examined the under side of the body I thought all the abdominal lights had gone out but, on careful examination, I saw that they had revolved and were facing aft, so that they were invisible from below. Of all the lamps, those beneath the eye were the brightest. And here my observations ended for midnight had come and gone. My brain buzzed, before I fell off to sleep, with thoughts of the unsolved problems in the life of *Nyctiphanes*—its isolation and its helpless gregariousness, its wonderful

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bodily system of illumination, and its unexplained reactions toward the sun by day, the moon by night, and my tiny adventitious light.

Until now our only direct connection with the real land of San Lucas Bay had been through the grip of our anchor on the bottom and my submarine tramps on and about the garden of eels. Early one morning we landed at the tuna factory wharf and walked on out on the Peninsula of Lower California. Behind and to our left rose the ever dominant Frailes, the last visible portion of the western spur of the great mountainous backbone extending north through Mexico as Sierras, on as the Rockies through the United States, Canada, and Alaska, to die out—changing from land to ice—in the glaciers and packs of the Arctic Ocean.

Climbing to the top of the dunes we could see beneath us the little Mexican town hidden in the hollow, beyond which a stretch of chaparral-covered plain extended to the distant mountains which bounded the whole horizon to the north. We walked on through gradually increasing plant growth, pure desert. Small elephant trees and moderate candelabra cactus were abundant. Overhead flew turkey vultures and many caracaras, the latter frequently alighting near by and watching us with interest. Perhaps the relative pallor of our faces in comparison with the dark-skinned Mexicans aroused false hopes

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of early demise. A woodpecker cackled and flew from cactus to cactus, mocking-birds flashed and finches sang in the distance, Small sand-coloured lizards scampered across our path, while red silver-underwings and black papilios flew past.

Finally I reached the great dune along the shore to the east of our anchorage and seated myself on its extreme edge. Toshio was behind taking a panorama of the whole bay, while beneath me in front George worked on a census of the flowers and plants. Far out at sea a minute black dot marked Templeton Crocker fighting a sail-fish or marlin, while close inshore John was dredging in the launch, and on the beach to my right the Samoans were pulling seines. The entire force of the expedition seemed in high gear at the same time.

Distant doves cooed so continuously that, like Dunsany's bat, they soon became part of the silence. Mockers sang half-heartedly and intermittently, and ravens croaked softly and lazily either a long way off, or through closed beaks if near at hand. A green bush a few yards away at the dune's edge was filled with a quartet of caracaras taking, like all the Mexicans in the distant village, a siesta. Now and then a new arrival walked up the steep slope of sand and joined his brethren.

I had thought of this mighty dune upon which I was seated, as one of those inexplicable wandering masses of sand which, in certain windless regions, for

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no apparent reason, creep here and there. Up the gulf at Inez we had come across such phenomena, glaciers, and lava-flows of sand, flowing with infinite slowness, needing years instead of minutes to reveal their real motion. In the present instance I was thoroughly mistaken. One of the Mexicans who had paid a visit to the *Zaca* told me that three years ago a terrific rain had fallen, both here and on the distant mountains and the resultant flood was such that a considerable part of the village was swept into the sea. He indicated the path of the swirling waters rushing from the mountains and its course now lay directly before me. For several hundred yards to the west below me was an area of quite intense green growth, in strong contrast to the dusty gray chaparral which covered all the rest of the land. Less conspicuous than my steep-sided dune was another slope beyond the green section which marked the farther side of the three-year-old torrent bed, now an exceedingly shallow but wide arroyo. There must be fresh water not far beneath the surface for the present greenness to persist, and indeed close behind the actual sand slope extending down to the sea water was a green, slimy pond, with much cracked mud on the landward side, indicating a former larger area of surface water. The pond, if such a forsaken thing could be recognized under such a name, was partly filled with piled-up branches and debris of land growths, which became perfectly explicable when we thought of it

as a vegetable terminal moraine of material brought down with the rush of the torrent.

So what we took for the result of some great hurricane stranded high on the beach was the remaining proof of the rain three years ago. The stack of piled branches looked like bleached bones and the feeling of death was heightened by the vultures which occupied every available branch and trunk upturned in the sand. With the red-headed scavengers were equal numbers of caracaras, all sitting and doing nothing, waiting either for another three years to bring an abundance of manna, or just waiting. Seeming too lethargic even to sleep, they simply perched and watched the scum on the bitter water. I credited them with sorrow at not being able to contain more liquid against the dry season which was due in the near future. But here I did them a wrong. Sad-looking burros and ribby cows drifted hopelessly up now and then, sniffed at the water and walked wearily off again into the desert. And then I realized that even the vultures could not drink here. Yet a sandpiper and a single white heron added to the thought of fish or other life beneath the slime. They were attracted to it only as we would be at the sight of a mirage, for they found nothing edible and never even wet their beaks but flew off in the direction of the Frailes, where tide-pools might afford living food. A ring of pelican skeletons emphasized the reality of thirst and desolation.

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The caracaras are strange birds and by far the tamest hereabouts because of their greater intelligence, or so I am induced to believe from their appearance and actions. As I watch them in their various activities they recall in turn the traits and characters of ordinary fowls, cariamas, vultures, and falcons. When a pair flies into a bush they recall slowed-up, gigantic (or distant) mocking-birds by reason of the flash of patches of white plumage. Their walk is slow and stately and their carriage and stance full of dignity, until they start to fight over some unsavoury morsel, when they become feathered harridans. They can impersonate an eagle or descend to the frowziness of ani cuckoos.

As one of many signs of cleverness I watched them digging for water. A short distance from the poison pond the land was pitted with small shell holes which had been scooped out by thirsty burros. Into these, two or three caracaras would descend and take turns at digging in one corner, in the course of time evidently uncovering a beakful of drinkable water. This I saw through my glasses and later verified by the claw marks and the remaining thick, sandy liquid. Two or three scoops with my hand would reveal a cupful of water, but I did not venture to test the saltiness. The moment any water was uncovered by the birds, all mutualness of effort ended and there ensued a wild scramble. The unfortunate individual which had made the final successful scratches seemed

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to gain little vantage therefrom, for the rush of his fellows invariably upset him or hustled him to the farther side of the donkey-dug hole. Sometimes the actual bird working at the happy moment appeared to be pressed down into the liquid, while the resulting sand slides immediately again buried the treasured water.

In spite of these lapses into disgraceful squabbling and feather pulling, when a caracara was perched on the top of a tall cactus, with the head up, showing the great hooked beak, and crest raised, it had a truly noble look. These birds were actual masters here for I saw the vultures drive away the ravens from a less than 'kill,' when the caracaras in turn would take complete possession. Once I saw a single caracara pursue a pair of ravens with such viciousness that both the ebony birds had to seek swift shelter in a thorn bush. I left my dune by ski-ing swiftly down the long slope, snatching a large yellow blossom as I went. A moment after my passage, knee-deep though it was, the sand grains had closed over the furrows and the surface was as unmarred as though I had never passed.

The trip to the water break in the great sand dune had taken us alongshore to the east. If we chose to go north from the little tuna factory we would have before us a tramp of eight hundred miles to the California border—eight hundred miles of mountain and plain all uniformly and monotonously sand and cactus,

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heat and drought. So we next turned westward, first through an unsavoury field of drying fish fertilizer, a tuna by-product, and on through a gap in the land end of the Frailes. Some unbelievably great storm had partly filled this with sand. I passed through, climbed a long, slowly rising dune and found a lovely view awaiting me at the top; a vast beach of smooth, pale sand, stretching down a great distance to the breakers, bounded in the distance by spurs of granite reaching to the sea.

We walked down the water across a quarter-mile of beach, and close inshore saw the fins of a half-stranded shark of small size apparently after some small fish which were flopping around in the backwash. Suddenly, ten yards farther out, just where the great swells were beginning to heap up making ready for the final curving break, a heavily built, twelve-foot shark leaped clear of the water and fell back. In the momentary glimpse I had of him I could distinguish at least three remoras, or shark suckers, clinging to him.

We turned and went on to the southward, toward the ridge which ran into the surf and separated this amphitheatre from the beach of the outermost Frailes. Here were monoliths in the superlative sense of the word. Three idols stood in a row, barely detached from each other and well apart from their mother mountain. One of them leaned slightly forward as if listening, while the others were erect,

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wrapped in the dignity which possesses something carved not by man, but by wind and wave and weather. All were veiled as to features, but all had distinct individualities. In the rarely beautiful photograph which we took, Dunsany must have found something of the spirit of his Gods of Pegana.

In another place four prehistoric pterodactyls peered at us from an overhanging ledge, while just beneath them a dozen round holes carved with mathematical precision by wind and rain lent conviction to the sudden-born belief that these flying dragons lived and deposited eggs (eggs of what size and shape!) in these dark circular caverns. Such imagery needed little aid from the imagination, so astonishingly realistic were some of the carven figures.

There was never a sharp line or projection in all the Frailes. Every outline was rounded, curved, softened, and although it was granite of hardest consistency, yet any painting should picture it with the softest of textures. One great monument was a sliver of the mountain, its base cracked and slightly pushed forward by three large rocks which had wedged behind it. It seemed as if the slightest leverage with the handle of my butterfly net would start the whole mass tumbling down in a crashing roar. So delicately balanced it appeared that I hesitated to climb upon it, although in reality a hundred oxen (or in this country should I say a thousand burros?) would in all probability not have moved it an inch.

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We rested for a time on a thousand-ton outjutting rock with a sandy cove beneath into which the highest waves slithered, rushing up a dozen successive lines of intersecting foam. Far out on the horizon two ships appeared, on their way north, their only effect being to arouse a feeling of satisfaction that we were not on them.

On our way back, when we had reached the last Fraile before turning away from the beach toward the pass, we had a sudden vision of birds in the air. My attention was first attracted by a caracara soaring, a feat which I never remembered seeing this species do before. Vultures were, of course, everywhere. An assemblage of eight was on the beach when we first arrived, holding a sad conclave over a very ancient and dried, but still delectably smelly, porcupine-fish, at which one bird was futilely pecking. As we watched, a second bird came up and half-heartedly rolled the fish over. They knew there was nothing left except the spiny shell, their nostrils were forever sealed against the still potent odour, yet the sight of the dead fish made them go again and again through this useless performance, while their fellows watched without enthusiasm and without hope.

To return to the last Fraile and the soaring birds. A breeze was blowing in from the ocean and must have caused a steady uplift of air on the seaward side. Here nine ravens were having the time of their

sable lives. It was sheer play—for once I had no hesitation in using this dangerously anthropomorphic word. Three would soar together, rising abruptly in a group, then half-fold their wings and drop like broad-headed arrows of darkness, turning just in time to sheer out from the cliff. Again and again, both with my naked eye and with my Number Sixes, I saw them turn completely over in mid-air like a tumbler pigeon. A raven would pursue another with swift loops while the pursued one twisted and turned, with never a flap of wing, supported by the steady upward rush of air. Whenever one was nearly caught, he uttered raucous croaks of mock terror. I say 'mock' because on the next uprise the roles would be reversed, and the first pursuer, easily identified by a dropped feather from the left wing, would become the chased. A caracara joined in and swooped in turn, dropping its legs and widespread claws when the ravens would turn over and slip away. Then three of them would go for the caracara, who fled until he gained altitude sufficient for another gravity drop. The ordinarily strained relations between these two species were temporarily forgotten in this united joy of unusual flight. Both species went for the vultures when these came within the aerial zone of play, but the latter had no sense of humour and moodily soared out of reach. This soaring business made up the major part of their whole lives and they saw nothing in it to be excited or jolly about.

Despite the refusal of the vultures to join in the corvine frolic, it is a fact, which would never be suspected, that vultures in captivity are more playful than any other birds I know. Many years ago, when I was building up the collection of birds in the New York Zoological Park, I noticed that several species of these birds, especially the red-headed and the king, considered the brooms of the keepers as objects of amusement, and when the morning cleaning of the cages began, they would leap awkwardly about, pick at the broom, and when a chance offered, drag it about and pull it apart. I made friends with a full-grown king vulture whose head-dress of scarlet and yellow wattles fairly put to shame the corresponding decorations of a turkey gobbler. This king vulture was wing-clipped and enjoyed the freedom of the enclosure where I had my summer office building. He thoroughly enjoyed being petted and treated almost as one would a dog and followed me about everywhere. He would stand still for as long a time as I would rub and scratch his head, and showed no objection to having his wings lifted and his feathers handled. Once or twice when I touched him with my gloves on he turned and tore off the covering with a single rip of his great hooked beak, and mumbled my bare fingers with the greatest gentleness between his mandibles, instantly discriminating between fabric and flesh. Vultures are the only birds except individual parrots which will allow

themselves to be rolled over on their backs and played with, with as little concern as a dog or cat. Another thing about these birds not generally recognized, is that they prefer fresh to any kind of spoiled meat, and it is only the disability of their weak talons and general lack of the powers of offence of hawks and eagles which compel them to become scavengers. If given the choice they will invariably choose fresh meat and a week or two of such diet results in their freedom from any hint of unpleasant odour. Under such conditions of food vultures are as inoffensive as parrots or pigeons.

Our former failure to obtain a specimen from the garden of cels was a continuous subconscious challenge, and now on our return to San Lucas, we determined upon another method of attack. Early one morning we started out from the *Zaca*, lying at her old anchorage, and in the otter boat with a stout wire trap headed for the site of our former failure. I had devoted so much admiring attention to the Frailes that this time I determined to confine my interest solely to the work in question. Yet at the first intimate glance I again succumbed, and as so many times before, the great masses again completely fascinated me with their beauty. Their mineral substance is as eternal as the planet, yet the lights and shadows played upon them as delicately as overtones of music. To describe them was as hopeless

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as detailing the patterns and relation of colours of a rapidly revolving kaleidoscope.

As we approached I distinguished two nests of ospreys, great masses of sticks surmounting a pair of mighty granite columns, like some strange type of unrecorded architecture. Soon a bird appeared, carrying a large stick, detected first by its shadow rushing along the face of the cliff, leading the eye along the path of invisibility to the substance.

We went to the little island fashioned from a single rock which rose close to the home of the eels. At first I landed on an even smaller rock, from which twenty pelicans reluctantly awakened, still more resentfully withdrew their beaks from the feathers of the back, and with dumb but quite obvious boredom and distaste took flight, to settle on the water near by and return as soon as I left their sleeping quarters. There was no sign of fright on their part. The canning factory, which was a perennial source of food, coupled with the harmless character of the Mexicans, who were too listless or too absorbed in gaining their meagre livelihood to give time to avian persecution—all this made for fearlessness on the part of the birds, and total disregard of man.

I was landed on this lime-covered speck and sought for bait for the trap and for our hooks. Sally light-foot crabs with big scarlet claws shared the islet with me, together with barnacles immune in their limey castles, and two species of molluscs. I had to have the crabs

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for bait, but they laughed at my first efforts of pursuit and attempts at netting, until I learned to swoop upon them around the contour of a rock or, more cruelly, to play pool with them, shooting down the butt end of the net handle, crippling them and dumping them in my pail.

We baited the trap and lowered it on the edge of the cel garden, then tied up to the rock and fished. This was the first place where we had been able to see a truly tropical parade of fish; white polka-dotted blue puffers, close to the surface, two feet away from our hands, forever nibbling at the bait. But their razor teeth enabled them to snip off bit by bit until all was gone and we were left with the perfectly good but bare hook. There were wrasse, red of tail, with yellow lines down the body and now and then a great rose-mouthed blenny slithered up a rock and perched on an imperceptible ledge like the cormorants on the cliff above us. Once a flash, like lightning in a murky sky, marked the path of a golden grouper. A neatly patterned demoiselle was jet black with a delicate lining of pure white to the posterior portion of the body and tail fins. I stood in icy water up to my waist waiting for one of these fish to come out of its cavern. When at last I fired a dynamite cap it was a split second too late, and the fish had passed. To my surprise it immediately returned to the same shelter and I got ready to shoot again. As I hauled up the bang-bang stick I saw something drift back and forth

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and found I had stunned one of the desired white-edged demoiselles, where it had been hidden in a cave in the heart of the rocks.

On my first helmet dive I climbed around the islet to which we were anchored, and on between it and the dim slope of the underwater base of the Frailes themselves. It was difficult navigating, for my path lay over a moraine of rocks, a mosaic in the three planes of space, the individual stones measuring from six inches to three feet across. Through the ruffled surface I could see the overhanging cliffs quite ready to topple at the slightest provocation and add to my rocky road.

With my first bang-bang I secured a small scorpion-fish. I had heard of the unpleasant qualities of this species, but nevertheless picked up the two-inch scarlet fishlet as he floated, stunned, in front of me. Before we reached the surface he began to revive and my finger was slightly pricked by one of his dorsal spines. The sharp pain and the swelling which lasted for several hours were similar to those of a severe wasp sting.

On the second dive three golden groupers swam past, too swiftly for me to aim. I walked out to a rounded cleft which opened into a submerged barrier, and through it, window-like, was framed a large grouper which drifted by, mumbling as he went. Then two sharks materialized in the mid-distance like some mysterious television of sorts. They swam

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slowly back and forth, watching me with silvery, mongol-slanted eyes, ever striving to formulate something with half-open, twitching, adenoidal mouths. At the second passing they were slowly eclipsed, not by retreating into the distance, but by swimming into an almost opaque haze—a smoke screen laid down by untold myriads of minute shrimps.

A pair of lovely electric blue demoiselles, new to me, were hovering about their pre-empted cavity in the rocks just outside the submarine window. I crept closer, took aim and signalled for the cap to be exploded. Both fish turned over, but by the time I had conveyed them up to the boat and into a bucket they had changed to dull brown without a hint of blue. The curtain of shrimp larvae was unaffected by the explosion, and there was no further trace of grouper or sharks.

Cold as I was I decided to dive once more and descended to the eel garden. From ten feet below the surface the cold increased and became really bitter. The eel garden was still flourishing. There was a very strong current against me, lifting me again and again off my feet, and the eels were all bent over in an obtuse angle in the direction of the current. As I crept up very slowly, those nearest, as usual slipped with equal deliberation down their holes. I held the dynamite stick close to one and waited, with my teeth chattering. At last the eel came up about three inches

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above the sand. The double charge of two caps exploded with terrific impact against my body, but the eel vanished and its hole with it.

The wire trap had drifted to the very brink of the steep outer slope, and with great difficulty I pulled it back, using the end of the ladder as leverage to keep me from following the trap down into outer darkness. I managed to get hold of the loose end of the rope and was dragging it, walking backward, when I happened to look down and saw a geometrically marked sting ray wavering off from beneath my foot.

When I had warmed up in the boat we went out beyond the Frailes and caught four gold-spotted mackerel. On the little pulpit rock was a baby sea-lion. He bent his head back almost to breaking point, looking at us upside down, but did not move while we drifted up and took his photograph.

The sequel to Assault Number Two on the eels is to be found in a short quotation from my journal of the following day:

'April 25th: The wind is worse this morning with white-caps even around the *Zaca*. John and I went to look at the trap. In it were two four-foot green moray eels, one of which escaped in the boat and almost chased us out. Brought them back and found their stomachs completely empty. If they had swallowed even one of our garden eels, it would at least have been an indirect success.'

VIII

TO MAZATLAN AND BACK

MANY similes could be drawn between a living, breathing organism and a splendidly equipped ship such as the *Zaca*. For example, if a sufficient quantity of oxygen should be withheld, a living creature would immediately feel the lack and soon cease to function. We had been provided with carefully estimated and correct amounts of fuel, fresh water, gasoline, and so on, but some distant clerk in a shipping office had made an error or gone to a baseball game at a critical time, and omitted to send us what is known as 'cooking gas.' This strange substance, whether solid, liquid, or gaseous, was absolutely essential for our existence on the coming long trip south to Clarion Island. So we had to radio for a supply, the delivery of which would mean a delay of several days. Crocker proposed a side trip as a time killer, a suggestion which proved so interesting that we were tempted later to cheer the defection of the wholly hypothetical baseball fan. This plan was to cross the mouth of the Gulf of California to Mazatlan and back, dredging and trawling as we went.

