PART I

REVIEW OF ACTIVITIES

July 1, 1962–June 30, 1963

REPORT OF THE CALCOFI COMMITTEE

There is a unique relation between the recreational and food fishing industries, the public and the research organizations in the California Cooperative Oceanic Fisheries Investigations, made possible by the Marine Research Committee of the State of California. The research organizations represent as wide a variety of skills as has ever been brought to bear on fisheries problems.

One of the important contributions of the Marine Research Committee has been the sponsorship of the series of reports, of which this is the tenth. Through this medium some of the scientific results are made available to a rather wide audience. Most of this volume of the Reports is given over to the publication of papers presented at a Larval Fish Symposium, held as part of the CalCOFI Conference at Lake Arrowhead on October 28 to 30, 1963. This is the third symposium that has been published in CalCOFI Reports. The first was the important symposium on "The Changing Pacific Ocean in 1957 and 1958," edited by Sette and Isaacs and published in Volume VII, pp 13–217 (January 1960). A "Symposium on Fisheries Oceanography," edited by Maurice Blackburn, was included in the succeeding volume (Vol. VIII of the Reports, pp 19–74 (January 1961)).

The ocean research conducted under CalCOFI has been coordinated research—hydrographic observations and studies are made concurrently with biological programs. Although this is a logical way of conducting oceanographi-environmental research, it has seldom been attempted in other fishery investigations.

Ocean research at the inception of CalCOFI centered on the environment of the Pacific sardine. We were soon able to demonstrate that it is possible to define and delimit the spawning range and season of a widely distributed pelagic species, such as the sardine and to follow its year by year changes in distribution and abundance. Sardine spawning was found to have both an extensive distribution and a variable one, requiring the systematic coverage of rather extensive oceanic areas off California and Baja California.

This coverage also afforded information on the young of other pelagic fishes in the California Current region—on anchovy, jack mackerel, Pacific mackerel, hake, saury, rockfishes, and flatfishes. In fact, it soon became evident that the surveys were one of the more effective methods available for resource evaluation.

The similarity in the distribution of the eggs and larvae of the northern anchovy and the Pacific sardine was noted early in the CalCOFI surveys. The young stages of both species were distributed mainly between Pt. Conception, California and Pt. San Juanico, Baja California. Although anchovy eggs and larvae were taken more consistently off central and northern California than the young stages of sardine, numbers were few to moderate. The two species had essentially the same spawning distributions.

In the last two volumes of Reports, the CalCOFI Committee has reported on the marked increase in anchovy abundance that has occurred in recent years, and the apparent take-over by the anchovy of much of the ecological niche formerly occupied by the sardine. More information is now available, which strengthens the hypothesis of interaction between these two species.

During the decade of the 1950's, the number of anchovy larvae obtained on CalCOFI survey cruises increased markedly: abundance in 1958 and 1959 was three times as great as in 1951. During the same period the number of sardine larvae decreased, especially after 1954. The ratio of anchovy to sardine larvae was about 3 to 1 in 1951; by 1956 anchovy larvae outnumbered sardine by nearly 10 to 1, and in 1959 by about 45 to 1. During the four quarterly cruises of 1962, there were 80 times as many anchovy larvae collected as sardines. The spring cruise of 1962 (6204–05) yielded the largest number of anchovy larvae ever taken on a single cruise. Based on standard haul totals, the number of anchovy larvae taken on this one cruise was about as great as the total number taken in all cruises of 1956, and greater than the combined totals for anchovy larvae for 1950, 1951, and 1952, so great has been the increase in abundance of this species. Anchovy larvae, as they have increased in abundance, have become distributed over a larger area, especially in the offshore waters off southern California, and have tended to co-occur more frequently with sardines. In 1958, 94 percent of sardine larvae were taken in hauls containing anchovy larvae, and the latter outnumbered the sardine larvae in these hauls by about 10 times. The disproportion between anchovy and sardine larvae had further increased by about 5-fold in the hauls where they co-occurred during the spring cruise of 1962.

Had the CalCOFI research been other than the broadly based environmental program we have followed, it is doubtful whether the interaction between the sardine and anchovy populations could have been

appreciated or documented, nor the associated environmental changes understood.