TO MAZATLAN AND BACK

We steamed out of the quiet of San Lucas Bay into a tempestuous sea, a sea with so rough a skyline that we had two sunsets and a green ray. On deck we finished dinner at the very moment of sunset or, more accurately, earthrise. From a full half-sun it diaphragmed suddenly to a speck of gold, almost instantly to return to half a sphere again. For a second it seemed to hold steady, then vanished, and was replaced by a sheet of clear, pale green. Only two of us saw it, so it must have occurred between winks.

Our first dredge next day, pulled with Mexico just visible on the horizon, was disappointing but strange. The lead weight, fully a thousand feet down, seemed to be striking against hard substances and came up shining with a maze of newly made facets. In each minute indentation was a bit of what looked like pure gold. We thought of the old Spanish galleons loaded with plate which came and went and were occasionally sunk along these coasts and of centuries-old cities. But we were fated never to learn whether our lead had crashed into the rotten hold of some forgotten treasure ship, for we lost the weight on a subsequent haul before we could set a chemist or alchemist to work!

Whatever the weight had encountered, the dredge gave us no help, for it was bent double with the net torn to shreds and quite free from jewelled crucifixes or golden Aztec idols.

Other dredges in this vicinity yielded at least

scientific riches. Once the bag appeared one-third filled with mud, but of so fine a texture that almost all was washed out before it came on board, leaving a clean residue of diverse objects. Even twenty and thirty miles offshore there was always evidence of strong currents in broken branches, bark, seeds and even leaves, and numerous bull's-head thorns. All the dead vegetation had taken on the hue of the mud, but many of the living creatures when washed clean showed tints as bright and often as iridescent as any pile of jewels could present.

Small, black, wriggling objects resolved into shining green and bronze fish. *Bregmaceros* to an ichthyologist. This is one of the very few fish which has the ventral fins drawn out into long filaments, which are a very evident adaptation for feeling one's way through life and mud.

Other fish were brotulids, relatives of the active, lizard-like blennies of the tide-pools. This branch of the group had found life more successful in the muddy depths of the ocean. Six of them came up in one haul, all muddy in colour, with fleshy fins, small eyes and decidedly unattractive personalities. They had the deep-sea facies indelibly stamped upon them, and were unable to swim in an aquarium, the lessened pressure turning them into reversed balloons, which bobbed helplessly about on the surface of the water.

A goggle-eyed scarlet squid fell from the mouth of one of the fish, and at this hint we investigated their

diet and found that in their muddy world they did themselves very well. They had feasted upon lantern-fish and luminous shrimps in addition to squids and copepods. In one stomach was a very short section of a fish which under the microscope resolved into the middle sixth of a *Bregmaceros*, the identification of this fraction being certain because it was the exact part which supported the elongate ventral fins.

In three separate dredgefuls of mud were tissue-thin, paper nautilus shells, emerging perfect and unharmed from the mass of heavy mud and stones. Yet when I let one fall accidentally on the deck from a height of four feet, it crashed into many pieces.

We dropped anchor in the harbour of Mazatlan about noon of the second day from San Lucas. Going ashore, we passed through the *aduanas* in a thick, exciting odour of copra, and up and around narrow, twisting streets. Suddenly we came upon the open ocean on the opposite side of the town, the latter being built on a slender peninsula. A winding concrete drive led on and on along the waterfront, until the houses became less frequent and finally died out. The way was broken now and then by steps which curved up some little, rocky promontory and ended at the top in a comfortable stone seat dedicated to the memory of a minor Mexican personage. Occasionally the waves broke across the lower steps so that one had to gauge one's climb by

the swells. Each of the concrete benches along the esplanade also bore the name and dedication of a man or woman. They recalled dimly what I had read of rubbing-posts in old Scotland, against which a passer-by might rub or rest his back, murmuring the while, 'God bless the Duke of Argyll!'

After the midday siesta the stores reopened and motor-cars of the most recent models began to arrive and park along the plazas. Between them horses appeared with high-pommelled saddles and bright trappings, tethered by little brown men with huge sombreros, revolvers, and cartridge belts, flaring embroidered trousers, and giant spurs. I think the omnipresent tiles were the greatest surprise to me, beautifully tinted and patterned as they were, inset in the proudest buildings and paving the sidewalks of the meanest streets. The supreme beauty in this respect was a series of five maps of the continents, each about eight tiles square, on the walls of the hotel dining room. Nothing could make a more perfect decoration for an open-air studio than these splendidly executed tiles of Seville.

On the *Zaca* in mid-stream I was awakened in my cabin early next day by the typical morning chorus of a tropical city: the complaining falsettos of burros and the broken strident challenges of degenerate junglefowl, punctuated by discordant church bells and ear-piercing raucous honks of motor-car horns.

I went up on deck just in time to see a magnificent

foreglow over the Mexican mountain ranges. Mazatlan was still in deep lavender shadow, the turquoise blue of the cathedral spires slowly separating itself from the surrounding more sombre tones. Near us was a great island like a small Gibraltar—Chivos, with the usual scanty fringed profile of tall cactus and low gray chaparral. I watched for the first appearance of the sun over the mountain skyline, but my eyes' focus was at least three suns' diameters distant from the first fiery outburst. I thought of the Volcan de Fuego a few miles to the southward in Colima which, a third of a century ago, I photographed at night. The cactus, the slow life of the Mexicans, the burros, the armed caballeros, the mountains—all were the same now as then. But the beautiful señoritas with their duennas to-day parade in costly motors instead of on their feet, phonographs and radios pour forth rumbas and tangos more frequently than do native musicians, and by going a mile away to the flying field, one could be in Los Angeles in six hours. Otherwise most of the life and all of the animals and landscape are unchanged from the days of the Arroyo del Muerto and Guadalajara.

As we steamed out of the harbour the last view of the now sun-drenched mountains showed quick sharp lines drawn close to the water; lazier, wavering ones farther up; and finally a great mass of slow-motion, interlacing gnats high in the air—the sky-writings of cormorants, pelicans and frigates.

Soon after we left Mazatlan I went out on the boom-walk and found salpas in chains very abundant. This statement may have a somewhat clearer meaning if I stop to explain that salpas are creatures sharing the earth with us to-day. More than that, although they look like blobs of jelly, and not very nice jelly, each with a small black or brown pellet as chief apparent ingredient of its inner organs, they have a special interest for us. They lack the symmetrical beauty and the rhythmical movement of jelly-fish, they have nothing of the comedy of crabs, the cleverness of spiders, or the varied loveliness of butterflies. Yet they are far above all these creatures in the scale of evolution, being actually on the same side of the great double division of animal life as ourselves. By this I mean that all this group known as salpas, or tunicates, possess a quasi-vertebrate youth. In the latter each one is an active, seeing, back-boned little creature with a theoretical possibility of development into fish, lizard, squirrel, or man. But this unconscious physical ambition dies and the adult becomes either a leather bottle with two spouts, growing to the piles of our wharves, or one of the glassy organisms now swimming along in immense skeins beneath me. (Fig. 4.)

As I lay on the warm boards far out from the side of the yacht with my face close to the calm water passing beneath me, I suddenly saw a thin red line which meant a worm of sorts, and caught it. Later,

as a matter of form before preserving it, I put it on the microscope stage and found that it was a most interesting transitional larval form of eel. Both the *Zaca* and the generator were stopped long enough for me to count the rays of the vertical fins before they turned opaque, and also to get all the usual measurements. A few minutes after death the fins became wholly clouded.

Soon after the worm-eel episode I saw a small fish dodge under the feather of a gull, and discovered that it was an infant dolphin fish an inch in length. Further examination showed the feather to be covered with the eggs of *Halobates*. This strange association I have learned to look for: examine a floating feather in the tropics and the chances are that it will be coated with a solid mass of the eggs of these oceanic water-striders.

Very young mullets were common all the afternoon. They swam around in threes and fours and when one got separated he dashed about with incredible speed, considering his size. Back and forth and around, driven by fright and the fear of isolation, covering several square yards, quartering it all, he finally rejoined his diminutive fellows. They could see the net under water several feet away and would rush off to safety; but if I swooped down upon them from straight overhead I invariably captured the lot. In one place I saw a solid ball of this species, numbering several thousands, swimming in an eight-

inch sphere. It rolled along with almost never a single fish moving beyond the periphery, a perfect example of the spirit-of-the-flock.

The following day, which unimportantly was the twenty-ninth of April, was another of our perfect gulf days, the sky and sea offering nothing but pleasant accessories to work. A flying-fish which we found under a boat and which had flown on board during the preceding night, proved to be the species *xenopterus*, which was first taken from the stomach of a booby forty-six years ago.

Again I lay prone upon the boom-walk while the deep-sea nets were going out, and gave my eyes no rest watching the creatures drifting past. Copepods are crustaceans, but in variety and numbers they are the insects of the sea. The one called saphirina is a sheer, reflecting, iridescent speck of a mirror, and thousands upon thousands of their flaming greens appeared and vanished, glowing from a depth of three feet to extinction point. The green lights were unblinking from the time they came into view until they passed beneath the boom, when they were suddenly quenched. The least shift in angle to our eyes altered the colour, and so, as they moved, they must have maintained a steady horizontal position; otherwise the light would vanish en route. Just beyond the end of the boom were countless myriads of tiny coppery lights. I let a few hundred drift into my net and we identified them as young saphirinas.

When we sat down on the boom and looked straight down, a multitude of violet lights passed and by running the eye carefully outward from this point the coppery was seen to blend slowly into the violet and even pink. But the green of the older sapphirinas seemed never to alter no matter what the angle, it was green or it vanished from sight.

A pair of red-billed tropic-birds swooped down, looked at me, called out to one another and went straight off on urgent business. Later a large turtle passed with two terns roosting on its shell. This is a common sight up and down the tropical west coast. The turtle seemed to be complacent about it; perhaps there was something of mutual help in warning of approaching danger, whether Zacas or sharks. Before lunch we passed close to a swordfish which was conservatively estimated at eighteen feet. The two sails were very far apart, rising high out of the water, and the aft one had many tears in it. Close behind, a dead squid more than a foot long appeared and had drifted almost out of sight when a swirl of water disturbed the vicinity; after the ripples settled the squid had vanished down some unseen maw of the sea.

In the afternoon, while we were watching the angle of the deep-sea wire from the extreme stern, the sea seemed quite devoid of life. This condition had lasted for about a half hour when a sail-fish leaped. A smack came to our ears from fifty yards away, so loud

and sudden that both the helmsman and I were startled. Having attracted our attention, the great fish proceeded to jump as if for his life; twice broad-side, every fin visible and spread to full extent, curved gently as to body; then back view; and next pure white underside. It was most thrilling, and coming out of the mirror-like calm and heat and motionlessness of everything, it was as dynamic as the first leap of a concealed jack-rabbit in the midst of the blazing dead desert at full noon.

The sea had been calm for two full days and already skeins of slimy seaweed drifted past in small tangles and blobs. It recalled the thirty days of flat calm in a Bermuda September when the sea became a mass of this algae. To-day, under the lens, I could make out nothing but vague outlines within which all sorts of detritus were entangled. Little cups, strung along the lines, were some kind of vorticella, while minute unattached things scurried back and forth. It was the veritable beginning of land, at present offering support only to the lowliest forms of life. If the calm and the algal growth should continue, the weed would doubtless thicken until the sea would be covered with a slimy molasses soup. Then the mind can see it become more and more solid, a barrier between the air and the water; and the horrible result to fish, to man, and to the rest of the world of life becomes inconceivable. A study of the seaweed in a high, stagnant, seldom-disturbed

tide-pool might adumbrate something of the awful future of such long-continued conditions.

I have written the last few pages somewhat as they came from my journal; I wished, first, to convey the reality of the staccato impact on our senses of one form of life after another, appearing from a calm tropical sea to an observer on board a moving vessel. I have intentionally used some unfamiliar words, sublimating them only with hints of form and colour. If some of the creatures remain for the present hardly more than names to many readers I shall not be surprised or disappointed. I have wanted in addition to transmit the mental viewpoint of ourselves—my staff and myself; to let the layman realize how our more extensive knowledge of the appearance and structure of these hosts of ocean lives is, in turn, forever bounded and overshadowed by the limitless horizons of ignorance which such knowledge opens up.

The first hint of primitive seaweeds and lowliest sponge life appears in rocks laid down at least five hundred millions of years ago. I have written these pages with the desire that the reader should join us scientists for a short space of time in a spirit of humbleness and wonderment in the presence of the living results of this earthly evolution.

IX

HIGH SEAS

ONE day in early May we slipped out beyond the calm shelter of Los Frailes en route for the little island of Clarion. We found heavy rollers awaiting us and had to eat standing, with out breakfast dishes balanced on the laboratory table. The everlasting insistence of gravity is never so obvious as in a rolling ship. The human eye and frame are sometimes quite unconscious of any change in horizontality at the moment when every round thing begins to roll rapidly away and whatever has edges or corners proceeds to bump and hop about with apparent knowledge of destination and the directed muscular control of highly intelligent organisms. A small vial will struggle and wriggle its way upward out of place among its quiescent fellows into the open, where it can give free rein to movement all fraught with intention and instinct.

As for books, my observation of them in times of oceanic stress has generated a firm belief in the occasional spontaneous assumption of knowledge which usually lies dormant in the words and phrases of their interiors. From a tightly packed line of

volumes one will shake off the immovability of mere binding and become a mountain climber. I have watched a slender, athletic *Fishes of Samoa* shake itself loose, only to sink back and be passed by a pudgy *Fieldbook of the Fishes of Bermuda*, which, seemingly making use of lever, wedge, and all other mechanical principles, shoe-horned itself up and out, jiggling along the laboratory table until it dropped, like Darius Green, with a crash to the floor.

Surface movement at sea alters one's whole psychological attitude toward the ocean. When it is calm we speak of 'it,' and it never seems other than a unit. We say 'the sea is calm.' It is a single enormous individuality, exactly as is Kansas or the Sahara. But to-day the circumference and the depth and the H₂O-ness of the Pacific are unthinkable. As it requires a distinct effort of mind to consider Mount Everest as merely a tubercle of Tibet, so the ocean itself becomes subordinated to the great roller coming at this moment toward us, mountaining high above the deck of the *Zaca*. When it seems inevitable that fathoms of ultramarine liquid must engulf us, the mighty swell raises the ship gently on its shoulders, passes beneath, on and out toward the horizon, finally to crash on some distant beach and sprinkle lofty palms with its spray.

The above superficially intelligible sentence, making use of the pitifully awkward and utterly inadequate words and phrases which we are doomed to

talk and write to every human outside ourself, bristles, upon a moment's reconsideration, with fantastic inaccuracy. Just as certainly as the phenomenon we watched last evening was not a sunset but an carthrise, so is it untrue that the watery wave, of which we discoursed so glibly, approached and passed us. It remained instead exactly where we saw it at that given moment. It is the movement which advances, the water itself being left, to all intents and purposes, absolutely stationary. So the spray which one so poetically imagines as dashing upon the distant coast, will in reality consist of the particles which at this moment are close to the shore waiting patiently for the travelling movement which my eye has registered in mid-ocean, to tear them temporarily from their fellow drops.

If we wish we may carry the reflections further, only occasionally searching our soul for near or far-fetched similes. For example, the lesser waves with which the roller is covered: look at any one as it forms, rises to its little height and finally spills over, enmeshing a few (again our language falters) bubbles, achieves an actual spot of foam, and vanishes into nothing. To be sure, by our attention and awareness we have fixed this particular little wave indelibly in mind, and if our camera had been ready we might have preserved a visible record of evanescent movement. This wavelet forms the link with a water motion which is the antithesis of the roller—the

whirlpool in a brook. Here we have the actual particles of water forever approaching, gyrating for a second or two, and passing away down stream. The temporary dimpling or whirling, pure motion, caused by some configuration of the bottom or by a stone, is the permanent thing in this instance. It is, as Huxley envisaged it so clearly, but for the grace of God, you or myself—a few particles of material substance entangled in and passing through our bodily whirlpool for a brief space of time.

Whatever abortive psychological meditations were induced by the roller, there was no doubt about the continued presence of the latter. We swung from side to side with such regularity that it would have aroused the respect of any reputable pendulum. By bracing ourselves we could write or type, but the use of a microscope was wholly out of the question. In walking about the *Zaca* we began to appreciate the great importance of spatial perspective. In the small cabins or along the passageways, arms and hands were in constant use to prevent crashing against the walls, and only the oscillation of curtains gave an *a priori* hint of directional swing. On deck, with the rail, the masts, the distant bow, and the water itself all giving warning, one could anticipate and counter-act and balance with little trouble. But focus one's attention through the microscope lenses, and stool, body, hands, and instrument formed a series of dis-

jointed links which might at any moment be swept off down hill, almost on the floor, before a stabilizing reaction could be set in motion.

Here we were, passing over one of the most interesting parts of the ocean, able to look down through momentarily clear window facets in the surface, aware that life known and unknown teemed there, and yet be perfectly helpless to get at it. It seemed as if this particular eighth of May in our lives would pass without any worthy scientific or memorable event. But, as so many times in my life, a brief period of relative uneventfulness proved to be accumulative, shortly to be interrupted by objects or occasions of more than ordinary interest. So at one-fifteen the helmsman called out that the tether string on the trolling line had broken. Here in the open ocean, one hundred and thirty-five miles southwest of San Lucas, we pulled in a dolphin fish, or, much better, as the Mexicans would say, *dorado*, for when it came over the rail it was a vibrating sheet of pure gold. This single colouration was unusual, although I have seen big three-footers almost as sheer pure colour. We took measurements as a matter of course and found to our surprise that it was the rarer and smaller species.

The larger dolphin fish (as thus opposed to the dolphin mammal) entered first into human record with the name *Coryphaena* which Aristotle gave to it because it reminded him of a helmet of gold.

Linnaeus wisely retained this excellent title and added *hippurus*, although the long dorsal fin standing erect far forward on the neck is more suggestive of a horse's mane than its tail. But the Swedish naturalist was so pleased with this effort that he committed himself to the bilingual horror of calling the smaller dolphin *Coryphaena* plus *equisetis*. Horror succeeded horror for dyed-in-the-wool systematists, for some unknown Upsalian type-setter substituted an *l* for a *t*, and the proof-reader, probably the Maestro himself, passed it, and so to-day there is schism in the taxonomic camps. My interest in the hair-splitting of names is purely academic, although no one realizes more than I the absolute importance of a definite handle. But when to-day, one hundred and seventy-eight years after its printing, I thumb my worn copy of the sacred little volume, the twelfth edition of the *Systema Naturae* of Carl Linnaeus, I am pleased at the sight of the smudgy changeling letter, whose only crime is the lack of—shall we say—a bar dextral; and I decide to adopt him hereafter. One selfish personal pleasure is that the sight of another's mistake seems to make my many ones less glaring, and the other is the satisfaction of sustaining the reign of the god Priority, which, if accepted as final, should take cognizance of printers' errors as well as of ignorant spelling or, in the case of *Coryphaena equiselis*, even of conscious mongrelization of languages.

It seems to me this unnatural marriage of a Greek and a Latin word is less acceptable than an honest error. But Article 19 of the International Nomenclatural Rules pronounces: 'The original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami*, or a typographical error is evident.' So 'Penury,' as the baptismal name of a baby bestowed by a slightly deaf clergyman, would not supplant Henry, at least in Zoological Nomenclature.

The distinction between the two forms is surprisingly slight. The male of the larger species is deeper and is supposed to have a few more rays in the vertical fins, but as far as present knowledge goes, a female dolphin with fifty-five rays in the fin along her back, and twenty-six in that which extends along the lower side of her body, would be unidentifiable as to species, and might reasonably be courted either by a male *hippurus* or a male *equiselis*. These long fins are fleshy and even with the fish on one's laboratory table the rays are not easy to count. The thought of a female dorado swimming up and down alongside an amorous suitor, searching for the exact count of her particular species, is a finny adaptation of 'He loves me; he loves me not' which is offered only as a momentary relief from the labouring of our taxonomic theme. We are reminded of Roland Young's quatrain:

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*'This is the little active flea,
We cannot tell the she from he
It's very difficult you see,
But he can tell, and so can she.'*

So while the Grecians knew these fishes well, and later in Roman times the colours of the dying dolphin became a regular floor show at the Lucullian feasts, yet to-day, more than twenty-two centuries after Aristotle gave them their lasting name, we can add little to the Whys and Hows and Wherefores of their lives. We can only say that our fifteen inches of molten gold leaped at our feather jig with the *Zaca* making a good seven knots in mid-ocean and that it had been feeding on a full dozen squids.