At the inauguration of the CalCOFI program we wished to test the widely held hypothesis that the marked fluctuations in survival of marine pelagic fishes was controlled by the oceanic environment. Oceanic environmental factors constitute an amorphous assemblage, but the factors usually considered to be the critical influences on the survival of the young stages of fishes include such physical hydrographic variables as temperature, density, turbulence, upwelling, currents, and such broadly-based biological factors as productivity.

The upper mixed layer is the zone in which the eggs and larvae of most pelagic fishes occur, hence is the part of the ocean in which we are primarily interested. In this layer most oceanographic features have one thing in common, they are constantly varying—changing with the season and varying from year to year.

The influence of physical environmental factors, such as temperature on the place and time of spawning of pelagic marine fishes is readily demonstrable. The differences between such years as 1956 and 1958 on the time and place of sardine spawning off southern California are especially striking.

We also began to look at our sardine data from earlier years more critically. It became evident that a large sardine population, such as in the early 1940's, had a depressing effect on year classes. Best survival occurred at middling population size, such as produced the strong 1939 year class. With the increase of the anchovy population it began to appear as though the adult anchovy and sardine stocks were acting together to influence survival in essentially the same ways as had large sardine populations.

This is an environmental influence, but a different and more subtle kind than had originally been envisaged. Instead of some variable physical conditions being the primary factor influencing survival of year classes, the basic agent may be adult filter feeding fishes.

We have now reached the stage in our investigations where we have an exciting and important hypothesis to test—the interaction or competition of pelagic species occupying the same trophic level.

To test this hypothesis we need more precise information on competition between species in the ecosystem. There are a number of gaps in our data that need to be filled. For one thing, we need to sample anchovy eggs quantitatively. The sampling of other stages must also be improved. The technical aspects of sampling are bottlenecks that are being actively studied and have to be solved, if we are to engage in more sophisticated studies of the competition between the young stages of sardines and anchovies. Some of the studies will require carefully planned experiments carried out at sea, others will have to be done under controlled experimentation in the laboratory. For carrying out the latter, it is essential that we be able to rear the larval stages of sardines and anchovies in the laboratory.—*E. H. Ahlstrom, J. L. Baxter, J. D. Isaacs,* and *G. I. Murphy.*

AGENCY REPORT FOR CALCOFI PROGRESS REPORT—VOLUME X

California Department of Fish and Game

The Department through its Pelagic Fish Program conducts research on the pelagic wet fisheries (those canned raw) with emphasis on Pacific sardines, Pacific mackerel, jack mackerel and northern anchovies. The two projects comprising the Program are (i) the Fisheries Investigations Project and (ii) the Sea Survey Project. Our overall objective is, "To assess the size, distribution, and age structure of the sardine, Pacific mackerel, jack mackerel, anchovy and other important pelagic fish populations and to develop an understanding of the dynamics of the populations relative to their management."

Our Fisheries Investigations Project studies the commercial and live bait catches, including sampling for size and age composition, and analyzing catch statistics, to measure trends in the fisheries. These data are necessary to understand population dynamics.

Our continuing catch statistics study includes monitoring, compiling, and editing source data, and determining the amounts and kinds of fish used as live bait.

The four major species, sardines, jack mackerel, Pacific mackerel, and anchovies, are sampled on a continuing basis for age composition to measure the sizes of year-classes in the fisheries. Determining ages for the sardine and anchovy catches is done in cooperation with the U.S. Bureau of Commercial Fisheries. Two publications resulted during 1962–63, and work was initiated to reduce a large backlog of jack mackerel age data.

We continued measuring fishing effort and determining fishing localities by interviewing fishermen and examining log books. Sardine catch-per-effort data for the years 1953–54 through 1959–60 were programmed and run through electronic computers. When these data are fully analyzed, we anticipate preparing a paper describing the results.

Monthly aerial surveys designed to measure the relative abundance and distribution of inshore pelagic fish schools, particularly anchovies, continued. A paper on aerial survey methods, along with data for the years 1954 through 1963, was being prepared.

We also continued a sardine morphometric study to determine if the known races can be separated by measurable physical differences. Measurements and counts have been completed on about 5,000 sardines and the data are being prepared for detailed statistical analyses.

The Sea Survey Project's major effort was directed toward changing the survey's scope from one concerned primarily with sardines to an overall investigation of the organisms in the pelagic environment. Principally, this called for developing new gear that would adequately sample species ineffectively sampled or completely missed in the past. To this end, a midwater trawl with a 50-foot-square mouth opening was designed in August, 1962 and has been used successfully since. The midwater trawl has taken an increasingly important place in our surveys and will be

our principal sampling device in the future, with the previously used blanket-net relegated to a secondary sampling tool. The midwater trawl is already producing much-improved information on the abundance and distribution of anchovies and jack mackerel, as well as being adequate for sardines and Pacific mackerel.

The routine sea survey in the fall of 1962 included three cruises covering the coastal waters from southern Baja California to Point Conception, California. Midwater trawl and night-light stations were occupied throughout this area, with both methods producing similar results. The survey generally found sardines very scarce everywhere, with especially low levels in California and northern Baja California. Fish-of-the-year were virtually non-existent. In contrast, anchovies, both young and old, were abundant everywhere.

In addition to the routine fall survey cruises, some special cruises were made. The first of these was a 30-day trip to Vancouver Island, British Columbia, in July and August 1962. We hoped to uncover some remnants of the sardine stock that once abounded there, and thus determine if they were the same or a different stock than sardines now found in California. Unfortunately no sardines could be located, so the question remains unanswered.

Two other special cruises were made to northern and central California in May and June 1963. These were primarily midwater-trawl surveys to determine what kinds of organisms occupy the pelagic environment there. Interesting hake, osmerid (smelt), and salmon catches were made in northern California. The central California cruise was incomplete because the midwater trawl was lost near San Francisco early in the cruise.

Finally, we started making a detailed analysis of past sea survey data concerning sardines. This work has progressed to the point where area-weighting factors, which reflect the size of an area in terms of the amount of biologically suitable sardine habitat it contains, must be calculated before the data for individual areas can be combined. Once this is done, the sardine populations can be considered as whole units and an analysis can proceed. Attempts thus far to obtain these factors with the aid of a computor have been generally unsatisfactory; therefore, other techniques will have to be considered.

Hopkins Marine Station

In the period July 1, 1962–June 30, 1963, the Hopkins Marine Station of Stanford University has continued to monitor the marine climate and plankton in the Monterey Bay area. Approximately weekly cruises were made on Monterey Bay, daily shore temperatures were reported from Pacific Grove and Santa Cruz, and once a month shore temperatures were taken at selected stations along the coast between Monterey and Morro Bay. The data collected in these operations have been compiled and distributed to interested agencies and individuals in the form of mimeographed quarterly and annual data reports.

California Academy of Sciences

Experimental studies of the natural responses of the Northern Anchovy to light waves were completed and the results of these studies were incorporated in a manuscript in press.

Continuing studies included re-analysis of all data on the responses of sardines and anchovies to electric fields, and the response of these species to vibrations. At certain frequencies the sardine orients itself away from the source and swims away while the anchovy does the opposite.

In cooperation with the California Department of Fish and Game field observations were made on the schooling behavior of a number of pelagic fishes.

La Jolla Biological Laboratory

The La Jolla Biological Laboratory of the U.S. Bureau of Commercial Fisheries is engaged in research on pelagic marine fishes of the California Current system, exclusive of tunas. The laboratory conducts most of its sea programs in cooperation with the Scripps Institution of Oceanography, investigates the age and size composition of sardines cooperatively with the California Department of Fish and Game, and conducts sampling of the sardine fishery of Baja California through a contract with the California Academy of Sciences. The program of broadly-based research includes such varied disciplines as physiology, biochemistry, fish taxonomy, plankton and fish behavior, genetics, biometrics and ecology.

As an integral part of its research program, the laboratory operates the 150-foot research vessel, *Black Douglas*. In fiscal 1963 the *Douglas* was at sea 185 days on four quarterly Cal COFI survey cruises, two resource evaluation cruises and several special cruises for behavior studies, life history studies and problems in quantitative zooplankton sampling.

The *Black Douglas* and the *John N. Cobb* of the Bureau's Branch of Exploratory Fishing and ear Research Base, Seattle, teamed up for two cruises, one in August, 1962, the other in February–March, 1963 to study the composition and abundance of pelagic fish and to evaluate potential commercial fishery resources, especially the Pacific hake. On the second cruise, several areas of heavy hake spawning were located by taking plankton hauls for hake eggs along a predetermined cruise track from the *Black Douglas*. The crew of the *Cobb*, guided by this information, successfully sampled several concentrations of spawning adults at 80 to 180 fathoms below the surface in these localities employing the large Mark II pelagic trawl, which has a mouth opening of approximately 70×80 feet.