After all my verbal excesses, I return to Linnaeus and find he has expressed all the salient facts of the case in five words: '*Habitat in alto Pelago. Pulcher-rimus.*'

The afternoon passed quietly until about six o'clock when we suddenly sighted a booby. I watched it while Crocker went below for his gun. It circled the *Zaca* twice and I could distinctly see its yellowish green beak. The head and neck were brownish, but there was a white band around the front of the breast which absurdly brought to mind the pattern of the Galapagos penguins.

The third time the bird swept around, a shot brought it down stone dead. The *Zaca* showed her

splendid manœuvering ability, and turning at the moment of the shot in an astonishingly small circle, she moved slowly toward the bird. Standing with a long-handled net just behind the dolphin catcher, I scooped it up and we were on our way again after a delay of only four minutes.

In return for its sacrifice I set myself to learn all I possibly could from this solitary wanderer so far from shore, for it dropped in the water one hundred and sixty-eight miles south-west of Cape San Lucas. It proved to be a male Brewster booby, whose home extends from the Gulf of California to the Galapagos Islands. It was slightly less than a yard in length and its wings spread six and a half feet.

As I was examining the plumage I saw a black spot scuttle through the breast feathers, and by waiting patiently with an open vial I secured a jet black feather-fly. Later we caught another. *Halobates* may be the only truly oceanic insect, although there is a Samoan midge which spends the whole of its life swimming under water in the coral lagoons, but this group of feather-flies travels far and wide with no exertion of its own, carried among the plumage of its host. Those we captured were well prepared to continue their race, for at the slightest touch a mass of eggs would exude from the body. Most of these eggs were very small but in the midst of them were one or two of large size. Possibly the eggs themselves may be retained within the mother's body

until they hatch. In the Galapagos I have seen unfortunate young boobies, still in the down, almost covered with these strange flies.

The next possibility was the stomach, and here I found an abundance of interest. The whole anterior part of the digestive tract was filled with a single large fish which proved to be a flying-fish, the common form of the eastern Pacific. The head was well digested but the rest had not passed far beyond the throat and was quite fresh. Since the great wing fins were eight and a half inches long, I could deduce that the total length of the fish over all must have been more than sixteen inches. The most important thing about it was the condition of the ovaries; they almost filled the body cavity and the eggs were large, pale orange in colour, and apparently quite ready to be deposited. Each egg had a diameter of two millimetres, or one-twelfth of an inch. At the first touch I saw, as I had expected, that the eggs were joined together by a maze of hairs, but further investigation solved a problem which had puzzled me for a long time.

Certain flying-fish, as I know, make a nest in sargassum or other floating seaweed. A solid ball of the algae seen floating along the surface, when lifted up, will be found bound tightly together by a multitude of very strong, fine, silk-like threads. In the heart of the mass are hundreds of eggs. None of the unlaidd eggs which I have examined in the past

was ready for deposition, and although the close connecting strands were always found, there was nothing to indicate how the wrapping was accomplished.

I lifted up a cluster of eggs from this fish and they came away easily with several long dangling threads. As I raised the eggs the strands continued to stretch and stretch until my hand had reached a height of thirteen inches before the last one parted. Beaded upon this long length were only two eggs, the remainder swaying at the tip of the forceps, not yet having to lengthen the particular strands attached to each of them. So here at last we had the explanation. The female flying-fish when she finds a suitable clump of weed, begins to deposit her eggs and by swimming around and around, the great lengths of inter-connecting strands unwind, the eggs passing out slowly along the silk. The strength of the slender cables which I tested in my fingers was much more than I expected. The elasticity was confined to stretching, for when I relaxed the tension, the line simply slackened and twisted back upon itself.

This slight addition to the life history lore of a Pacific flying-fish had as its greatest defect its indirectness. Its method and course of procedure should be chanted rather than written:

HIGH SEAS

*This is the Zaca
That brought the Man
Who shot the Bird
Which swallowed the Fish
Whose nearly hatched Eggs
Were seen and found
And putinajar by the Scientist.*

Which furnished an excellent opportunity to pragmatize my Fowler on the usage of relative pronouns.

Early on the following morning I was able to continue and complete my study of the nest, eggs, and young of the California flying-fish by the most direct method imaginable.

About fifty miles farther south, nearer Clarion, the *Zaca* was slowed up and a big mass of floating kelp pulled aboard. Several good-sized fish dropped out and the fronds were, as usual, alive with hundreds upon hundreds of large green isopods, besides a dozen or more small crabs and many naked molluscs. All these creatures were part and parcel of their seaweed home, blending in colour, texture, and pattern, their individual outlines lost in the lights and shadows of the fronds and floats.

The most interesting organic jetsam was two batches of flying-fish eggs which began hatching as soon as the kelp arrived on deck. We cut off the entire lot and gave them our best aquarium. Both in

general and particular structure they corresponded to the other eggs taken from the body of the parent, so we could be sure they were of the same species. The eggs were attached to long ropes of silk. Each rope was composed of scores of threads, forty-three in one instance, all twisted into a single skein around which the eggs formed a solid coating so that only in a few places could the silken core be seen. I could lift a string eighteen inches or more quite free from the attachment of any subsidiary rope. These skeins were wound around and around the kelp stems and fronds so that we had to cut the stems to get them off. There was no entangling as in the case of the sargassum weed. This was the general arrangement evident in the ovarian eggs ready for deposition, which, as above described, I examined in the fish taken from the stomach of a booby.

It was a beautiful adaptation to the difference in vegetable attachment or anchorage. The short, finely divided fronds of the sargassum which forms the foundation for the flying-fish nests in the Atlantic, demand loose, separate threads with the eggs beaded sparsely along them, and these, like fluffy hair, are entangled in and serve to bind together the small floating balls of sargassum. Such short threads would slide off the kelp with no means of holding on, as the surface is exceedingly slippery and the stems and fronds large and coarse. In this part of the Pacific the sargassum is confined to the Gulf of California,

and as soon as we go outside we find the kelp dominant.

One of the masses of eggs was evidently the work of two fish, for one lot was newly laid and in the early stages of segmentation, light amber or darker golden brown. These eggs were apparently inextricably mixed with the others, but we were to find that this was not actually so. The second batch appeared to the eye as black as caviare, freckled with many small orange dots and two bright green spots. The embryos were fully formed and the spots were the little eyes looking out. In spite of the intermingling, whenever one of the amber strings was lifted it came away free and clear, except that at the last there were several turns and twists around the other eggs, showing that the second fish had woven her way in and out of the stems which had been used by the first flying-fish. I have observed the same thing in the Atlantic; a single ball of weed showing two and sometimes three distinct stages of development, far too distinct to have come at the same time from a single set of ovaries.

The eggs were about a twelfth of an inch in diameter and the embryos were curled once and a half times around, the only break in the outside curve being the slight elevation of the scarlet heart. Within five minutes of putting them in water almost all of the early brood had hatched, with an infinite amount of wriggling. The young fish swarmed to

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the surface and floated with half-outstretched fins much like the full-grown ones. They were only slightly more than a third of an inch in length, and already they glowed with black and white and iridescent green and blue. They lived, some of them, for five days and at last succumbed to water chilled a few degrees beyond that to which they had been used.

Late one afternoon I swung over the rail and went out to my favourite perch at the end of the boom-walk. For a while nothing happened on the water except the quick darts here and there of the ocean striders which, although insects, rather deserve the name of petrels.

Several pieces of nondescript flotsam passed, too far out to be salvaged. Finally a bit of something drifted along the path of the *Zaca*, and I scooped it up from the Pacific Ocean and dropped it into the four-by-four-inch sea of a laboratory dish. After dinner I remembered and took the dish to my table and settled myself, without any definite reason or expectation, to see what I had caught.

It turned out to be a thin bit of cork bark about two inches across and my first glance showed it animated with active lives, all uninterruptedly and terrifically busy about their affairs, as if being in a glaring light under a microscope lens were the most usual of situations. The entire edge of the diminutive

raft was lined with barnacles. No matter which side was tossed up by the waves, the barnacles could not lose. If they were in the centre they might find themselves floating on the upper side with only sporadic access to the water. But how in the name of all wonderful things could this certainty of favourable position be brought about, when the young barnacle only hits the bottom, or any material object, but once, and sticks there? It was as reasonable as if a geranium, not caring for its place in the shade, should move across a flower bed to the sunny herbaceous border.

At any rate here was a fringe of frantically beckoning beings planted exactly where they should be, reaching out eager fists which unfolded into clutching fingers, dragging in anything of oxygen or food which happened, out of all the great extent of ocean, to come within their reach. As I looked, instead of just barnacles, the cluster gradually resolved into individuals, and in five minutes I could distinguish this one from that, and that from the others. Knowing what I do about the life of barnacles and in spite of this slight insight, I am always surprised to see so much of a crustacean appear and disappear. It seems as if the undistinguished parts of a mollusc, some headless bivalve, ought to protrude from this shell-covered case instead of the half umbrella of many rib-like appendages forever opening and closing.

Five of the largest barnacles had smaller ones grow-

ing to them, a sort of superficial animal-graft. Some were on the base or on the various bits of lime on the stalk, or on the edge of the waving valves themselves, so that with every breath of their host or parent they got a free ride. The older ones had a wide vacuolated foot of thin hard tissue, quite white and fitting closely to the roughnesses of the bark foundation. The arrangement of the pieces of shell, each connected by a narrow strip of muscle, was most ingenious. The back was a long curved bow of lime which rested on and strengthened the muscular hinge, acting as an external skeleton, and the other pieces fitted exactly like the old-fashioned puzzles of a half dozen pieces of wood which could be shifted into rectangles and crescents and even more interesting objects. The head of this static shrimp was buried deep within the shell at the bottom, with eyes gone, antennae lost, and only his posterior raised high in water, his hind legs enormously elongated into a feather fan of life.

He and his clan of *Lepas* might well look down with contumelious feelings on the ordinary barnacles which are as sessile and fixed as volcanoes. He dangled on the end of a short but mobile stem, like the anemones which grow in our gardens. I watched one for a long time, and as food did not seem as abundant in my little glass dish as he had been accustomed to find it in the broad Pacific, he slowly twisted on his stem, revolving far in one direction,

then in the other, but moving more at the rate of second-hand speed than by any sudden contraction of animal muscle. Finally he dipped down beneath a brother who grew in the way, and grasped at the water beneath the neighbouring stem; so he had hardly more than the mobility of a sunflower which swings about, following the course of the sun throughout a day.

The little life raft of cork was not only a support for the barnacles: it was a grazing ground for a herd of naked molluscs. There were twenty altogether, varying in size from one which was three-fourths of an inch in length to infants which had barely emerged into the world.

They were inconspicuously coloured unlike most of their brethren on coral reefs—a milky gray, with numerous long tentacles of the same colour, each with a granulated core of reddish brown. They were unbelievably busy, browsing on the surface of the cork, creeping here and there, colliding, and rearing up in momentary battle before turning aside. The cork itself looked precisely like a telescopic view of the moon, with scattered craters, down which the snails descended and where, like cattle in the valleys between terrestrial hills, they apparently found rich fodder. Their travels brought them every now and then into swinging range of the barnacles' feathery scythes, where they would receive buffets and devote a few minutes to an attempt to force their way past

the recurrent blows, but gave up at last. Their infants fared better, since they could creep beneath the sweeping legs and extend their explorations to the barnacles themselves, climbing up and around the stalks, and over the outer surface of the shells to the very edge of the front valves. Unwittingly they probably did the barnacles some slight service in cleaning their outsides of algal or other growths, but the mechanical shrimps never knew it, nor, for that matter, did the snails.

Also finding life pleasant on the barnacles was a flatworm, oozing along the stems. It was a mere sliding bit of slime, with two specks for eyes, but no other structure visible, and seeming to retain its vague form more, like a stream of water, by the tolerance of gravity than by any cohesiveness of tissue.

Down near the south-east edge of the cork, in solitary state, was an amphipod, perfectly still, save for the waving of his swimmerets. This made the genesis of the activities of the barnacles vividly real, going back how many hundreds of thousands or millions of years to the time when they too were free-swimming creatures, a life now conceivable only in their near relations or in the activity of their own newly hatched offspring. Our amphipod was olive-green (fashion in corkland seemed to decree only dull tones this season), with dark antennal bands, and pink eyes completely covered with a delicate

white honeycomb of separate lenses. As far as I could see he was the only one of his kind within my microscope cosmos, and he was also the only inhabitant who, by any possibility, could make his way to another cork planet, if such there was in this waste of waters.

Something in the whole setting made my mind leave the silly fears and worries of this earthly life. I went up the companion way and looked out at the black ocean, the night wind of a sudden squall whistling through the rigging, mist-filled blasts rushing past, the tumultuous swells and waves making death in them certain for a human being within a few minutes. Then I went back to the laboratory and looked quickly at the fauna of the cork. I watched its ceaseless energy and movement, its hopes and desires, its successful adaptation to the small environment. From this my mind went on past my six-foot self and my world to some super-corkland, and I looked down at the *Zaca*, a tossing chip on whose surface and in whose interior were a score of little beings, all somewhat naked molluscs under the skin, all bustling about their various importances. The barnacles and the snails and the lonely amphipod grew in significance, and my world of human beings took its rightful place as only one among a host of many sizes and dimensions of other worlds.

As I watched my corkland, the activity increased

beyond the ordinary frenzy of feeding. The browsing snails browsed intermittently and crept about more restlessly. They met and passed without any delay for rearing and resentment. The barnacles twisted about more on their stalks, and their fans went into higher gear. Something was affecting this world which I could not explain. Then came the antithesis. A drowsiness slowed down everyone and finally there was rest. A thought struck me and I dropped several pipettefuls of fresh salt water into the glass container, and like the coming of dawn to a sleeping city was the spreading through the water of vivifying oxygen. I shifted the town to a new dish and all the speed of action began again. No wonder these creatures find life possible only on the tossing ocean if they use up the oxygen in a good-sized dish so quickly. Again I thought of the narrow confines within which human life can be maintained on the surface of Earth, a range of less than two hundred and fifty degrees between viable heat and cold, and a vertical extent of not much more than five miles.

When I have finished this expedition, knowing that almost all I have accomplished is an increased appreciation and realization of my vast fund of ignorance, I shall never forget the barnacles and the snails and even the flowing bit of matter on the stalk, and they will take on greater importance. Floating past the very spot out in the Pacific will be other bits of cork and other barnacles. But I am content

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to remember that I was able to catch up my particular corkland, and to watch and share with enthusiasm and complete absorption in a momentary cross section of the little lives. And I will do this with the greater satisfaction because when I had finished my watching I gently dropped overboard the cork and its tenants. They had acquired merit and without the loss of a single life had fulfilled a certain phase of their destiny. Then I went to bed.

X

CLARION: THE LONELY ISLE

FOUR hundred miles south-west of Cape San Lucas the bottom of the Pacific pushes abruptly up through two miles of black, inky depths into the warm sunlight, and on for another thousand feet. This bit of dry land, measuring two by six miles, is known as Clarion Island. We had chosen it for our third and last focus of exploration and study. I had greatly desired to visit a Pacific oceanic island in order to compare the general conditions existing there with those of Bermuda in the Atlantic. Clarion fulfilled every requirement.

Whatever place I am studying always becomes an individual of sorts, or rather possessed of some small special spirit whose influence is everywhere apparent. Inez Bay was a gentle, friendly, feminine personality, whom we woke from sleep, but so quietly that she watched us with tolerant, pleased, half-closed eyes as we went about our work. She secreted nothing, held nothing back, making us feel that only the limitations of our senses prevented our solution of all her mysteries. She even held her breath so that nothing should cloud the face of the

watery window, wide open to our human eyes. If we had stayed on we should have come perilously near to taking all her kindness for granted, expecting such favours as due to our valuable investigations in the name of science.

San Lucas presented a mixture of characters, all moderate, fraternal, leaving us to our own devices, not expecially interested, absorbed in their own occupations, but evincing a definite guardian spirit. After writing this I realized that unconsciously I had defined the dignified cluster of Gray Friars, imagining apposite characteristics of Los Frailes.

Clarion, as we shall see, was to us a lonely hermit, a flagellant, cruel to himself and, while devoid of animus, offering nothing of help or kindness to any intruder. Whatever we learned or accomplished was an *Inspiteof*.

The island, together with three sister specks several hundreds of miles away, is known as the Archipelago of Revillagigedo which, when a Mexican says it, becomes a soft sibilant whisper of a name, full of charm. The pronunciation of this word is a worthy dinner-table addition to the names of two Mexican volcanoes, Po-po-ca-táy-petal and Ix-toc-sée-watl. It goes thus, Ruh-véeya-hee-gáy-do.

On the tenth of May the *Zaca* came within sight of Clarion and anchored at the entrance of an open bay on the south shore. It is a strange thing to come to an island like this, or to any place on earth wholly

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new to us, and even before we have put foot on shore, while we are still looking at major landmarks and features that come to the eye at first sight, to know that all these which now are surprises will, after a week's time, become memories, and memories which may crop up throughout the rest of our life, unexpectedly and at incongruous moments. That Red Headland would, at the end of a week, vanish forever into the faintest of faint mists against the southern horizon. Yet for no reason at all, it will re-create itself in my memory on some most casual occasion, or when I am threatened with death.

My first impression, looking toward the west, as Clarion came in sight, was of high precipitous cliffs, strata sloping at oblique angles, much dark red and less gray. The profile of the island was of high rounded summits, with slopes covered with pale greenish vegetation. There was very little exposed rock; the soft grassy growth covered everything.

On the south side at Sulphur Bay which we approached slowly, the cliffs were less high and more even, ending in two long, curved beaches with more low, black lava cliffs beyond. White dots massed here and there resolved in the glass into colonies of boobies. As we neared the shore frigate-birds, boobies both brown and white, and a few tropic-birds soared overhead. A dozen pairs of mating turtles were scattered about in the water. Thus far the tropic-birds were the only reminder of Bermuda, Clarion's

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mountainous character and lack of all human occupation emphasizing this difference. But our later comparisons were to be concerned with less conspicuous and more significant phenomena. (Fig. 17.)

The moment we began preparations for landing we realized the amazing individuality of this island. It came near being an absolute no-man's-land, for there was only one short extent of shore in the entire circumference, possibly fifty yards in width, where it was possible for a boat to land. We piled into the dory, were towed by the launch to the outermost swell, and turned loose. Frank the Samoan took the oars, headed for a bit of sandy beach bounded by great black boulders, and watching his chance, drove in on a curving green swell which broke just in front, and carried us headlong amid froth and bubbles, and we jumped out into two feet of backwash. Only in this narrow lane was the full strength of the encircling waves of Clarion broken. Close on each side great breakers roared past us. Eight or ten feet high they were, with crests blowing back like the manes of white horses. (Fig. 18.)

The island is guarded on every side by this never-ceasing pounding of waters and very few human beings have ever set foot upon it. So isolated is Clarion that many of the creatures which call it home are distinct from all their relatives living in other parts of the world. On our first walk we saw

four species of birds, a snake, and a lizard which are peculiar to this two-by-six speck in mid-ocean.

The girdle of crashing waves exerts very important effects on the animal life of the shore. Large coat-of-mail shells and limpets are the only molluscs which can withstand the eternal pounding, for every movable stone has been cast high up on the terraced beaches, and sheltering cracks and crevices are few. Only the great scarlet grapsus crabs, the Sally light-foots, can slither with impunity over the rocks, clinging fast with their eight stout legs. Even the tide-pools are not free from the beating breakers and the fishes which find them safe are few in number.

The lava foreshore with its scattered black boulders vividly recalled the littoral of Galapagos. Beyond this a terrace of broken coral and shells rose steeply to the very edge of a welter of morning glories and palmate cactus. And now we saw how wrong we were when we thought we saw the slopes covered with soft grass. For hundreds of yards the cactus formed so solid a carpet that not a step could be taken inland. And often when the long soft stems of the grass seemed to afford easy walking we learned to our cost that it was only a thin covering for more cactus.