During the past fiscal year studies on blood antigens have revealed that in the Gulf of California there is a third subpopulation genetically distinct from the northern and southern subpopulations off the west coast of California and Baja California. The southern coastal population remained off Baja California and did not contribute significantly to the California commercial catch during the 1962–63 season.

A project to determine methods of rearing pelagic marine fish larvae was initiated as part of the physi-

ology program. A pilot study is underway in the Scripps experimental aquarium building, but because of space and equipment limitations, the studies are restricted in scope. Upon completion of the new laboratory with its sea water facilities, this problem will be alleviated. A research program dealing with plankton behavior was begun in the latter part of fiscal '63 with preliminary work on the avoidance of towed nets by zooplankters.

Utilizing a temperature-gradient block, an experimental study was made of the effect of temperature on the incubation time and development of embryos and early stage larvae of sardine and anchovy. It was shown that the anchovy can tolerate and develop normally in water as cold as 11°C, whereas the sardine does not develop normally below 13°C. A comparison of incubation times showed that the anchovy takes somewhat less time to develop to hatching than the sardine at all temperatures.

As part of a study of the energy balance for adult sardines, the physiology program has been studying oxygen consumption and carbon dioxide production of the sardine at different temperatures and under different swimming conditions. A metabolism tank permits the simultaneous recording of carbon dioxide production (measured by changes in pH) and oxygen consumption (measured with an oxygen electrode) in individual adult sardines. Adult sardines do not appear to "rest" but always maintain active swimming movements. Only when fish are severely strained and are unable to maintain headway against a current is there a distinct change in the oxygen uptake.

The study of sardine and anchovy behavior was carried out in a 31,000 gallon tank beneath the the Scripps pier. Observations were made on the quite different types of locomotion of the two species, and on a peculiar driving behavior which has been interpreted as aggressive action by individual sardines. Feeding activities were also studied as well as the initiation of the "feeding frenzy" exhibited by hungry fish. Gaping, or the wide distension of the mouth and gill covers for a few seconds at a time, was periodically exhibited by both sardines and anchovies, often following feeding. The reaction of anchovies to line barriers, made of black thread and translucent nylon monofilament was studied. For the smallest spacing used, 3 inches, the black thread was a more effective barrier than the monofilament.

The distribution and numbers of sardine eggs and larvae in the CalCOFI survey area during 1962 was investigated on four quarterly survey cruises. These cruises cover the spawning distribution of sardines in the eastern North Pacific, exclusive of the Gulf of California.

Sardine eggs were fewest in number and had the most restricted distribution since the inauguration of CalCOFI surveys in 1949; most of them were taken close to shore, at the inner stations on sampling lines. About 80 percent of occurrences were at such stations or within Sebastian Ciscaino Bay (central Baja California). Only about 5 to 6 percent of sardine eggs and larvae were taken off California, the remainder were distributed off Baja California, especially off central Baja California.