The first of the great sandy beaches we named at sight, Turtle Beach, for many trails led up from the water and across its wide expanse, each looking like the track of a miniature armoured tank. They led

directly to patches of disturbed sand with which later on I was to become intimately acquainted. Looking seaward beneath the great, green onrushing waves, I detected what I thought were four large lava rocks on the bottom. A second glance showed them to be turtles waiting for nightfall before creeping ashore. No crash of water could injure their solid armour.

The first reptile I saw was a medium-sized snake, earthen brown in colour, on the lava rocks near the water. I caught it without trouble. Farther on a coot lay dead on the coral, a storm-blown waif, the first of its kind ever recorded from Clarion. Nine ravens came down from the nearest hills, looked at us, croaked dismally, and flew off.

Next a brown, wren-like, yet warbler-like bird flew up from the beach and sang a short, zizzing song with a catch in it, more like that of a warbler than a wren. This, however, was the brown Clarion wren, living here and nowhere else in the world. A dove flushed from our path and a turquoise lizard appeared and vanished in the same second of time: both were natives and peculiar to Clarion.

All of them recalled nearly related species which we had seen in Mexico and Lower California, but their separateness seemed to me far more trenchant than any variation in colour or size. It made real the centuries upon centuries of isolation, the months and years marked on Clarion not by any human calendars

but by the indistinct seasons, the regular and thousand times repeated time of breeding and nesting of every creature, and the unseen, unrecorded æons of storms and sunshine, days and nights.

As we walked along the upper level of the beach, well above the reach of storm waves, we came across traces of small booby colonies, the ground-nesting blue-faced ones. Many of the nests were already deserted, having served their use. All of them were merely separate, bare, rounded patches with white guano radiating in every direction. The radiating effect is due to the instinctive effort of the sitting bird to keep the nest as clean as possible. In each of these localities were a very few birds still on their nests, incubating one or two and in one case, three eggs; still more rarely a booby was found sitting on newly hatched chicks. They were all late nesters, having suffered some accident to their first eggs or young, and were quite fearless, just as I had seen them in the Galapagos years ago. We had to push them, snapping and biting, off their nests to inspect the eggs. Often, on following days, these birds alighted on oars or on the deck of the launch, showing absolutely no fear of a man in a boat.

Usually one bird incubated while its mate was away fishing. In one case the male booby, recognizable by the small size of the pupils of his eyes, was standing by the nest and flew off at once. The sitting bird allowed me to look at her eggs and then sud-

denly seemed to realize that she should be afraid; so forthwith, with no effort, she ejected a fourteen-inch flying-fish and flew away. She had apparently just come in from fishing and had taken her place on the nest while her unfed mate was ready to start to sea. I salvaged the fish, for it was quite fresh and a perfect specimen. The booby returned within two minutes after I left her nest.

In another instance the ejected fish was partly digested. I went a little way off and watched the indignant bird waddle back, and although the unpleasant morsel was covered with sand until it looked like a breaded veal chop, she swallowed it with gusto, sand and all, and settled again upon her egg.

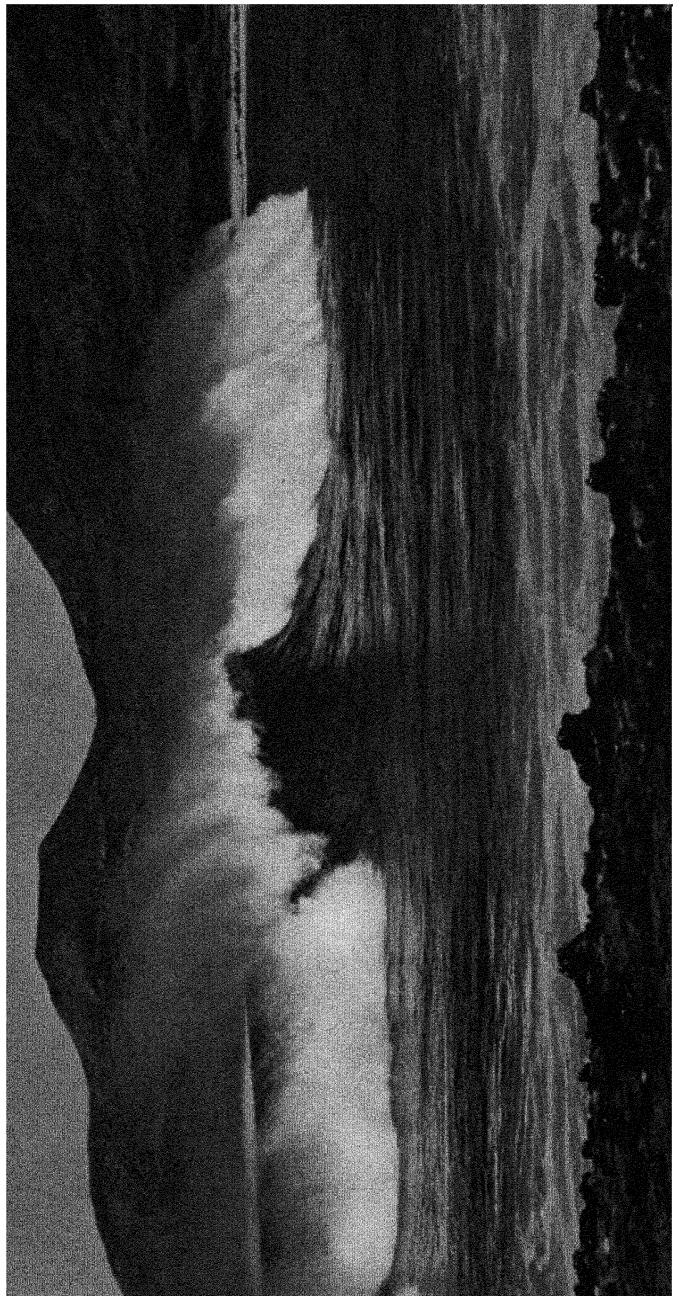
The distinction in voice between the sexes was as marked as that of pupil diameter. When the female booby was taking her turn on the eggs she resented my approach with a squawk or quack like one of the hoarse notes of a barn-yard hen, or perhaps more like the voice of a duck but much deeper. The next bird to be encountered would differ in outward appearance only in the small pupil, but his warning cry, when uttered, would be merely a ridiculously high, shrill *peeeeeeeP!* like the call of an overgrown chick.

The syrinx, or voice box, of the young boobies and the full-grown female has rounded dilations of bone at the juncture of the trachea, but this character

disappears in the adult male bird. Here we have an exact relation between voice and the structure of the vocal organ, for the high squeaky voice of the male parent is evidently on the way to obliteration.

The frigate-birds regularly rob the boobies of their hard-earned food; I know in several cases the victimized birds had to catch twice again as many fish before they could escape to their nests with an adequate meal. Once, when Crocker was fishing from the launch, he had an unusual experience with one of these robbers. A frigate-bird swooped down, gently lifted the flying-fish bait and carried it twenty feet aloft. There the bird held it, slowly following the boat, regulating his speed exactly to that of the launch, until after several minutes of skilful manipulation he disengaged the fish from the hook. He then swallowed the morsel and flew off as nonchalantly as if he and his ancestors had always fed in this manner. When a feather jig was put on, a booby began to follow and watch it, while the same frigate-bird, ready to rob him, trailed along many feet up in the air. But the booby soon detected the falseness of the lure and left it.

Near the end of the sandy beach and well inland we found large colonies of tree-nesting, red-footed boobies, perhaps five hundred birds in all. For their encampment they had chosen the only groups of good-sized bushes in the lowlands of Clarion, a small,



THE WHITE HORSES OF CLARION. Clarion Island is ringed about with all but impassable surf whose high-flung spray blows far into the air. (18)



RED-FOOTED BOOBIES. Colonies of these tree-nesting boobies greeted us on Clarion. Whiteness and curiosity were their dominant character and characteristic. (19)

compact mass of euphorbias, all well guarded by cactus. Although there were three separate colonies, the solid, terrible phalanx of cactus permitted a near approach to only one. Dozens of last year's birds in brown plumage took to flight as we approached, leaving the white adults sitting upon their well-built nests, with young in all stages of growth. Some were just hatched, with a straggly gray covering of scanty down which left them quite unprotected. The next stage was of birds like powder puffs, little balls of white swan's-down with protruding lead-coloured beaks and bright beady eyes. They were vitally interested in everything which went on around them, and especially in ourselves, visions which must have been wholly beyond their experience. (Fig. 19.)

The nests were close together, almost touching, and each parent had an unending feud with every neighbour. There seemed to be a tendency to blame the worry about our presence upon one another, and the nearer we came to any particular section, or any one branch or bush, the more intense became the rioting in that vicinity.

Some of the older nestlings looked larger than their parents, the fluffy character of the down making the size appear a third greater than it actually was. The voices of this species reminded us of the maddening, whirling, raucous rattles so dear to the hearts of revellers on New Year's Eve.

I saw a burrowing owl take to wing and fly up a

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dark gully in the heart of the booby colony. A number of these little owls had their homes underground immediately beneath the nests of the sea-birds. They were the most delightful of all the island birds and almost as tame as the boobies. Whether perched in the top of a dead branch or in the grass runway at the entrance of their burrow, they greeted the human invaders with a series of bobbing curtsies which seemed so much a welcome that one felt like bowing in return. Crocker and Toshio captured a female and its nearly full-grown young, and the latter is now bowing and scraping to visitors at the Zoological Park of the New York Zoological Society, the first burrowing owl ever to reach New York alive. (Fig. 20.)

When we come to any place new and strange, whether city, desert, or island, our attention at first is attracted and held by the loudest noises, the most brilliant colours, the most bizarre forms. If the scene is an island such as Clarion, and our object the study of the living creatures, the first few days pass in a turmoil of distracted activities and impressions. Then the fever of uncorrelated observation and indiscriminate collecting dies down. There comes to eye or ear some minor overtone, the first of a host of details, infinitely more lasting and significant than the more blatant sensory signals. Out of the chaos of fleeting first impressions arise intrinsic patterns of colours,

odours, voices, movements, habits—the vital and necessary mosaic which ultimately must mirror the scene and place to writer and reader.

On the twelfth of May, after watching the *Zaca* start dredging in the open sea we set out confidently at low water for the real tide-pools of Clarion, and at once felt the teeth of the island's inimical spirit, a spirit which seemed to challenge and block every attempt at scientific investigation. Here were most excellent pools full of fish, pools hidden behind a high barrier of craggy rocks. We unlimbered and immediately were startled by a thunderous explosion from some place invisible, and a second later a perfect deluge of foam and water descended upon us and upon the pools, which instantly overflowed their rims. So abrupt was the cliff outside and so powerful the surf that only a slight difference in density and consistency of water particles distinguished high from low tide. We had to give up serious tide-pool work except in a few rare locations.

Leaving the geysered pools we climbed a high cliff and found a precarious seat on the edge between the solid culture of low, impenetrable cacti behind and a sheer drop to the waves beneath. A few feet beyond where I sat was a bit of colour as startling as a loud cry would be to the ear—a rock covered with a solid unbroken sheet of orange ochre lichen, with a turquoise lizard draped over one rim as only the lizard or a Hokusai could do it, a dual force and

harmony of pigment which *a priori* would be thought impossible.

Leaving the pools behind I climbed down to the shore, and shedding everything but shorts and shoes crept as close as I dared to the seething, crashing waters. The molluscs were few and far between, and to find them I had to go to the outermost rocks. Here in the very zone of the smashing water were giant chitons and limpets. The former could usually be reached if I chose carefully between incoming waves, slipped a knife edge between rock and shell, levered it up, and scrambled back to some secure hold while the foam washed over me. The limpets almost without exception were beyond human reach.

The thin amount of life under stones or between them was very noticeable. This, too, was due to the ceaseless pounding, and any movable rock was constantly shifted and rolled, gathering no animal moss or life of any kind. There were many pot-holes with one or two stones at the bottom, and the smoothness and depth of these attested the tremendous and eternal stirring force of the ocean's contact with this isolated isle.

Almost every one of the few organisms had had to dig itself in, to resist being torn away and destroyed. The rare long-spined urchins were withdrawn into deep crevices with their mass of needle spines compressed into a very narrow segment. The short-

spined ones were deeply embedded in coral or in actual lime rock; prisoners for ever, but safe from death by wave force. The only living creatures active and free on the naked rocks were the ever-present scarlet crabs which flattened and gripped with all their sharp claws, defying the heaviest surf.

We kept on along the coast and by accident discovered and passed through a veritable slit of an entrance to an enclosed lovely rocky area. Here was a pool which, at least for an hour at low tide, was free from direct attack on the part of the waves. Before and after this scant duration of time, the surges made the entrance impossible and the pool a cauldron.

Frank, armed with tethered harpoon, had disappeared through a second cleft, humming some Samoan song whose minor quavers came to us above the low, distant roar. We were left alone and for a time remained dry enough to give some attention to details of the life around us. The overhanging cliff shut off all the breeze and this rocky room, floored with the pool and ceilinged with heaven, was quiet. In it Clarion forgot itself and slept. The pool became a window and all its secrets plain.

From its surface rose eight monsters, temporarily quiescent in lava, their black heads protruding in a sort of fearful school. The most ordinary was amazingly like the head and snout of a bull elephant seal while the nomenclature of the rest would tax the

imagination of a Syme *cum* Dunsany. One was unquestionably a mipt! Their absence of motion only added to the sinister effect, enhancing the idea of waiting for something. The ruffle of a restless fish set their shadows moving, and everyone knows that the shadow of a monster is more awful than its substance.

The most colourful of the pool people were demoiselles, which were earthen brown on the fore part of the body, changing gradually to hyacinthine blue set off by brilliant yellow eyes. The most abundant—the minnows of Clarion—were the silvery kuhlias (they have no common name) with their black and white banded tail fins, flashing when they turned like the flag of a rabbit. A school of friendly old abudefdufs mingled with as many pale green surgeons, whose narrow vertical black lines contrasted with the broader ones of the sergeant-majors. Little else was visible until I threw in a hook baited with a toothsome snail. Instantly there came a rush from under a rock, and a rainbow wrasse hooked himself. The hook went back and the same thing happened. All the others which swam about in full view bit with interest but with no vim; tentative nibbles which saved their lives but exhibited no individuality. But the green and violet and ochre and blue glories in scales kept hidden until the bit of snail came into sight.

Close behind me two Clarion doves cooed in

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some anxiety, for their rough nest of fine sticks and grass was in a crevice ten feet overhead. There were no eggs as yet, but spring had come to Clarion as witness the turtles and whales. The doves looked much like our mourning doves with considerable white to the tips of the tail feathers and several black spots on the shoulders. In addition there was a touch of cerulean around their eyes, a green of 'burnished iris' on the neck, while the legs and feet were of delicate coral. The note too was very like that of our New England pastures.

We went around the pool to pass farther to the west, through another opening when I saw a wren fly up from an overhanging cliff with a caterpillar in her beak. I walked as near as the cliff would permit and looked up and there was an untidy mass of delicate grass stems wedged into a crevice well out of our reach. The wren soon left and perched on top of a mass of rough red lava and sang. As I have said before it was only partly wren-like—a fine wire of a song, a short but drawn-out zizzing, then a catch and a brief varied end. It vibrated loudly in this rocky room. The wren's home was within sight of the dove's nest, and from where I stood, I could just see a third Clarion home, indicated by the head of a white booby, brooding on the cliff from which we had come.

From this quiet home of the dove and the wren we crept through Frank's gorge and seemed in

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another world. Here were three jagged capes reaching out and splitting the onrushing surges, blocking their ceaseless efforts to wipe Clarion out of existence. Not a dry rock summit was to be seen and all except the very ridge ran white with a hundred cascades after every wave. We crawled out, found saddle-like contours which we could grip with knees and thighs as we would a bucking horse, and here we tried hook and line fishing. Great whales spouted and gambolled in mad, titanic courtship just outside the reef, and beyond them the *Zaca* slowly dragged her slender wire thread back and forth.

Boobies swooped overhead and scarlet Sally light-foots skittered over the rocks, and always the foam and spray crashed around us and washed up until we were in a slather waist deep, trying to salvage our fish-lines and keep our balance on the sharp, slippery surfaces. In every swirling, green and white mass I could see the water-filtered purple of blue jacks, the orange of the angel-fish, and the black of great groupers. In spite of lost tackle and the fight to keep our seats we caught one of each species. The moment the hook sank to the bottom it tangled in the short prickly coral, but this was the only place we found where direct contact could be made between shore and offshore rocks.

Now and then I would get an abstract vision of my present cosmos, and see myself on this bit of volcano tip above the two miles plus of ocean depth,

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with the next nearest land more than two hundred miles away—a minute dot in mid-ocean and I a veriest pigmy, striving to wrest a few secrets from an environment so difficult and so alien to human-kind; the rocks where the least slip gashed our flesh, or the surging water into which a fall would mean instant death. In the midst of this steely hardness and knifelike sharpness lived and gently sang the wren and the dove.

XI

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THE eternal barrage of the crashing waves kept the tide-pools of Clarion almost free of unattached life, and we had found that we ourselves were no exception to this scouring process. In obtaining even the most meagre collections we were constantly threatened with disablement from the sheer weight of the masses of falling water. Handline fishing from the rocks had proved as feasible as dry-fly casting into gorse.

Offshore the waters teemed with fish, from the very curve of the breaking swells to outer depths where all swimming life vanished into the submarine twilight. We had been driven back from the front line shell-holes of the shore, but we had in reserve six methods of attack—still fishing, trolling, harpooning, night light, helmet diving, and waterglass.

All of these proved their worth and their results interdigitated and supplemented one another and made our scientific hearts glad. Yet the imperfections of human fishing methods are apparent when we divide them into blind and visual, the latter represented only by diving and waterglass.

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Any account I may write of the work with the waterglass will prove to be only so many additional pages of text, whereas it should be an epic. The ocean near Clarion was ideal for the use of this glass-bottomed box, for while the water itself was quite clear, the surface was always ruffled. Throughout our stay the trade-winds never ceased, with the result that when we fished blindly we might as well have dropped our line into a pool of ink for all that we could see of hook or bait.

Here, for the first time, we put the waterglasses through a long-sustained trial and the results were beyond our greatest hopes. For our technical reports we secured quantities of facts dealing with colours, colour changes, abundance and inter-relationships, all valuable, but of scant readable interest. But a review of them revealed a network of comedy, of drama, of absorbing episodes, the abstract interest of which often threatened concentration on more essentially ichthyological data.

Our waterglass studies began at Clarion in the afternoon of the twelfth of May, when we went shorewards in the dory, and with the launch standing by in case of need, anchored as close to the breaking place of the swells as we dared. Full eight feet in height a roller would come in from the open ocean and crash on the rocks to the west, sending up to heaven a geyser of fine white spray. The same wave, curving obliquely toward us, would gradually lose force

until it passed beneath, gently lifted and lowered us, and then, a moderate yard in height, curved, broke, and slithered up the beach. If we had watched this self-same wave as it swept on to our right—to the east—we would have seen it regain height and force and crash wickedly on the black dyke of lava in its path. When we saw these pitiless great walls of water rise on both sides and then diminish at the exact spot where we were anchored, we experienced some of the sensations of Moses when the waters of the Red Sea began to pile up. What a boon to a marine zoologist such an experience would be!

After anchoring, we began an intensive survey of the water and the bottom. Two of us hung over the side of the boat with our heads deep within the floating waterglasses. From the interiors our excited voices emerged in indistinct mumblings and roarings. The third member of the party sat, notebook in hand, striving to make sense of the vocal confusion which reached her ears.

The visibility was perfect. We could identify a two-inch fish fifteen or twenty feet down, and every colour, pattern, and movement was distinct and clear. A sea-window in the hand was worth a dozen in a glass-bottomed boat if only because of its mobility. We could turn and tip the boxes at will, controlling every angle and, as far as the water permitted, every direction. Occasional wandering schools of small fry and inquisiting sergeant-majors

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swam up, banked, and gazed through the window at us with interest but unconcern. Otherwise our scrutiny had no effect on underwater life.

Even in this heaven-sent safety land where we were anchored the surge back and forth would have made helmet-diving precarious and of slight value. In the scenes taking place below us the actors were carried back and forth in slow rhythm. Every fish kept its relative distance from every other one, and as our boat accompanied them, only the slightly shifting background was affected.