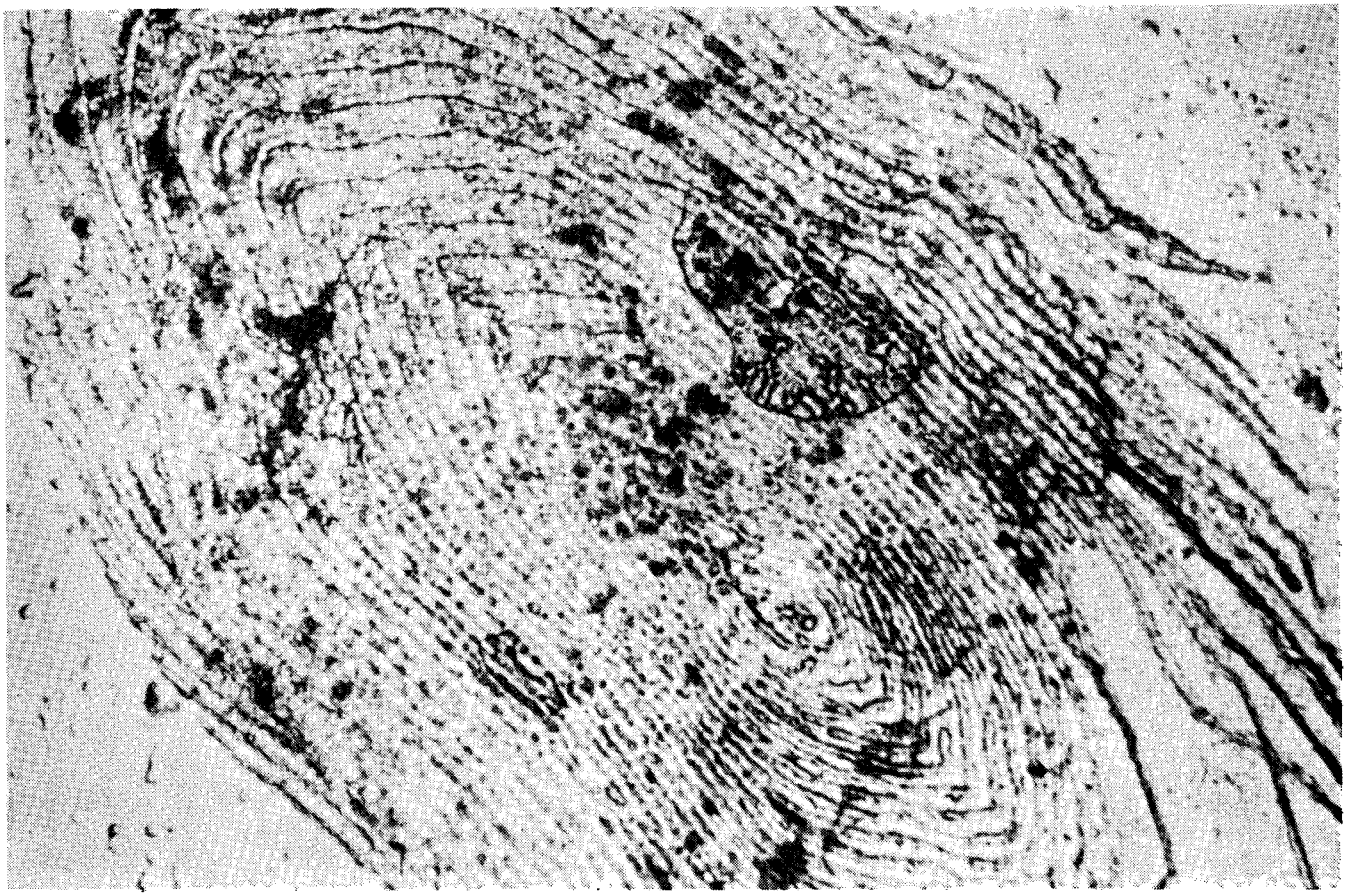
Because of this inshore distribution of sardines, a change has been made in the inshore coverage on CalCOFI survey cruises, beginning with the April-May cruise of 1963. A total of 58 near-shore stations have been added to the inshore portions of the 25 station lines between San Francisco, California and Santa Maria Bay, off southern Baja California (lines 60–140). These stations are spaced within 2 to 4 miles of each other, and the innermost on each line is as close to shore as is compatible with water depth and vessel safety.

The distribution of anchovy eggs and larvae during 1962 offered a marked contrast to the sardine. During the first half of 1962, anchovy larvae occurred in 62% of all plankton hauls taken in the CalCOFI survey area; approximately 95% of the anchovy larvae sampled in 1962 were taken during these two cruises. During the second half of 1962, anchovy larvae occurred in 31% of the hauls, but constituted only 5 percent of the annual total. Anchovy larvae not only occurred in 8 times as many hauls as sardine larvae, but the average abundance per positive haul was nearly 10 times as great. Hence less than 2 percent as many sardine larvae were taken in 1962 as anchovy larvae. Furthermore, anchovy larvae occurred at all except 4 stations where sardine larvae were collected. Wherever sardine larvae presently occur they have to compete with a much larger group of anchovy larvae. The disparity in numbers between the two species was greatest during the first half of the year, and all hauls containing sardine larvae also contained anchovy larvae during these cruises.

Two major projects of the laboratory during the past fiscal year were the planning of a new research laboratory and of a new research vessel to replace the *Black Douglas*. The planning of the new facilities was carried out cooperatively with personnel of the BCF, San Diego Laboratory. The new laboratory, a four-building complex, is being constructed at the north end of Scripps campus on land donated to the Government by the Regents of the University of California. The new research vessel, to be named the *David Starr Jordan* after one of America's leading ichthyologists and first president of Stanford University, will have an overall length of 171 feet and a 36-foot beam. It will be constructed of welded steel with raked stem and transom stern with two partial decks below and two superstructure decks above the main deck. More than a third of the ship's enclosed area will be devoted to laboratories and scientific support areas.