A dense school of several hundred yellow-tailed surgeon-fish passed slowly and was shortly succeeded by at least a thousand black-lined surgeons in an equally crowded swarm. After this we saw fish only singly or in small groups. Six was usually the maximum assemblage of the citizens of this Clarion underworld.

We began fishing with bits of snail, but for some time only small species were attracted by the swaying bait. Wrasse, squirrels, and demoiselles, like the habitués of free lunch counters, endeavoured to get something for nothing, and were uniformly successful, nipping off tiny bits until the hook was revealed, bare and naked.

Suddenly we saw newcomers, a very large seabass and two small sharks, all less than four feet in length, arriving together. For no reason at all, we dubbed the trio the Bruiser, Cain, and Abel, which

proved to be of use, however, to our notetaker. Abel had a nick out of his dorsal fin. About this time I felt a jerk and saw that a third species of trigger had ingeniously managed to hook himself through a gill and was manifesting some attendant emotion. I drew him up slowly and with little objection on his part. The performance attracted but slight attention from the cruising trio, the significance of which was not apparent until later. The trigger was landed and dropped into the live-box. He was a very elegant fish, jet black with narrow, snow-white seams wherever the fins joined the body. His physical being was unhurt, but the offence to his dignity was evidenced by much eye-rolling and frantic fanning with his pectorals.

I descended into my window and watched the Bruiser and his friends the sharks. None of the other fishes showed the least fear of them. The small fry swam about, passing close in front of the great mouths, and in general there was no change in tension or in movement on the part of any of the fish in sight. The bass kept close to the bottom. With my hook already picked bare, I swung my line toward him and hit him on the back with the heavy triangular sinker, making him swerve slightly but with no sign of either fear or anger. The same was true of the sharks when the line pulled against their bodies. Soon they drifted off and disappeared from view.

Frank, at his end of the dory, fishing blindly, now caught a small snapper almost at the surface, lifted it on board, killed it, and cut the flesh into firm, well-shaped bait. This, we were glad to see, proved less attractive to the small people of the deep; wrasse of some unknown species, zebra-tails, and lovely orange squirrels hovered about but could make no impression on the lure.

A twelve-inch mottled grouper slipped out of a hole in the rocks at the bottom, drifted nearer, and with a snap took my bait and hook. I began as before to haul him in when the Bruiser and Adam's offspring suddenly appeared and swam rather excitedly into the foreground. The whole psychology of the water area in view was suddenly changed. When I pulled on the line and the hooked grouper frantically struggled, upside down part of the time, all the small fish became tremendously excited and darted away, after which they returned and swam close to the straining fish.

When this happened I began to experiment. I hauled in several feet, and, when one of the sharks came close, eased off again. Instantly the small grouper regained his balance and normal appearance. The shark or the sea-bass would move up and hold their heads close to the smaller fish, watching it exactly as a dog, snarling and about to bite, will sometimes keep its mouth close to one's hand or leg, threatening to snap at the first motion. After a

few seconds, when the threatening fish moved away, I would repeat the process with identical results.

Even the little wrasse, when I watched them individually, were seen to rush for a moment at the struggling grouper, although it was many times bigger than they. It was recognition and reaction to strangeness or abnormality, aroused in this case by excited terror and helplessness; the same instinct which impels cows to gore a member of their own herd when she gets her horns caught in a fence.

Never before had I realized the absolute governing law of necessary fitness, as when I watched the workings of this whole dramatic sequence. First, this mingling piscine fraternity, carnivores and herbivores, small, medium, and giants, weaving in and out, drawn together and interested in the same dangling bait. The only direct disturbance under normal conditions was when the blue-and-brown demoiselles chased some fish away from their home, and this was only a harmless pursuit and warning. Yet close beneath all this lay dormant an electric reaction, ready to flare up at the adequate stimulus. What had been a host of friends or at least tolerators was turned into an ever-contracting circle of terrible foes. When the tethered grouper regained his balance the smaller fish would disperse almost immediately and forget everything in the pursuit of the bait on another hook; the fish of a size more equal and perhaps of identical species to that of the hooked fish

would watch the victim for some time longer, while the large fish, in another fraction of a second of struggling, would have seized, bitten and devoured it.

When trolling with line or with rod we sometimes felt a captured fish, putting up a splendid fight, suddenly cease its struggles. When we pulled it in there would remain on the hook only a mangled head. A shark or some large fish had taken it in mid-water. Here, through the clear waterglass, was the visible beginning of a similar tragedy, if we can afford to give it that name after our own unwarranted interruption of the life of the fish by means of bait and hook.

The following morning we again anchored the dory as near as possible to the shore. It was the calmest morning yet, and we were directly over great heads of coral which we coveted. I knew that if I went down in the helmet I would be swept back and forth together with the fishes, yards at a time over and across the coral gardens. Frank, our giant Samoan, looked over and said, 'I get 'em,'—as simple as that. Remembering my own past attempts, I doubted, and while I was doubting he slipped overboard. Through the waterglass we could see him in acute perspective, the soles of his feet chiefly in evidence, going down and down. Finally he reached and felt his way to several clumps, and at the last one turned his head upward and nodded. Then a straight rise, a sea-lion-like snort, and the great grin appeared. 'Can

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do,' was all he said, saving his breath, and I ceased doubting. He went down again with the crook bar. Twice the surge tipped him clear over and twice he twisted and worked from the opposite side before the return push of water interfered. I lowered the diving ladder and he climbed with a fair-sized piece of coral. The next time he began his climb with a head three feet across. Under water this was not so bad, but it seemed to develop hundreds of pounds additional weight as it rose above the surface. With the help of a rope and an oar, three of us heaving and I levering, we managed to dump it aboard and into the great washtub. I watched Frank carefully on a third dive. He never fought the water, but allowed himself to drift until he needed force and then let the swell do much of the work for him. It was sheer submarine jiu-jitsu. He seemed instinctively to know the mechanical forces and stresses and balance of the two worlds, that of the land and air, and that of water.

Later we found that his energy was well spent. In the coral were fish new to us, moray eels, zebra gobies, and a host of scarlet shrimps and crabs, and dozens of other beings whose sleeping, eating, and breathing world was confined within this maze of curved and twisted limestone catacombs.

After the coral was aboard we began fishing and waterglassing once more. The schools seemed more hungry than yesterday, and an orange cloud of angel-fish followed the bait everywhere. In the heart of

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their assemblage appeared two cighteen-inch file-fish, strange, elongate, angular creatures, with forever pouting mouths and lips. Their expanse of skin was pale green whercon were etched almost readable hieroglyphics with punctuation spots of turquoise blue, many of the unknown letters and words being delicately shaded with one of several colours and tints. We could marvel and admire but real appreciation could best be rendered by a master craftsman of the illumination of a Book of Hours. The file-fish nibbled and nibbled but would not take even the tiniest of hooks into their mouths.

The same enormous herd of yellow-tailed surgeons which we saw the day before was still there. The leaders began grazing on some great rock, and the main mass drifted up, gathering so thickly that they pushed against each other, many standing upside down as they gnawed at the seaweed, packed so densely that the rock was completely hidden. In the midst of the swimming crowd appeared a greenish yellow trumpet-fish over a yard in length, nudged by the multitude, once rolled quite over, yet not seeming to mind the surgeon mob.

This time the larger fish with whom we played the game of life and death were two very large groupers and a single shark. Frank again caught a footling grouper and I took his line and played it. At the first sign of distress one of the large elder brother groupers came close, and, turning slightly,

nudged the caught fish with what, for lack of a better name, I may call his shoulder. Whenever he did this I instantly loosened the line so that the victim recovered and swam quietly upright with every semblance of natural balance. Then the grouper would sheer off, but at the least sign of renewed struggle he again swam slowly in and rubbed his side against the smaller fish.

Soon the shark came up and at that moment the dory gave an unexpected lurch so that inadvertently I jerked the line. The shark, with a single movement, pushed aside the big grouper and had half the fish in his mouth. I saw no effort at biting or twisting, but the cut was perfect with no shreds of tissue. The grouper at once moved forward, took the rest of the fish, together with the hook, and was caught in turn. We hauled him up and he proved to weigh thirty-six pounds. Meantime a score of medium and small fish had gathered, dashing about after particles of food invisible to us, and showing no fear throughout the whole performance. Among the crowd were even three additional small groupers of the exact size and appearance of their unfortunate brother.

Day after day we staged this and similar dramas, always with interesting and unexpected variations, strange to our over-water eyes. I kept realizing anew the joy of this clear window watching. Frank in the near-by launch, lacking a waterglass, now and then pulled up a shark which he did not want, or

caught and lost his hook on the bottom, while I with the simplest instrument imaginable, had the whole world beneath me revealed as clearly as the land and air round about.

A blue-finned demoiselle not over four inches in length had its nest or at least its localized home directly beneath us. While I watched, it attacked and drove off four fish measuring from one to two feet in length; a grouper, a yellow-tailed surgeon-fish, a blue jack, and a small shark. In spite of their disproportionate size and their ability to engulf the little fish with a single snap, they each and every one shied somewhat and turned away. This was not accident, they were not all about to turn aside at that particular moment; of that I was certain for I had seen similar occurrences before. There was some sort of recognition or tolerance of the right of ownership. Whatever we call it will be criticized as an anthropomorphic interpretation, but the facts are as I have stated them.

Shifting from the demoiselle I saw an unusually large octopus shoot out from beneath a head of coral toward a table rock. It was spotted exactly like one of the big groupers and at that instant one of the largest of the latter swam around the other side of the rock and the two passed. Neither paid any attention to the other, but, as the octopus flowed by it seemed as if part of the grouper was leaving its body, so exactly were the pattern and colours imi-

tated. From my perspective directly overhead the two passing bodies partly overlapped and I had for a moment the unexpected illusion of an extrusion of molluscan ectoplasm.

The octopus came to a standstill on a ledge of the rock. I was heading my bait toward one of several groupers of a species new to me, and was concentrated on the fish as it drifted away from my reach, when suddenly my hook was seized. I tried to pull it loose and found it caught fast. Shifting the direction of my waterglass I saw that the octopus had the bait and was holding on for dear life. When I pulled with all my strength the body of the cephalopod moved slightly; that was all the hint other than ocular, that I had not caught my hook in a crevice of the rock itself. I drew the line down over the gunwale, took a half hitch when the boat lowered, and held tight on the rise. It was suddenly released and I looked down and saw the octopus—almost black now instead of pale gray mottling—in mid-water, on its way up to the boat. Before I could swing it inboard it let go and shot down, swift as a squid, to the bottom again. No fish in sight, large or small, showed any emotion at sight of the strange creature's trip up or down.

In the midst of our waterglassing, the launch returned from the *Zaca* with a huge shark towing behind. It was a tiger shark which had been caught on the hook which always hung baited over the

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stern. The rope was attached in turn to an empty gasoline tin, and at the clatter of this tin everyone within hearing would instantly rush to see what was caught.

We followed the launch to shore, slipping over the side of the dory in waist-deep water and running through the smother of foam before the onrush of the next wave. With block and tackle the enormous creature was hauled slowly up the beach out of reach of the water, and then measured and weighed piecemeal. The hook had fallen out of its mouth during its first struggles, but both hook and line were twisted about the head and body so tightly that it could not free itself, and had been harpooned from the deck. The liver alone weighed two hundred and ten pounds and the entire animal totalled seven hundred and fifty, and measured twelve feet and nine inches over all.

The persistence of movement in these cold-blooded creatures long after death, as we know it, is remarkable. With the head cut off and the body sectioned, weighed, and thrown aside, denuded of all its internal organs, still the muscles twitched and twisted for many minutes. This female tiger shark had eaten two large shearwaters, a good-sized green turtle, shell and all, a large porcupine-fish, a full-grown grouper, and several smaller ones.

The shearwaters belonged to the species which nests only on Clarion and its sister islands, and although we had watched carefully thus far we had

seen no signs of them. Their presence in the stomach of the tiger shark helps to explain why seabirds like to perch on floating logs and the backs of turtles. Shearwaters especially would seem to be reasonably safe from any such tragedy as being pulled under. Either they were resting on the water feeding, or were picking up a bit of food when death overtook them. The turtle in this case was quite whole, showing no signs of being crushed or bitten.

The day had been overcast and only now at sunset the clouds cleared away and gave free play to those horizontal rays of light which occasionally add such a sense of unreality to the last few minutes of day. Here, illumined most weirdly, was this strange creature of the sea, yielding up its secrets, with the separate tissues still clinging to the semblance of life long after the whole had begun dissolution into its fundamental elements. A Clarion raven, from a neighbouring cliff, softly croaked his approval of the scene.

Our ratings of success in the battle with the hostile spirit of Clarion worked out something like twenty per cent for the tide-pools, five per cent for shore fishing, and ninety per cent for shallow waterglassing. We now attempted deeper water and I had the launch tow us to a wholly exposed indentation west of Sulphur Bay. While still well offshore, we cut loose from the launch and rowed slowly toward the high

cliffs against which the waves broke and which here was the abrupt rim of Clarion.

By this time the use of the waterglass had become a part of our regular routine work. Under certain circumstances kneeling upon hard boards and hanging over equally hard bulwarks, with one's head far down in space may be good for one's soul, but it is a position exceedingly trying for the body temporal, especially when one's frame is so indifferently upholstered by nature as mine. So we introduced a soft cushion of spongy rubber for the alleviation of knee torture and a thick, kapok-stuffed pillow for whatever part of the anatomy rested upon the side of the boat. From then on prolonged observation became a much happier occupation.

Bottom appeared dimly far beneath our keel but not a single fish. Once a barnacle-studded turtle swam slowly over the face of the rocks. When I put over a hook baited with a generous amount of ancient snail I had an instant response. A squad of olive-green trigger-fish appeared from nowhere. They admired the odour and appearance of the bait but their mouths were too small to take it in. They were followed by a school of black jacks, swift, piratical fish, seizing bait and hook without hesitation and fighting to the last gasp.

Looked at from above, the locomotion of these two species was markedly different. The triggers turbinated through the water, their long vertical fins constantly

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waving, with serpent-like, progressive undulations, while the jacks used the tail propellers, and held out the falcate arm fins as balancers.

A third type of fish, olive-green like the first two, came into view, and easily held the centre of the stage of our interest during the morning. This was the green chub. A more sombre, inconspicuous fish could not be imagined, and its technical name of *lutescens* seemed a complete misnomer until I sighted a ninth, then a tenth, and eleventh individual. The first eight were swimming dimly below us when a gleam of gold through the water made us believe we had seen a golden grouper. Another and another came and mingled with the school of chubs and at last we realized they were merely a xanchoristic, or, in plain words, a golden-yellow phase of the green chubs. Next we saw a dark green fish with a bright yellow cap, then another all yellow except for black snout and tail. The black markings on one side would sometimes not coincide with those on the other, but there was never a mottling or admixture of the two. They were as distinct as two different colours can be. The green normal phase was dominant but I should say that at least a third of all seen this morning were yellow or with yellow markings. I once counted nineteen wholly yellow chubs at once.

Two major problems were involved. The first was the basis of variation which can produce results so

rare in nature. The Elizabethan collar of the ruff, among the wading birds, came to mind, also the red and black wrasse *Bodianus* of the Galapagos which vary so radically.

A second thought was induced by the sight of a school of these fish, two-thirds wholly olive-green from snout to tail-tip and with them others so bright golden that they could be seen far away through the broken and ruffled surface without the aid of a waterglass. They all associated in perfect harmony. Can these fish be colour-blind to yellow and not notice that their mates are so unlike themselves? Or does such a radical departure from the usual not bother them? Fishes of many species often associate in the same school, as is also true of birds, but these schools of chub were large enough to make certain that they knew each other for the same kind. And what about the sexual differences in colour in fishes? Such can play no part here; recognition must lie with other characters.

A more personal thought is how slight an aberration or a trivial shift of colour to our eyes can attract, hold, and absorb our attention. These yellow phases became the chief object and subject of most of our first day's work in this cove. They were the direct cause of my asking Crocker for the Samoan Pemasa Utu to come with us and bring his harpoon in the afternoon.

When we returned to this particular place I began

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to get ready to troll the fish to the surface. I told Pe that when I got them up I hoped he could harpoon one. Just as I finished speaking he asked if this was what I meant. Looking around, I saw him holding a yellow chub out to me on the tip of his harpoon. The fish had come to the surface beneath the boat the moment we stopped and he had captured one. Toward the end of the afternoon he got another, also wholly yellow. Try as we would we could not get a picd one. They have small mouths and are rather timid, and whenever I used a small hook I could not get it to the chubs through the greedy barrage of the black jacks. We caught a number of very large groupers, principally to see what they were feeding upon. One of the last I hooked weighed thirty-eight pounds, and when we examined its last meal we found a fresh, perfectly good chub, yellow all over except for much of the lower surface and tail which were irregularly black. In every respect this perfectly answered our requirements.

The morning's work covered four or five places where we held the boat still with oars while we watched. I told the launchman to tow us to a second tiny nick in the Clarion coastline which I ultimately named Zaca Cove. In the centre of this baylet we found ourselves unexpectedly over a large flat mass of rock, about a hundred feet square, which rose abruptly from the dim and blue bottom far below. The submerged mesa was from twelve to fifteen feet

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below the surface while the bottom of the little bay was about fifty feet deep. The rock was a great mass of lava with old intrusions marking the surface into great rough squares. The top was bare in places and fairly flat, much of it covered with the low branching coral like that in Sulphur Bay. A few patches were bright green, apparently alive and growing. Lichen-like algae coated other parts, with a scattering of long-spined urchins and a few snow-white ones. My first glance showed a huge lobster crawling along just out of reach of our longest harpoon.

It was a paradise for fish and during our first session we identified thirty-two different kinds. In numbers the violet-spotted rockfish easily led all the rest, a dense school of about five hundred drifting along in the deeper water alongside the rock, half-way to the bottom. A cut-up fish tied to a stout fish-line, but with no hook, proved an excellent lure and wherever we moved a trailing lot of fish followed. Wrasse of many patterns and colours were abundant and abudedefdufs were never more golden. Now and then we would get a thrill as we recognized some species never seen by us before. For example, close to the brown field of coral I saw a small fish less than six inches long, flying like a parrot or wrasse, and when it banked and looked up at us it showed a head of rich maroon, a body of shining purple, separated by a broad collar of yellow. The last time I had seen the purple-headed wrasse was when I

bang-banged one and stunned it in a tide-pool on one of the Pearl Islands, Panama.

Then a flash of yellow and a fair knife-blade of a fish turned to nibble at the hanging gardens on the sheer drop of the underwater cliff, and a truly tropical—Eastern Tropics—form came clearly into view. It consisted of a square of yellow, bright chrome or lemon, with a small black head leading out into an unbelievable long beak, the lower part of which was a delicate pearl gray. The large black spot at the base of the anal fin completed the details of pattern and we knew we were looking at a long-beaked butterfly-fish. To find it elsewhere we would have to go thousands of miles west, to Hawaii, Tahiti, Samoa, and Tonga. Its discovery was another proof of the usefulness of the waterglass, without which we would never have added it to our list.

After lunch we returned, bringing Pe again, to harpoon if need be, and Toshio to make a sketch of the top of the reef, and, if he should again appear, of the rare butterfly-fish. Up to this time we had fished and watched. Now I intended to try diving. It was here or never in the vicinity of Clarion. The water was fairly calm and even in the heavy swell running as usual, we were lucky to have the bottom of the bay so deep that each wave remained intact until it actually struck against the cliff. We lowered the anchor over the edge of this Almost Island the Second, and the gentle wind drifted us against the eastern side.

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In this position the anchor, though only halfway to the bottom, held us stationary, the rope sliding up and down over the rim of the reef. We were about two hundred feet from the north side of the cove, from the actual Clarion. To the south, mountainous swell after swell came rolling in, rising high above our horizon, passing beneath us, and then forming a great fearsome wall of water, still holding itself in check until it roared in enormous spouts of spray against the black lava cliffs.

I climbed overside and felt the helmet slip on, then started down the ladder. The alternating upward pull and sudden relaxation was not unfamiliar, and very soon I could anticipate the change and let myself go, never fighting, never going rigid. Halfway down I stopped, swung out on one hand, and looked around. Short of Galapagos I have never seen such a sight. To be sure we had been watching the whole scene from above, and throughout my whole dive I saw only three additional species. But the difference in angle, the close approach, the feeling of intimacy and identity with this water world, added a reality which can never be conveyed in spoken or written words. Looking through the waterglass one is still in the upper light and air; here, both body and mind are transmuted into the actual cosmos of these fish. My body was bathed by their atmosphere, they were close, surrounding me, looking at me as a friendly stranger.

The table of rock seemed much smaller than it had from above. Its surface was flat as we had thought, but covered with patches of coral in the form of mounds, excellent for everything but walking. On all sides the breath-taking drop into the blue depths formed a circle shutting me off from all hope of return by walking or climbing. There was no comforting rise of rock, whose slope might lead me back to the sun-bathed air overhead. Before this, my undersea walks had always been upon some shelf, or the bottom not far from an ascent to the dry land. Here, except for the black, worm-like hose, I was stranded in mid-water.

I was far from alone, however. If I could have taken time to count them I would certainly have reached two thousand before exhausting the number in sight, with other fish constantly arriving. As I landed on the rock, it seemed to me that most of the biggest ones had gathered at that exact spot to greet me. I have never seen such fearlessness. I was assuredly the first human being to walk the bottom about this island, and the fish attested this by coming as close as they could get. The big mottled groupers almost rubbed shoulders with me and the remembrance of this same performance just before they seized a hooked fish did not tend to the acceptance of their flattering intimacy with any equanimity. The small sharks wove in and out among the rest, but were more wary, evidently not liking the swaying rungs

of the ladder. The bumpheads, however, excelled the groupers. They swam constantly between my legs and actually touched me again and again. Whenever I tried, I could reach out and rub their scales.

The swell was incessant, and I found that the only way I could concentrate at all on observation was to stand on a fairly even head of coral, cling to the lowest rung of the ladder and balance with bent knees. The rung would sink to knee height, and then slowly and irresistibly rise until, with my arm fully extended overhead, it lifted me several feet off the reef. Or I would be led by the ladder ten or twelve feet ahead and then swung back to the identical spot I had left. This progression was by no means always slow or regular, and part of my mind and all my body had constantly to be on the alert for variations, as when I would be wafted sideways and dropped unceremoniously into a depression or small valley, when I had to choose quickly between letting go of the ladder altogether and hoping for its return, or climbing up several rungs and regaining my former stance.

Yet there came many intervals of comparative quiescence when I could forget moving water and gravitation, and cruel coral knives and files, and devote my whole attention to the fish. The first impression was one of satisfaction that we had so correctly recognized the species, and especially the delicate details of characters of the forms strange to

us, through the waterglasses. I realized how much the experience we had gained through past years counted in taking advantage of every bank, every turn and twist made by the fish, appraising the side and ventral surfaces and correctly recording pattern, shapes, and colours.

I looked up at the opaque, ruffled, and quilted under-surface and there saw two comic, but immensely reassuring sights—two small, square windows of perfect clarity, each framing an anxious human face. My wave changed the expressions into relieved grins, and I returned to my wonderland.

The yellow chubs were still the most amazing thing about the whole assembly, and they, too, were tame and came within arm's reach. I noticed that every pied individual had black as the dark part of his pigment pattern. The lovely blue, yellow, and black Clarion surgeons were busily feeding on the bottom and had no time to spare for me, although their grazing brought them occasionally in actual contact with my shoes. The young of the angel-fish, which I coveted greatly, were everywhere on and in the coral, and crept in and out of the crevices between the higher branches like rainbow mice. The ladder caught on coral once and broke off a sizable piece. This gave me an idea and I waggled my hand, making the diving sign for the steel crook-bar, which soon came drifting down and struck with a gentle clank on my helmet. Out of water it would have brained me.

I had rather a bad time of it, but at last managed to get sufficient leverage to pry off several small pieces. These I carried up one at a time, holding the coral under one arm, and hopping up a rung or two whenever the pull slackened. Later we found these bits alive with scarlet and other hued beings, and proved that the faunas of the shallow and the deep coral heads were very similar.

The last time I dived I made up my mind to try for one of the beautiful immature angel-fish. They were only four inches in length, and while they glowed with rich orange, they lacked the warm dark colour of the posterior body which their elders showed, having instead a half-dozen vertical lines and spots which recalled the pattern of the huge whale sharks. I got started all right with the bang-bang, then discovered that the insulated wire had drifted around my helmet and even under the rear copper flap. I could not free myself, so reached up to secure a higher hold, and in doing this lost my all-important small net and had to let go of the ladder to retrieve it. The shifting water made all my apparatus as active and agile as the fishes themselves and with most of my attention devoted to keeping myself right side up, my props did almost what they pleased.

I located one little angel-fish which seemed to live in a small bit of coral, and saw that he popped in and out of a particular opening on my side. I rested the tip of the bang-bang pole close to his front door and

waited. The fish failed to appear, but an unusually large swell did, and shifted me, my pole, and everything in my present world except the rock itself. When I was redeposited I found that the wire had caught in the coral and broken off a piece, and everything was now performing gyrations in mid-water in front of my face. The biggest of the groupers and four sizable companions were delighted at this and followed the flying coral everywhere, nipping toothsome bits from it and at times fairly brushing against my skin. The coral was heavy, and before I could acquire a fresh balance and disentangle it, it worked loose by itself, and now as I swung along, the bright red dynamite cap waved about me like mad. A bumphead was attracted by the scarlet fire-cracker-looking object and took it in his mouth several times. It was now my turn to be excited, wondering when the cap would explode and whether any considerable damage would ensue both to him and myself.

Racked and bleeding, I saw that the miserable little angel-fish had a dozen side doors as well as the front one, and I gave up ignominiously, climbed the ladder, and disentangled myself. Clarion had clamped down hard on any greater attempt at intimacy. I listened to Toshio's mumblings and grumblings in the depths of his waterglass and finally discovered they were expressions of intense satisfaction. When I peered down and saw the long-beaked butterfly-fish feeding just behind where I had been

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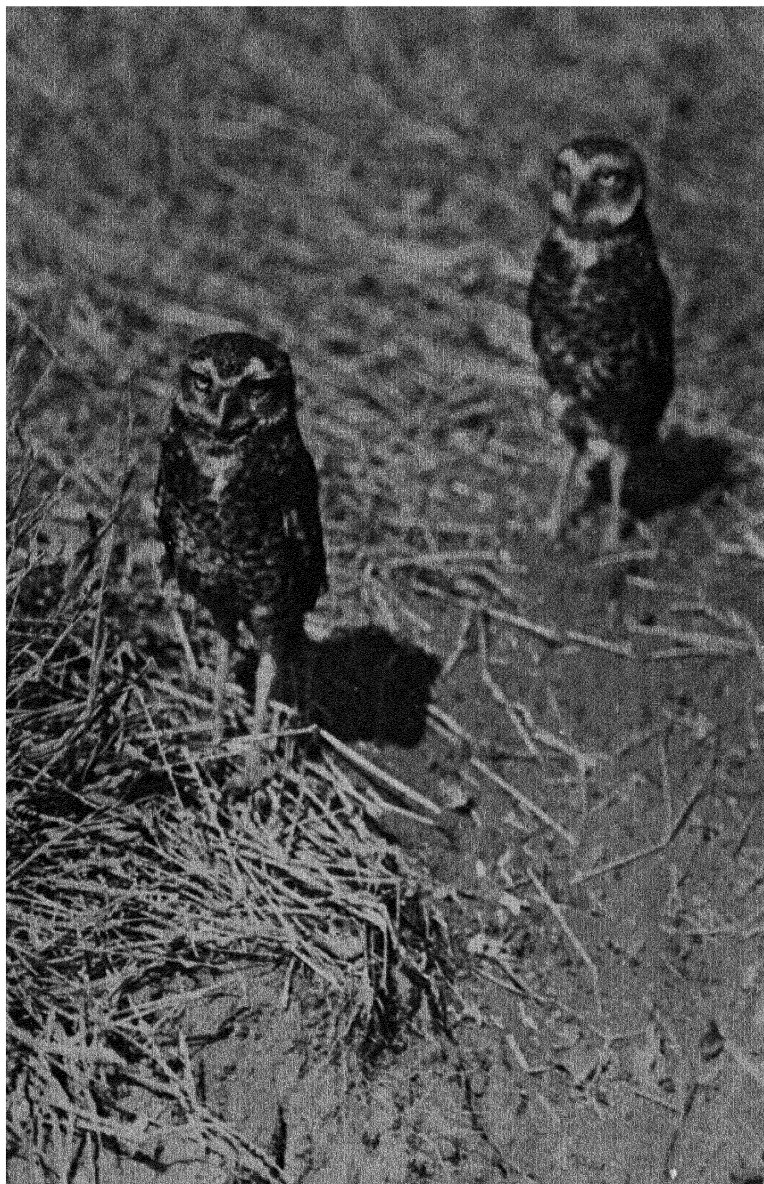
standing, and examined Toshio's exquisite painting of the fish drawn through the waterglass, I felt that after all we had outwitted the unfriendly spirit of Clarion and in our waterglass, underwater work had won a ninety-nine per cent victory.

XII

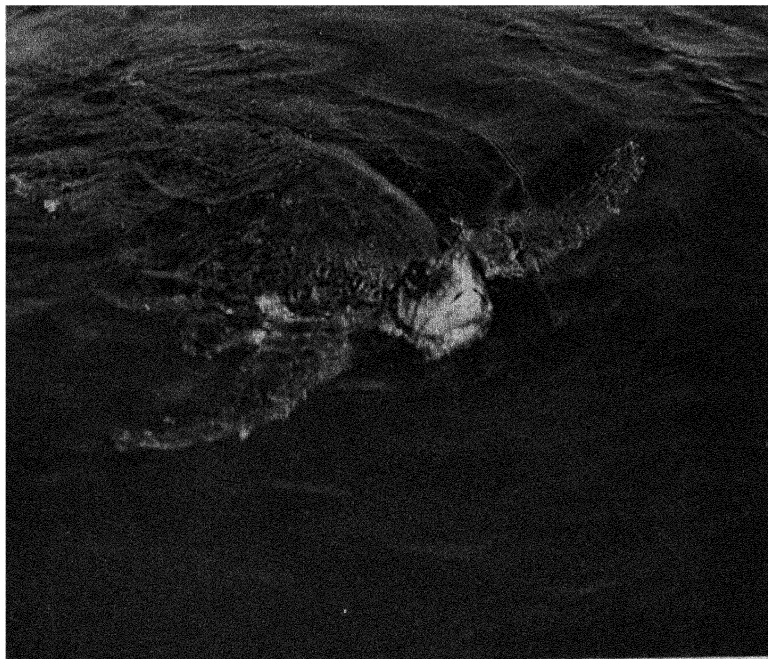
TURTLE SANCTUARY

SOMEWHERE in the vicinity of two hundred millions of years ago small, lizard-like creatures began to put difficulties in the way of their enemies by storing up plates of lime or bone in the skin of their backs. Right down to modern times armadillos have had the same idea with marked success, while snails have built marble houses around themselves since early in the dawn of life. Our *n*th grandfathers, indeed, withstood right sturdy blows when ensconced in metal armour, a protection as wholly external as the shell of the snails.

Going back to the hard-skinned lizards, the advantage of their defence led gradually to the inclusion of the actual bones of the body—the vertebrae of the backbone coalescing and the ribs broadening until their edges touched and fused. If the lizards had stopped there, they would have had to roll up into a ball, like pillbugs and armadillos and hedgehogs, to ensure protection when an enemy turned them upside down. So a bony framework came into existence over the lower surface, and this in turn bridged the gap along the sides, uniting with the dorsal armour.



BURROWING OWLS OF CLARION. *Quite without fear, these little owls watched us from the entrance of their burrow, giving stiff, jerky bows as if in welcome to their island home. (20)*



GREEN TURTLE. *Swimming slowly, the turtles work their way inshore at Clarion, and in the blackness of night dive through the breakers and creep up the broad sandy beach. (21)*

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Thus was developed a most efficient cuirass, with openings for feet, head, and tail.

The law of compensation came into effect and the stronger and more extensive the armour, the slower and heavier became the owners, and in the course of time we find their descendants stumping about the earth as tortoises. We know little about the actual details of ancestry of these engaging reptiles, but in the mid-Permian, say, two hundred and twenty-five millions of years before to-day, a small lizard lived in South Africa of which we have collected odd bones and have matched them into position, and finally have clothed these significant relics with the name of *Eumotosaurus*. Although it had teeth, yet it possessed rather wide ribs and other undoubted hints of chelonian forebears.

The success of armoured defence, of this mobile tank evolution, is proved by the fact that tortoises form one of the five reptilian groups which, out of eighteen, have survived into modern times. Long after tortoises had become well established, some bright side-line—bright or lazy or venturesome—fell into the water, geologically speaking, and discovered that it was easier to float along than to drag one's bony armature overland. Massive five-fingered posts of limbs gradually shaved down into thin flippers, and sea-turtles came into being. (Fig. 21.)

Paleontology cannot as yet show us the gradations of this change, but we know that it must have

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occurred far back in time. One hundred millions of years ago that great inland sea, extending over all of the central United States from Mexico and the Gulf to the Arctic was full, not only of mosasaurs and plesiosaurs, but of the giant paddle-limbed sea-turtles *Archelon*, which measured as much as eleven feet over all.

Ever since, with penguin-like flight, sea-turtles have traversed all the warmer waters of the planet's oceans, and this very evening one of them reluctantly provided the green turtle soup which introduced my dinner.

I have compared their mode of progression with that of penguins, and the simile could be extended with entire accuracy to include the flight of petrels and gulls which pass so swiftly overhead. Turtles are the only aquatic reptiles to use the forelimbs in this way, for the pelagic sea-snakes, as well as the surf-loving crocodiles and Galapagos lizards, all swim by undulations of the tail. Yet while turtles have gone far beyond the webbed-toe conditions of snappers and other fresh-water tortoises, they have never attained the viviparity of ichthyosaurs and oceanic serpents, and are thus still dependent upon the land for the continuation of their race.

I have seen these turtles in both hemispheres and along the shores of four continents, but not until my week on Clarion Island did green turtles leave the realm of exclamatory recognition and become

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exciting individuals, objects of intense interest and wonder.

One of the most important characteristics of animals is mobility, the power to move here and there over the earth's surface. In plants this is very restricted, and in the organic worlds voluntary movement is non-existent. Although green turtles have the power to fly swiftly through the water, yet they spend a great deal of time dozing at the surface. Only a practised eye can distinguish between a floating turtle and a clump of kelp or a drifting log, and this frequent and prolonged immobility actually induces effects that ordinarily concern only vegetation or the rocks of a reef.

Now and then, off Clarion, we would discover a turtle floating quietly, with eyes asleep, but ears very wide awake. Or it might have a tern or small gull perched on the sloping back, the bird also asleep or preening its plumage. At any moment, like Sindbad's camping place, the turtle-shell isle might sink from view. If the drifting chelonian happened to be a female, she and any avian passenger might be roughly capsized by the advent of one or more amorous males who made up in unturtlelike activity what they lacked in delicacy of courtship.

Well to the north we were able to capture one of these floating turtles, and the method of capture was almost epic. One morning early Frank Taiga saw the sleeping turtle near the yacht, and said, 'I think I

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get him!' It was as reasonable as if I should see the moon rising and say the same thing. The Samoan and the first mate left the *Zaca* in a tiny folding boat and sculled to within a hundred feet of the slumbering reptile. Frank then slipped overboard so gently that not a ripple sprcad from the spot where he vanished. It seemed as if many minutes passed. Then the turtle suddenly rose up and over on its back and swam itself and Frank back to the boat, where both men hoisted the dazed creature aboard. It furnished new notes on food, parasites, and structure, and completed the fulfilment of its destiny by subsequently reincarnating into delicious soup. It was a delight to see a human being pit his skill against a creature of the open sea, and win in spite of the keen hearing and the chance of a vicious bite. (Fig. 22.)

While this turtle was only two feet in length it weighed seventy-five pounds. Like any rock on an offshore reef it had a plentiful growth of short, red seaweed on the lower back, while clusters of barnacles had sprouted here and there.

Two crabs were living and thriving near the tail of the reptile, just as they might on a drifting bit of seaweed, and often beneath turtles at sea we saw schools of small fish seeking sanctuary as they would under a log. Shark-suckers frequently attach themselves to the under shell, and parasitic crustaceans skitter about on the rough skin of neck and tail.

In a hasty search of a score of volumes I find that

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eighteen credit the green turtle with an exclusively vegetarian diet. Yet this single specimen which we examined had the stomach crammed with more than four hundred delicate, transparent, gelatinous firolas, or shell-less flying snails, as innutritious food to our minds as could be imagined. In addition there were twenty-eight small scarlet lobsters.

Sometimes the launch would pass a happily mated floating pair of turtles when a third jealous element would shoot full speed at the objects of his divided emotions. If his trajectory was poor and he aimed too high, he would scrape clear across and over them and roll back into the depths, like a missed tackle in football. Or the edge of his shell would strike straight and fair with an audible smack, and all three would heel far over and go down slowly by the stern.

A further stage in this procreative programme was revealed when I went ashore on Clarion on the sixteenth of May. On a wide extent of sand to the east of our landing place were about forty turtle tracks made during the previous night. Above high tide it was difficult to distinguish the more recent marks from the palimpsest of the preceding nights, but between tides the sand had been swept clear of all old records.

At first glance the beach seemed to have been traversed by a brigade of baby caterpillar tanks, but close examination revealed an unexpected intricacy

and beauty of design. The maximum width of the larger tracks was nearly three feet and detailed comparison of ten or twelve showed very little variation. Shorter or greater length of successive units of the pushes probably indicated varying degrees of haste. (Fig. 23.)

The outermost pattern was made by the fore flippers which alone provided the means of propulsion on land. Each effort resulted in a delicately incised loop, all of these being so perfectly connected that they formed an unbroken scroll or series of lunules. These were exactly like the conventional waves in old Egyptian and Chinese paintings. Each wave consisted of twenty or thirty fine, concentric lines, indications of the scales in which the flippers were incased.

Next inside the tracery of the swimming or pushing paddles were the deep, parallel furrows caused by the boundary of the elevated central portion of the plastron, punctuated by successive indentations of the edges of the dragging hind flippers. From ridge to ridge in the centre of the trail was a smooth zone about eight inches wide, caused by the continuous pressure of the flat mid-plastron region. The only mark on this smooth, narrow path was an occasional nick, looking somewhat like the slight flick of a finger in soft sand, a tiny snow-shoe track or tear-shaped impression. This showed where the tip of the tail rested between every push. It must have been lifted

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clear at each shove for the intervening spaces were immaculate.

After dinner, in company with the two Samoans, I left the *Zaca* and went on shore, and for two hours nothing but turtles filled my consciousness. It was almost dark before the launch cast us loose and the two men began to row landwards. I looked ahead and saw the north star just topping a distant, thousand-foot mountain, while straight behind was the *Zaca* with her two mast lights. Delicately balanced on the tip of the taller was the base of the Southern Cross.

The roar of the surf to right and left was deafening, and soon we began to rise and fall on successive swells. The rowers hung quietly for a time, then choosing a propitious wave, they pulled with all their strength, and rising high in the air we slithered swiftly in. A second momentary balance and the giant Frank Taiga lifted and carried me over and through the beach smother as if I were some light bundle. On the next great wave the dory was launched again and in the dim light we watched it and the solitary rower rise and fall, again and again, so steeply that capsizing seemed inevitable.