Scripps Institution of Oceanography Marine Life Research Program

The Marine Life Research Program is the University of California, Scripps Institute portion of the California Cooperative Oceanic Fisheries Investigations Program. Its efforts are broadly aimed at achieving an understanding of the currents, chemistry and creatures of the eastern North Pacific. The pri-



Example of fish scales from the sediments of the Santa Barbara Basin. A study of such scales recovered at different depths in these sediments may give insight into the relative abundance and fluctuations of abundance of various fish during the last few thousand years. The microfossils associated with the fish scales may record the way that the ocean currents varied during the same period.

mary efforts of the Marine Life Research Program have been concerned with the near-surface waters of the California Current, but support from the National Science Foundation, Atomic Energy Commission, Bureau of Commercial Fisheries, the Office of Naval Research, the Marine Research Committee, and others, have greatly enriched the Program. This support has enabled the Program to expand, to launch investigations into the parent waters of the California Current, to probe into the deeper waters underlying this area, and to greatly enlarge the repertoire of tools and instruments available for the investigations. In addition, associated programs within the La Jolla complex have developed and have greatly expanded and diversified the inquiries into the eastern North Pacific.

There is a special pertinency in this expansion of investigation into this great oceanic region. As the world's pulse quickens to the increasing exigencies of the problems that beset mankind, there is increasing international awareness of the potential of the oceans to meet human needs. There also is an increasing realization of the challenge that the ocean presents to the human intellect. Thus the years of continuing surveys, studies, analyses, and of advancing insight into this "best understood region of the world's oceans" constitute an immensely valuable base from which to expand new inquiries and to launch new probes.

The following briefly discusses this continuing program and the new directions of investigation, points up some of the important findings, and outlines the directions of future research. Some detailed results are published within these reports and others are published elsewhere, as listed in the publications.

Monthly surveys were conducted for the first ten years of the investigations. In some months these covered the entire CalCOFI area. Since 1961 the principal surveys have been carried out quarterly and with increased range, particularly seaward. These surveys have thus documented the near-surface ciruclation, chemistry and organisms over more than a decade.

The early period of the CalCOFI observations was characterized by surface waters of a slightly lower temperature (especially in spring) than the long-term mean. Much warmer conditions obtained in the latter part of 1957, in 1958, and in part of 1959. This change was the subject of an issue of the Reports (VII). Since 1959 and through the first part of 1963, the surface temperatures have been more nearly normal, that is, instead of the huge areas of above- or below-normal

temperatures that had characterized the warm and cool years, there were many small areas of above- or below-normal temperatures spread irregularly over the region.

The explanation for the variations of surface temperature apparently lies in the behavior of the winds over the North Pacific. During the early period the winds from the north were somewhat stronger than the long-term mean, but in 1957 and 1958 they were weaker than the mean. Since 1959 the winds have varied rapidly and irregularly, and no long periods of strong or weak winds have occurred.

During the persistent "cold" years the zooplankton increased in general abundance and assumed a more northern character. The jelly-like salp dominated the zooplankton in some of these years. In the warm years, there was an influx of more southerly organisms and the proportion of salps greatly decreased. The total volume of zooplankton was reduced but was richer in crustacea and other more substantial organisms.

As discussed in Volume IX of the reports, a policy has been adopted to intensify study of past data and to employ ship time for the investigation of special features and to test hypotheses. The quantity and distribution of many major species from all important groups of zooplankters continues to be studied and reported. The dominant groups of zooplankton, the copepods, has been the subject of special study and an atlas of species distribution is in advanced preparation. A special cruise supported by the Atomic Energy Commission will enable us to explore the distribution of water properties and organisms in the deep water under the California Current.

The Biomass Analysis Laboratory has been organized and work commenced on the analysis of zooplankton from the standpoint of their organic content. Plans for this were discussed in Volume IX of the Reports. The zooplankton are now being measured in a way as measures their effect on the environment as food, grazers, predators and associates in the pelagic milieu. The zooplankton are divided into some twenty-one groups, and by size, and the volumes of the divisions are measured. From these results should emerge an enhanced understanding of the quantity, nature and variation of this important component, and we should be able to evaluate the importance of transport of this organized food into the California Current system.