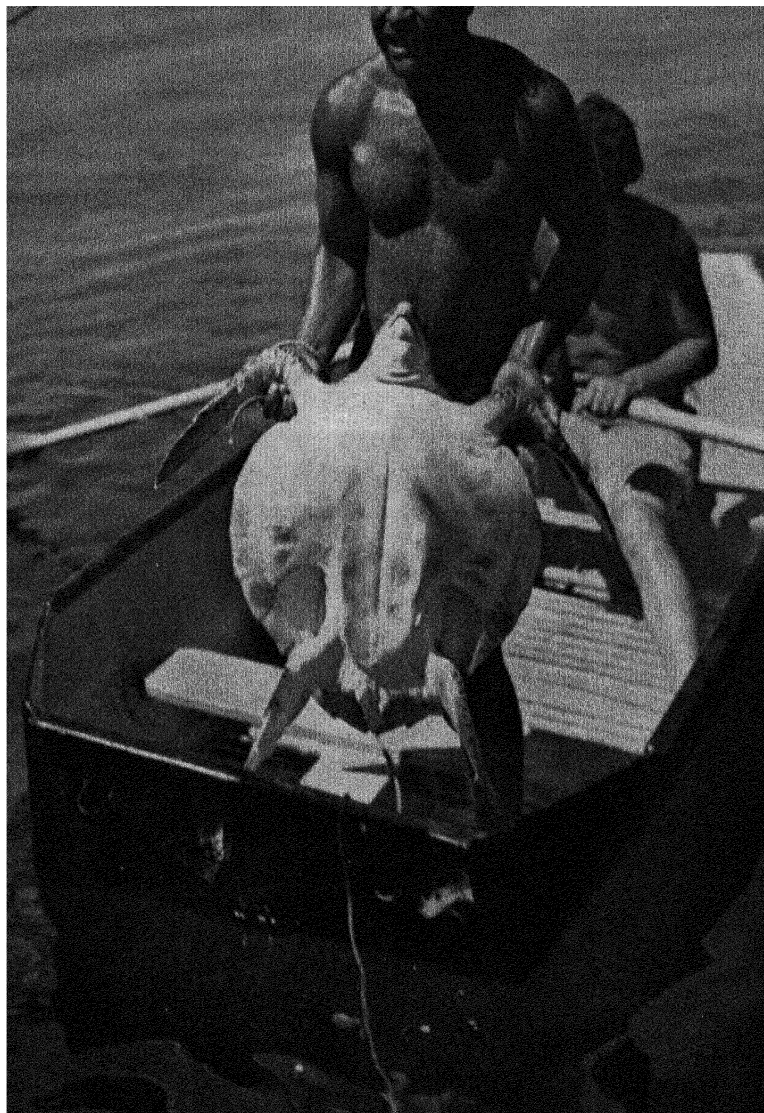
By the light of two acetylene lanterns we started eastward along the beach. After a few steps the lights had to be extinguished, for none of us could stand the sandflies. They came by billions, entering ears, nostrils, eyes, and filling our clothes. They did not bite but just suffocated us. The lanterns were actually

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hazy in the dense mist of the creatures. They covered my bare arm like a prickly sweater. The flashlight did not attract them so much, but wherever I turned it weird shadows swept over the white coral—magnified images of the individual minute midges which were actually on the glass. These insects should by rights be called coralfies, for the moment we stepped on to the sandy part of the beach they vanished. Lights or no lights, as long as we were on the broken coral the midges made life unbearable.

We walked on, flashing the light all around. Not far from the water on the black lava I saw a small dark brown snake. It seemed to be unlike the one I had found in daylight, having lines of black spots on the body, so I picked it up and cached it inside my shirt. We had to watch our way over the huge scarlet grapsus crabs which never moved from our path. When I reached down and patted them, it disturbed them not at all.

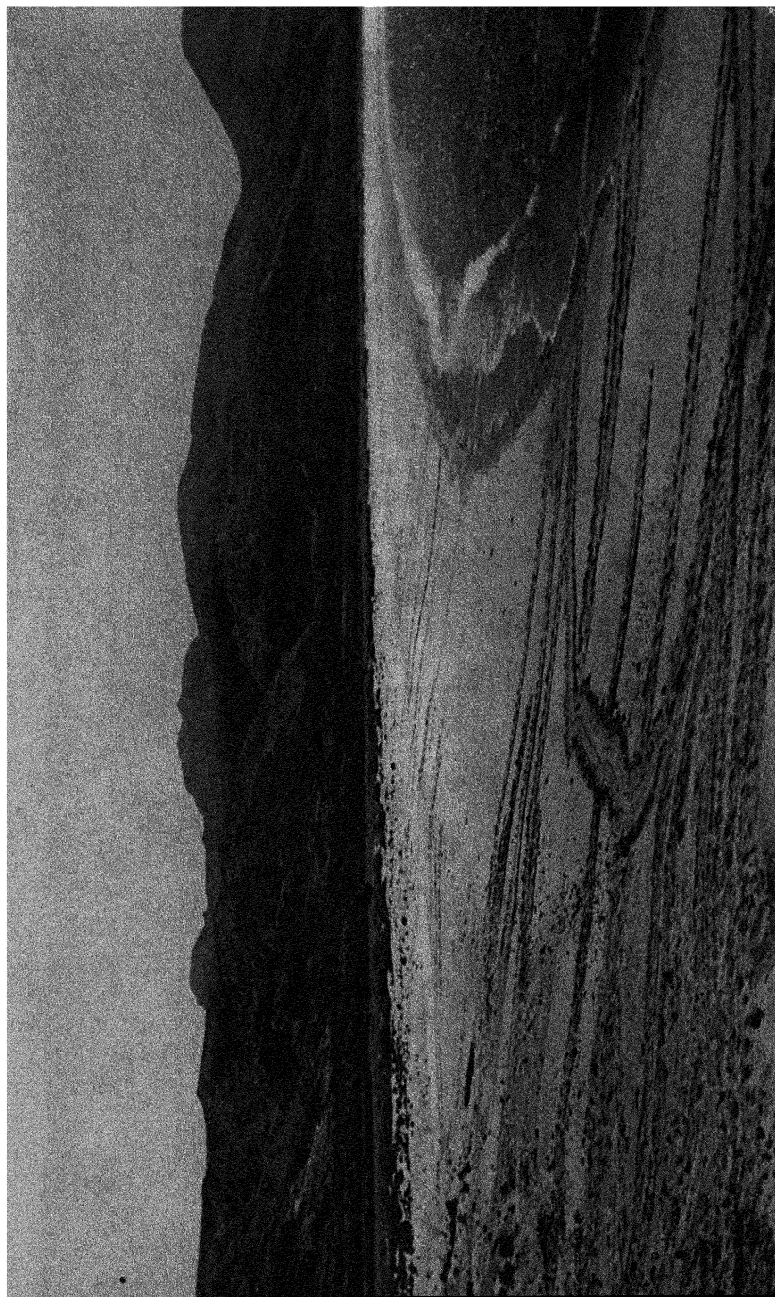
After climbing over the second out-jutting dyke of lava, we came to the real sand beach, where at once we discovered fresh tracks, and a few yards from the rocks we found the first turtle. In a few minutes we had counted thirteen. Two were still in the surf, the tide having begun to go down. Others were halfway up. I watched them carefully. They would make about three lunges with both fore flippers simultaneously, the hind ones remaining practically helpless, and each effort gained about



MAN VERSUS TURTLE. *Frank, the Samoan, dived overboard, swam beneath this turtle and caught it in the open sea with his bare hands. (22)*

{Overleaf.

TURTLE BEACH. *Daylight reveals the track of the turtles made the preceding night. Hundreds of eggs are now safely hidden beneath the sand at the top of the beach. (23)*



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eight inches. The fresh tracks at night looked exactly as I have described them, with double, deep central furrows and a regular succession of lateral patterns on each side, the mark of the hind flippers being absorbed in the larger impressions of the fore. (Fig. 23.)

Nine turtles were at the summit of the beach and either resting from their herculean labours of pushing up through the soft sand, or actually at work. The first process was to sink themselves in a fairly deep hollow below the surface. This was done by lowering the head and jamming it into the sand, making swimming motions, very deliberately and simultaneously, with both front flippers, and then doing the same with the hind ones, although these limbs worked alternately. When this had been kept up for a while the turtle was almost suspended upon an isthmus of sand connecting two side cross bridges, with the sand swept away fore and aft, making an hour-glass figure of sorts. After a rest the right or the left front paddle would work at the same time as the opposite one at the posterior end of the turtle, resulting in a revolving motion, first to one side, then to the other, until the hour-glass had been changed into a circular pit with the great reptile balanced on a central projection. After, at the most, a half dozen efforts, the turtle always rested for a considerable time, evidently exhausted.

The whole thing was astonishing when considered

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in the abstract: this enormous creature, weighing several hundred pounds and spending its whole life in a medium which supported a considerable percentage of its weight, suddenly to swim ashore and to gouge a way through soft, clogging sand, and dig itself in at the top of the steep beach. Its flippers, head, and back, and even its eyes were covered with sand. The exchange of the all-supporting water for the thin air and the obstructing sand would seem to offer almost insurmountable obstacles to the accomplishment of the most important and vital act of its life.

By studying six or eight individuals which happened to be at different stages of the operation, I was able to visualize the whole sequence. After establishing itself more or less horizontally in a well-excavated depression, the next phase began; the scooping out of the hole into which the eggs would be poured. Three turtles were in the midst of this particular activity and unless I had seen that it was almost identical in each case I should have been tempted to endow the first with incredible skill and intelligence. It must be remembered that no turtle of this species can by any possible chance ever see its own tail or hind flippers. In the turtle at work, furthermore, the head was always lowered and, with eyes fast shut, was jammed tightly against the side of the hollow, helping to give leverage and stability. The egg hole of the turtle under considera-

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tion was already about twelve inches deep with perpendicular walls less than eight inches across.

The operation is extremely difficult to describe owing to its intricacy. The hind flippers alone function, while the fore limbs, head, and body are perfectly immovable, and might just as well belong to some wholly alien sleeping organism. One flipper is tightly pressed against one side of the hole just at the surface of the sand. The other is delicately raised and the tip curled inward as our four fingers can be brought around to the palm. The whole flipper is then lifted and with an exquisite accuracy as if gauged by keen eyesight, and as perfect efficiency as if guided by a superbly working machine, the folded webbed fingers are lowered into the centre of the hole to the bottom. When the sandy surface is encountered, the flipper unfolds and the tip pushes gently down and down, not with an awkward shove or marked muscular effort, but with several gentle insinuating motions until the tip is buried several inches. Then the hand-like organ again bends around and starts upward with a good fistful of sand. This is not only lifted but it is completely enclosed, hardly a grain being lost, and as it rises, the whole limb executes a twist and turn which one would never think possible when the ordinary oar-like function is considered. The twist is so complete that when a final flick throws away the load of sand, it is sent directly backward parallel with the side of the turtle and

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far away from the excavation. This ensures that none shall fall back.

But meanwhile there is the opposite side of the hole to consider. Throughout the manoeuvre of, let us say, the left foot, the right has been pressed flat against the opposite upper edge of the hole, holding back any possible sand slide. But in spite of all, a certain amount of sand has drifted down on top of the flattened foot. To cope with this, the moment after the left flipper has cast away its load, the right one snaps up and forward, scattering its adventitious covering of sand far forward toward the head. The latter motion is instantly succeeded by the rolling up of the fingers and the descent into the hole, repeating to the finest detail the elaborate manoeuvre of its fellow. The left flipper, in its turn, is now pressing back its edge of the hole, and the sequence is complete.

But this is far from the whole tale, and occasional phenomena intrude themselves, adding, if such a thing were possible, to the wonder and mystery of it all. The sand is more or less dry and crumbly, and even the instinctive skill of a mother chelonian might not be able to keep the hole symmetrical to a sufficient depth were it not that when needed a fine shower or mist, not of urine, but of clear water, is sprayed over walls and bottom. This miracle keeps the sand in a condition of slight moistness, insuring sufficient cohesion and diminishing the possibility

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of collapse of the walls. Next morning, even with the greatest care, we were unable to excavate a hole of corresponding size without continual sand slides, and this with the use of eyes and hands and all our exalted intelligence.

As long as we directed our light at the posterior part of the turtle it kept up the work, but a continued flash into its half-closed eyes made it stop and lift its head. This, with an elaborate swallow of air, was all that the reptile could summon as an expression of surprise—perhaps the turtlean equivalent of ‘What an amazingly short night!’

When we encountered an animal crawling up the beach, a short stop and examination would work no change in the machinery of its journey, but if we annoyed it or tapped the shell, it turned about at once and with increased lunges made straight for the water. No efforts on our part could alter this going into mental reverse. As far as we could see, the night’s operations were at an end. Every turtle I sighted seemed like a great rounded piece of lava which had worked its way up through the sand. I have never seen less organic beings. Pemasa rolled one over when it waved its flippers once or twice in mid air and then resigned itself to this new fate. No stone-turning creatures or leverage phenomena had ever before entered its life or those of the tens of thousands of its maternal ancestors, and it knew no solution. It was well above the highest of tides; the

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next day's sun would bake it and soon death would come, within a few yards of its watery home. After I examined it we canted it back and it lay as inert and passive as if nothing had happened. Perhaps the dragging thoughts in the dull brain were still on hole digging, and had not yet caught up with the fact of revolution. Resentment of that might come later.

One turtle halfway up the beach showed signs of recent combat, either with creatures such as sharks or with a rival of its own kind. The shell was badly dented at one place and the neck bitten. On the top of the head was a single huge white barnacle, slightly tilted to one side, absurdly like the tiny fool's caps which clowns sometimes wear, all the funnier on this eternally emotionless creature. On the carapace a cluster of the same crustaceans was thriving. Two of these we pried off, the slight scraping being sufficient to send the turtle scampering down the beach—using the word as defined in chelonian parlance.

These turtles were three feet or more in length, deep in proportion, and had endured life for perhaps many scores of years, but even they were vulnerable to what we are pleased to call natural causes, and at the farthest end of our nocturnal walk there loomed a huge form in the surf lying side on to the beach. I went close to it as the waves receded and saw that it was long dead, but even now it held a position

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that no other four-footed vertebrate would hold in death—the head down on the sand and the two fore flippers folded forward alongside it, as a dog will sometimes lie facing the fire in sleep. The shell showed no signs of violence. Perhaps this individual had succumbed to some internal parasites.

One of the turtles busily digging at the top of the beach had lost a large piece out of the right hind paddle and although its brain knew nothing about it, this flapper was excavating much less effectively than the left. At first, the hole was slightly unsymmetrical, but as I watched, I could see the perfect flipper taking on more and more work, exceeding its share of half the labour, and the final sweep of my flashlight revealed an excavation round, deep, and perfectly moulded. Instinct and adaptation are more mysterious than all our modern explanations would have us believe.

Before I left for good I went off by myself and watched the largest and oldest turtle. Here, hundreds of miles from the Mexican coast, it was laying its eggs. At the same time others were similarly occupied on distant beaches of Australia, while during the coming months of summer, individual green turtles would drift up New York Bay and direct their dim vision to the towers of the city itself. Sand-clogged eyes, almost closed nostrils, motionless for limbs—these showed no signs even of passive vitality in the great beast before me. Yet its heart-shaped, low-

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arched shell was streamlined for swift motion, its flippers as cunningly moulded as the fins of shark or swordfish. So all-important are these organs that in a newly hatched turtle, like the legs of new-born colts, the flippers are of extraordinary length, as long as the entire body.

On each forward paddle of this turtle there remained only a single claw to recall lizard ancestry, but beneath the thin scaly skin were gloved five fully-boned digits to separate forever this reptile from even the most highly developed fish.

The last flash of my light showed the turtle digging, digging, without cessation, mechanically as if controlled and motivated by some auxiliary caudal brain of superreptilian intelligence, missing hardly a grain, moulding a smooth, round womb in the sand, which would receive the ova and ensure the moisture, warmth, and safety necessary for the development and hatching of a new generation.

Here and there on the beach ghostly boobies appeared within the circle of our lights. Some at the edge of the bushes were sound asleep, balanced on a weather-worn coral rock, standing on both legs with beak buried deep between the wings. Even with the light six inches away they were not aroused, but at the startled grunting squawk of a distant bird they instantly became fully awake. The glare did not frighten them even then and they could see nothing of us, so they remained quiet and stared. Whenever

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we patted one gently on the head it would skitter along the sand for a few yards and then, boomerang-like, return to our feet. One devoted pair, which refused to be roused, were sitting close together upon two extremely unpleasant-looking, newly hatched chicks.

Giant red-brown crickets crawled but never jumped about the sand, and once I heard a Clarion wren singing sleepily from a clump of great lava rocks among the cactus. The night life of this isolated island was not greatly varied, but exceedingly strange, with the juxtaposition of a thousand thousand midges, eleven labouring turtles and the peppering of rocks and sand with great scarlet crabs.

Pemasa, the Samoan, told me many interesting things about the turtles. It seems they often dig several false holes, night after night, and leave them gaping, finally to go to some inconspicuous place beneath a small bush to deposit the eggs. After the laying is completed the turtles go away and do not return until the day of hatching, when they come back and lie offshore waiting for the scrambling host of turtlings to reach the water, not, as I asked, to guard them in any way, but most horribly to devour them. I am glad to say that I believe this to be quite devoid of scientific truth. It recalled Pliny's unforgettable paragraph on sea-turtles written more than eighteen centuries ago. Philemon Holland quaintly renders this: 'In the sea they live of muscles, cockles and

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such small shell fishes, for their mouths are so hard that they be able to crush and breake stones therewith. Their manner is to go aland, where among the grasse they lay egges as bigge as birds ege, to the number commonly of an hundred. When they have so done, they hide them within the earth in some little hole or gutter, fare enough from any place where the water cometh, they cover them with mould, beat it hard downe with their breast, and so pat it smooth, and in the night time sit up them: they couvic a whole yeare before they hatch. Some say, that the looking wistly upon their egges with their eeyes serveth instead of sitting.' Pliny continues, 'The female refuseth any intercourse with the male untill he has placed a wisp of straw upon her back.'

A pleasant account is that of Topsell, penned a mere three centuries ago: 'Some againe say, that after they have hidde their Egges in the earth for forty dayes, the Female cometh the just fortieth day, not fayling of her reckoning, and uncovereth her Egges wherein shee findeest her young ones formed, which she taketh out as joyfully as any man would do Gold out of the earth, and carryeth away with her to the Water.'

Pliny's last words are too good to omit, exceeding even his credulity: 'And although it bee incredible and not to be spoken, yet some there be who have written, That any ship maketh way more slowly

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at sea, that carrieth within it the right foot of a tortoise.'

Let us return for a moment to the fate of the newly hatched turtles. The horror and disbelief aroused in my mind by the suggestion of wholesale infanticidal cannibalism on the part of the mother turtles are, as a matter of fact, a reaction of alien anthropomorphic emotion on my part, and only of hypothetical interest to the young reptiles themselves. If fifteen hundred emerge and scramble down the beach, representing the offspring of my eleven egg-laying females, it is certain that fewer than twenty-five will ever live to become adult. Whether they will slip down the eager maw of fish or shark, gannet or cormorant, sea-lion or porpoise, or actually satisfy the momentary appetite of their own parent is hardly of more than theoretical concern to the subjects of the bill of fare.

We had apparently reached Clarion at the very height of the breeding season of the green turtles, for the offshore water was fairly dotted with them at times, the majority mating, three pairs sometimes being seen in close proximity. During several hours of trolling one day, we sighted more than fifty turtles of which about forty were engaged in courtship activities.

When we returned to the landing beach and flashed signals to the *Zaca* the breakers were crashing in quick succession. We watched the small black

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dot of the dory coming closer and closer. In a brief respite of relative calm when there seemed to be a wave missing from the eternal sequence, the boat shot in, we tumbled aboard and dived immediately into six huge rollers, our bow rising so high that it pointed full at the head of Scorpio. But we reached the yacht without shipping a drop.

An hour later when I was in the cabin writing out these experiences, I was called on deck. The gibbous moon was well up, but still stained with the orange of its rising, while the water had suddenly calmed and completely lost its heaving swell. *Zaca* and the pacific-with-a-little-p ocean, and the dim isle of Clarion were all equally soundless and quiet. I looked ashore and tried to imagine that unimaginable scene in the heart of the distant sand, nine great turtles lying prone, with head, brain, and front limbs apparently wholly ignorant of the mysterious activities and finished craftsmanship of their busy hind flippers.

At my next formal dinner, when the guests are absorbed in the delicacy of their green turtle soup, I will rejoice in the memory of the brooding turtles of Clarion Island.

APPENDIX A

PUBLISHED SCIENTIFIC ARTICLES RELATING TO THE ZACA EXPEDITION

1. INTRODUCTION, ITINERARY, LIST OF STATIONS, NETS AND DREDGES. William Beebe. *Zoologica*, New York Zoological Society, 1937, vol. xxii, pp. 33-46.

2. SIX NEW BRACHYURAN CRABS FROM THE GULF OF CALIFORNIA. Steve A. Glassell. *Zoologica*, 1936, vol. xxi, pp. 213-218.

Summary: The following new species of true crabs are described: *Mithrax* (*Mithrax*) *mexicanus*, *Stenocionops beebei*, *Actaea crockeri*, *Pilumnus pelagius*, *Chasmocarcinus ferrugineus* and *Cymopolia zaca*.

3. BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA. Jocelyn Crane. *Zoologica*, 1937, vol. xxii, pp. 47-78.

Summary: Seventy-three species of true crabs are recorded, of which one is described as new and sixteen have not been previously recorded from the Gulf of California. Numerous field notes concerning colour, food, habitat, and egg counts are included.

4. PORCELLANID CRABS FROM THE GULF OF CALIFORNIA. Steve A. Glassell. *Zoologica*, 1937, vol. xxii, pp. 79-88.

Summary: Eleven species of porcelain crabs are recorded, including two new species. New locality records are noted, extending the known ranges of several species both geographically and bathymetrically.

5. A NEW CHRYSOMELID BEETLE OF THE GENUS *MONOXIA* FROM LOWER CALIFORNIA. Doris H. Blake. *Zoologica*, 1937, vol. xxii, pp. 89-91.

Summary: This is the description of *Monoxia beebei*, the beetle which occurred in thousands on Santa Inez Island.

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6. OXYSTOMATOUS AND DROMIACEOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA. Jocelyn Crane. *Zoologica*, 1937, vol. xxii, pp. 97-108.

Summary: Of the seventeen species of box, sponge-carrying and other specialized crabs recorded, the majority have previously been known from only one or two specimens. Observations on colour in life, food notes and egg counts are included in many instances.

7. CARIDEAN DECAPOD CRUSTACEA FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA. Fenner A. Chace, Jr. *Zoologica*, 1937, vol. xxii, pp. 109-138.

Summary: The twenty-nine species of caridean shrimps recorded include one new genus and nine new species. Two of the latter were taken from the stomach of an American Eared Grebe. Of the remaining twenty known forms, nine had not been previously recorded from the region visited by the expedition. Of these nine species, four were entirely unknown to the fauna of the Pacific coast of America; two of the four were described from the tropical Atlantic and the other two are Indo-Pacific varieties. Colour notes made in the field are included.

8. POLYCHAETOUS ANNELIDS FROM THE WEST COAST OF LOWER CALIFORNIA, THE GULF OF CALIFORNIA AND CLARION ISLAND. Aaron L. Treadwell, *Zoologica*, 1937, vol. xxii, pp. 139-160.

Summary: Seven new species are included in this collection of thirty-four species of segmented worms.

9. HOLOTHURIANS FROM THE GULF OF CALIFORNIA, THE WEST COAST OF LOWER CALIFORNIA AND CLARION ISLAND. Elisabeth Deichmann. *Zoologica*, 1937, vol. xxii, pp. 161-176.

Summary: The fourteen species of sea cucumbers recorded include five new species and six which have had their geographical distribution greatly extended. Only three were already known from the region explored.

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10. ECHINODERMS FROM THE WEST COAST OF LOWER CALIFORNIA, THE GULF OF CALIFORNIA AND CLARION ISLAND. Fred C. Ziesenhenné. *Zoologica*, 1937, vol. xxii, pp. 209-239.

Summary: This collection of starfish, sea urchins and serpent stars consists of sixty-five species, of which two are new and many others rare or little known.

11. HERMIT CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA, Steve A. Glassell. *Zoologica*, 1937, vol. xxii, pp. 241-263.

Summary: Of the twenty-six species of hermit crabs included in the collection, eight are new. A number of new locality records are given, some extending the known range nearly twenty degrees of latitude.

12. SERGESTIDAE (CRUSTACEA DECAPODA) FROM THE LOWER CALIFORNIA REGION, WITH DESCRIPTIONS OF TWO NEW SPECIES AND SOME REMARKS ON THE ORGANS OF PESTA IN SERGESTES. Martin D. Burkenroad. *Zoologica*, 1937, vol. xxii, pp. 315-329.

Summary: Of the six sergestid shrimps included in the collection, two are described as new species, while two others have never before been completely diagnosed.

13. PENAEIDAE FROM THE REGION OF LOWER CALIFORNIA AND CLARION ISLAND, WITH DESCRIPTIONS OF FOUR NEW SPECIES. Martin D. Burkenroad. *Zoologica*, 1938, vol. xxiii, pp. 55-91.

Summary: Of the seventeen or eighteen species of peneid shrimps represented in the collection, more than half were previously known incompletely if at all. Five species, of which three are new, have not heretofore been recorded from Pacific America. Five other species have previously been known only from juvenile species or from a single sex.

SCIENTIFIC PUBLICATIONS OF THE EXPEDITION

SCIENTIFIC REPORTS IN PRESS

CORALS AND SEA-FANS. Dr. E. Deichmann. Museum of
Comparative Zoology, Cambridge, Mass.

MOLLUSCA. Drs. Hanna and Hertlein. California Academy
of Sciences, San Francisco, Cal.

FISH. Dr. Beebe and Mr. Tee-Van. Department of Tropical
Research, Zoological Society, New York City.

APPENDIX B

TEXT IDENTIFICATIONS

PAGE	LINE	
I	8	Slender Snipefish, <i>Macrorhamphosus gracilis</i> (Lowe)
4	23	Third Volume of Voyages gathered by M. John Baptista Ramusio
11	1	Cedros Island Deer, <i>Odontocoelus cerrosensis</i> (Merriam)
11	1	Cedros Island Rabbit, <i>Lepus cerrosensis</i> (Allen)
11	19	Brittle Stars, <i>Ophiura lütkeni</i> (Lyman)
11	20	Club-spined Urchin, <i>Lytechinus anamesus</i> (H. L. Clark)
11	22	Thorny Oyster, <i>Spondylus crassisquama</i>
12	21	Kelp, <i>Macrocystis pyrifera</i>
12	27	American Egret, <i>Casmerodius albus egretta</i> (Gmelin)
14	1	Willet, <i>Catoptrophorus semipalmatus inornatus</i> (Brewster)
19	3	Bryozoa, <i>Tubulipora pacifica</i> and <i>Tubulipora pulchra</i>
20	18	Kelp Isopod, <i>Pentidotea resecata</i> (Stimpson)
21	3	Naked Mollusc, <i>Flabellina</i> and <i>Archidorois</i>
21	18	California Bonito, <i>Sarda lineolata</i> (Girard)
25	1	Black-footed Albatross, <i>Diomedea nigripes</i> (Audubon)
34	23	Herring Gull, <i>Larus argentatus smithsonianus</i> Coues
37	24	Eared Grebe, <i>Colymbus nigricollis californicus</i> (Herrmann)
38	7	Brandt Cormorant, <i>Phalacrocorax penicillatus</i> (Brandt)
40	28	Surf Scoter, <i>Melanitta perspicillata</i> (Linnaeus)
40	28	Lesser Scaup, <i>Nyroca affinis</i> (Eyton)
41	1	Western Gull, <i>Larus californicus</i> (Lawrence)
41	2	Western Raven, <i>Corvus corax sinuatus</i> (Wagler)

TEXT IDENTIFICATIONS

PAGE	LINE	
42	9	Pacific Sail-fish, <i>Istiophorus greyi</i> (Jordan and Hill)
42	11	Blackfish or Pilot Whale, <i>Globicephala scammoni</i>
44	11	Pacific Sea-lion, <i>Zalophus californianus</i> (Lesson)
44	14	California Brown Pelican, <i>Pelacanus occidentalis californicus</i> (Ridgway)
45	12	Northern Frigatebird, <i>Fregata magnificans rothschildi</i> (Mathews)
50	25	Yellow-fin Tuna, <i>Neothunnus macropterus</i> (Schlegel)
50	25	Skipjack, <i>Katsuwonus pelamis</i> (Linnaeus)
51	19	California Sardine, <i>Sardinops caerulea</i> (Giard)
56	26	Sea Pansy, <i>Renilla edwardsii</i> (Herklots)
58	9	Black Angel-fish, <i>Holocanthus passer</i> (Valenciennes)
58	10	Polkadot Blue Puffer, <i>Tetraodon setosus</i> (Rosa Smith)
58	26	Sunstar, <i>Heliaster kubiniji</i> (Xantus)
59	13	Parrot-fish, <i>Pseudoscarus perico</i> (Jordan and Gilbert)
59	23	Yellow-tailed Surgeon-fish, <i>Xesurus punctatus</i> (Gill)
60	2	Burrowing Eels, <i>Taenioconger digueti</i> (Pellegrin)
60	27	Crocker's Blenny, <i>Acanthemblemaris crockeri</i> (Beebe and Tec-Van)
63	22	Dolphin, <i>Delphinus delphis</i> (Linnaeus)
67	18	Striped Marlin, <i>Makaira mitsukurii</i> (Jordan and Snyder)
76	8	Bay Shark, <i>Carcharias aetholrus</i> (Jordan and Gilbert)
76	24	Crevallé, <i>Caranx caninus</i> (Gunther)
78	21	Pacific Amberjack, <i>Seriola colburni</i> (Evermann and Clark)
79	1	Sand Launce, <i>Ammodytes sanlucensis</i> (Beebe and Tec-Van)
79	15	Small Devilfish, <i>Mobula sanlucensis</i> (Beebe and Tec-Van)

TEXT IDENTIFICATIONS

PAGE	LINE	
79	17	Sierra Mackerel, <i>Scomberomorus sierra</i> (Jordan and Starks)
79	18	Red-billed Tropicbird, <i>Phaethon aethereus mesonauta</i> (Peters)
79	18	Black-headed Gull, <i>Larus philadelphia</i> (Ord)
82	23	Great-tailed Grackle, <i>Cassidix m. mexicanus</i> (Gmelin)
85	12	House Finch, <i>Carpodacus mexicanus</i> (sub sp.)
90	2	Northern Phalarope, <i>Lobipes lobatus</i> (Linnaeus)
90	16	Roundmouth, <i>Cyclothone acclinidens</i> (Garman)
90	19	Lantern-fish, <i>Lampanyctus mexicanus</i> (Gilbert)
90	20	Silver Snipe-eel, <i>Serrivomer sector</i> (Garman)
91	18	Brown Booby, <i>Sula leucogaster brewsteri</i> (Goss)
94	11	Gray and Orange Starfish, <i>Oreaster occidentalis</i> (Verrill)
94	25	Scarlet-finned Blenny, <i>Emblemaria micropes</i> (Beebe and Tee-Van)
95	20	Screw Shell, <i>Turritella marmorata</i> (Kiener)
96	15	Banner-finned Blenny, <i>Emblemaria oculocirris</i> (Jordan)
98	21	Triton, <i>Fasciolaria princeps</i> (Sowerby)
99	28	Chub, <i>Kyphosus analogus</i> (Gill)
100	21	Pacific Green Moray, <i>Gymnothorax castaneus</i> (Jordan and Gilbert)
101	11	Osprey, <i>Pandion haliaetus carolinensis</i> (Gmelin)
102	3	Yellow-footed Gull, <i>Larus occidentalis livens</i> (Dwight)
102	12	Curlew, <i>Phaeopus hudsonicus</i> (Latham)
102	12	Turnstone, <i>Arenaria interpres morinella</i> (Linnaeus)
103	4	Inez Island Lizard, <i>Callisaurus draconides carmenensis</i> (Dickerson)
113	3	Inez Jack Rabbit, <i>Lepus californicus</i> (Gray)
113	28	Dwarf Desert Tree, <i>Bursera microphylla</i>
114	15	Red-headed Vulture, <i>Cathartes aura septentrionalis</i> (Wied)

TEXT IDENTIFICATIONS

PAGE	LINE	
115	22	Silver Under-wing, <i>Argynnis</i> (sp.)
117	3	Frigate bird, <i>Fregata m. magnificens</i> (Mathews)
118	11	Transparent Shrimp, <i>Palaemon ritteri</i> (Holmes)
118	17	Great White Heron, Albino San Lucas Great Blue Heron
118	18	San Lucas Great Blue Heron, <i>Ardea herodias sanctilucae</i> (Thayer and Bangs)
118	18	American Egret, <i>Casmerodius albus egretta</i> (Gmelin)
119	18	Golden Grouper, <i>Mycteroperca rosacea</i> (Streets)
119	29	Sergeant Major, <i>Abudefduf marginatus</i> (Bloch)
119	29	Opaleye, <i>Girella nigricans</i> (Ayres)
122	6	Spotted Sting Ray, <i>Urobatis maculatus</i> (Garman)
122	10	Long-tailed Ray, <i>Amphotistius dipterurus</i> (Jordan and Gilbert)
122	17	Gar, <i>Tylosaurus exilis</i> (Girard)
122	18	Half-beak, <i>Hyporhamphus roberti</i> (Cuvier and Valenciennes)
123	15	Moonfish, <i>Selene brevoortii</i> (Gill)
123	23	Puffer, <i>Spheroides annulatus politus</i> (Girard)
124	28	Brown Moray, <i>Gymnothorax dovii</i> (Gunther)
125	5	Lizard-fish, <i>Synodus scituliceps</i> (Jordan and Gilbert)
125	9	Porcupine-fish, <i>Diodon holocanthus</i> (Linnaeus)
125	15	Electric Ray, <i>Discopyge ommata</i> (Jordan and Gilbert)
125	25	Snapper, <i>Lutianus argentiventris</i> (Peters)
126	8	Grunt, <i>Haemulon sexfasciatum</i> (Gill)
126	15	Cardinal fish, <i>Apogon retrosella</i> (Gill)
127	12	Murex, <i>Murex bicolor</i> (Valenciennes)
128	10	Flounders, <i>Etriopus crossotus</i> (Jordan and Gilbert), and <i>Symphurus atrarventatus</i> (Jordan and Bollman)
128	10	Dwarf Gurnard, <i>Prionotus xenisma</i> (Jordan and Bollman)
128	11	Harlequin rock-fish, <i>Prionodes fasciatus</i> (Jerryns)

TEXT IDENTIFICATIONS

PAGE	LINE	
129	20	Yellow-green sea cucumbers, <i>Holothuria zaca</i> (Deichmann)
129	29	Pearl-fish, <i>Encheliophis jordani</i> (Heller and Snodgrass)
131	11	Long-spined Murex, <i>Murex recurvirostris</i> (Brod-erik)
131	21	Turquoise-cyed Hermit, <i>Dardanus sinistripes</i> (Simpson)
133	7	Black Mitre, <i>Mitra zaca</i> (Strong)
134	3	Mexican Lantern-fish, <i>Lampanyctus mexicanus</i> (Gilbert)
138	14	Porpoise, <i>Phocaena</i> (sp.)
142	10	Yellow-fin Tuna, <i>Neothunnus macropterus</i> (Schlegel)
145	8	Cigar-fish, <i>Decapterus scombrinus</i> (Valenciennes)
159	25	Spotted Midshipman, <i>Porichthys notatus</i> (Girard)
159	27	Pearl-bearing Midshipman, <i>Porichthys margaritatus</i> (Richardson)
160	14	Dwarf Lobster, <i>Munida refulgens</i> (Faxon)
160	15	Ocellated Shrimp, <i>Eusicyonia disedwardsi</i> (Burken-road)
160	29	Bubbleshell, <i>Bulla gouldiana</i> (Pilsbry)
162	6	Collector Shell, <i>Xenophora robusta</i>
163	18	Box Crab, <i>Calappa saussurei</i> (Rathbun)
163	29	Serpent Star, <i>Ophiothrix galapagensis</i> (Lutken and Mortensen)
166	5	Whale Shark, <i>Rhineodon typus</i> (Smith)
173	5	Amphioxus, <i>Branchiostoma californiense</i> (Andrews)
174	12	Hammerhead Shark, <i>Sphyrna tudes</i> (Cuvier)
179	27	Luminous Shrimp, <i>Nyctiphanes</i> (?)
183	26	Caracara, <i>Polybarus cheriway auduboni</i> (Cassin)
184	1	San Lucas Ladder-backed Woodpecker, <i>Dryobates scalaris lucasanus</i> (Xantus)
184	2	Western Mocking-bird, <i>Mimus polyglottos leucop-terus</i> (Vigard)
195	26	Sally Lightfoot Crab, <i>Grapsus grapsus</i> (Linnaeus)

TEXT IDENTIFICATIONS

PAGE	LINE	
196	21	White-edged Demoiselle, <i>Microspathodon dorsali</i> (Gill)
197	14	Scorpion fish, <i>Scorpaenodes xyris</i> (Jordan and Gilbert)
202	13	<i>Bregmaceros maclellandii</i> (Thompson)
202	18	Brotulid, <i>Lepophidium emmelas</i> (Gilbert)
203	10	Paper Nautilus, <i>Argonauta pacifica</i> (Dall)
207	11	Dolphin fish, <i>Coryphaena hippurus</i> (Linnacus)
207	18	Mullet, <i>Mugil curema</i> (Cuvier and Valenciennes)
208	7	Flying-fish, <i>Cypselurus xenopterus</i> (Gilbert)
216	18	Lesser Dolphin fish, <i>Coryphaena equisetis</i> (Linnaeus)
219	20	Brown Booby, <i>Sula leucogaster brewsteri</i> (Goss)
221	7	California Flying-fish, <i>Cypselurus californicus</i> (Cooper)
223	17	Kelp fish, <i>Heterostichus rostratus</i> (Girard)
239	9	Clarion Snake, <i>Coluber (Masticophis) anthonyi</i> (Stejneger)
239	11	Coot, <i>Fulica americana americana</i> (Gmelin)
239	13	Clarion Raven, <i>Corvus corax clarionensis</i> (Rothschild and Hartert)
239	19	Clarion Wren, <i>Troglodytes tanneri</i> (Townsend)
239	21	Clarion Dove, <i>Zenaidura macroura clarionensis</i> (Townsend)
239	21	Clarion Lizard, <i>Uta clarionensis</i> (Townsend)
240	8	Blue-faced Booby, <i>Sula dactylatra californica</i> (Rothschild)
242	27	Red-footed Booby, <i>Sula sula websteri</i> (Rothschild)
243	29	Clarion Burrowing Owl, <i>Speotyto cunicularia rostrata</i> (Townsend)
248	12	Black and White Tailed Kuhlia, <i>Kulia taeniura</i> (Cuvier and Valenciennes)
248	15	Abudefduf, <i>Abudefduf marginatus</i> (Bloch)
248	21	Rainbow wrasse, <i>Thallasoma grammaticum</i> (Gilbert)
250	19	Blue Jack, <i>Caranx medusicola</i> (Jordan and Starks)

TEXT IDENTIFICATIONS

PAGE	LINE	
250	20	Orange Angel-fish, <i>Centropyge clarionensis</i> (Gilbert)
250	21	Grouper, <i>Mycteroperca jordani</i> (Jenkins and Evermann)
255	13	Yellow-tailed Surgeon, <i>Xesurus clarionis</i> (Gilbert and Starks)
255	14	Black-lined Surgeon, <i>Acanthurus triostegus</i> (Linnaeus)
256	3	White-scamed Trigger, <i>Melichthys radula</i> (Solander)
260	22	Zebra Goby, <i>Zonogobius zebra</i> (Gilbert)
260	22	Red Coral Shrimp, <i>Crangon ventrosus</i> (H. Milne Edwards)
260	22	Red Coral Crab, <i>Trapezia cymodoce ferruginea</i> (Latreille)
261	1	Green File-fish, <i>Alutera scripta</i> (Osbeck)
261	21	Trumpet-fish, <i>Fistularia</i> (s p.)
264	28	Tiger Shark, <i>Galeocerdo arcticus</i> (Faber)
265	24	Clarion Shearwater, <i>Puffnus auricularis</i> (Townsend)
268	7	Green Chub, <i>Kyphosus lutescens</i> (Jordan and Gilbert)
271	29	Purple-headed wrasse, <i>Thallasoma duperrey</i> (Quoy and Gaimard)
272	13	Long-beaked Butterfly-fish, <i>Forcipiger longirostris</i> (Broussonet)
275	1	Bumphead, <i>Bodianus diplotaenia</i> (Gill)
282	28	Green Turtle, <i>Chelone mydas</i> (Linnaeus)
284	21	Turtle Crab, <i>Planes minutus</i> (Linnaeus)

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