Understanding of the basic phytoplankton productivity will be greatly advanced by the organization of a new research group fostered by the Institute of Marine Resources and established on the San Diego Campus. This group will carry on productivity and food-chain studies. The Marine Life Research Program will closely cooperate with these investigators in ship operations and has transferred its micro-nutrient work into this new activity.

In like manner a future marine physiological laboratory on the San Diego Campus will greatly enrich the general program in the future.

A new and highly promising line of investigation has been undertaken in the last year. This is an historical study of the California Current system. The investigation has the purpose of reconstructing, as far as is possible, the oceanographic, meteorological and biological history of this region. There are, of course, many reasons to do this. The fifteen years of investigations have revealed some years of sharply differing oceanographic conditions. The nature of the climatic changes and watermasses involved are now sufficiently well understood that unusual observations in the past can now probably be interpreted sufficiently to enlarge our understanding of the long-term conditions and changes.

The historical investigations will be based on two different sources. First, written records of early explorers, survey parties, whalers, galleons, etc. will be studied for the conditions that they reveal. Specific years with unusual events will be particularly sought. There is much to be learned from these records. It is known that rather profound climate changes have occurred, with unusual storms, tropical fish and other remarkable events influencing the coast at least as far north as Central California, in some years.

Intimately tied with this documentary study will be a detailed study of the unusual stratified sediments of the Santa Barbara Basin. These unusual sediments, described by Emery, constitute a "memory" that the ocean possesses of the water masses and creatures that have influenced the coast in the past. To some degree these sediments also record climate changes, such as years of unusual rainfall. They also may tell us something about the variations in the past abundance of fish!

These sediments are apparently deposited very rapidly ($\sim$ 1 mm per year), and the skeletons of the microorganisms from the various water masses have settled to the bottom here and have been preserved. River sediment also is deposited and an early inspection of one core shows many easily identifiable marine fish scales preserved in these annual layers (see photograph). Following an analysis of cores from the Santa Barbara Basin it will be particularly important to find other sediments of this type elsewhere along the coast so that the study can be broadened.

It is not impossible therefore that in the next few years we may be able to develop tools that will tell us much about the variations in climate, in circulation, and in the relative abundance of various fish in this part of the California Current for the last thousand years or so and with almost a year-to-year resolution.

Particularly important will be the relative abundance of different species over the period and the manner in which changes in their abundances are related to the changing water masses.

During this last year considerable progress has also been made in the understanding of the studies of day-caught and night-caught larvae of the Pacific sardine and northern anchovy. This is extensively reported in this volume. From these studies a measure of growth and mortality of sardine larvae is derived that is quite consistent with the spawning success as measured by catch statistics. From this study it may be possible to understand the spawning success

of a pelagic species in the year of spawning rather than by awaiting data collected in later years. The larvae caught in the day are apparently not dead or dying as previously thought, but are a special category of larvae that represent the proportion of the larval population that is being removed by mortality. The are alive and growing. They may be merely less alert, weaker or singly distributed (i.e. unschooled) and hence more readily caught both by the net and by their predators.

Other important indications emerge from this study. The sardine larvae is apparently more successful where they cohabitate with the anchovy than where they are separate. This merely argues that both seek similar "good" conditions. Also, the *mass* of sardine larvae and anchovy larvae appears to increase at a constant rate with age. This argues that the larvae are limited by a fixed rate of food input. Development of instruments has continued during this period. Progress has been made in solving the problems of deep-moored instrument platforms. One mooring in 600 fathoms off La Jolla has now been in for more than one year. Other tests have shown that the weakenesses are being corrected. The recording system is successful and within the next year there will be extensive tests far off shore. It appears that the goal of developing stations that can be moored in 3000 fathoms, that will take hourly obervation down to several hundred meters, and that will survive for six months in the open sea can now be realized.

Several new collecting devices have also been developed for better sampling. This includes an all-plankton netting 10-foot midwater trawl, a new opening and closing net for tandem towing and a current meter that will record currents down to 3000 fathoms for 4 weeks.

This concert of new tools now makes it possible better to explore such regions as the abyssal waters and creatures underlying the offshore portions of the California Current and the great faunal boundaries of the eastern North Pacific where the types of creatures change abruptly.

A special cruise through the North Pacific Current is therefore planned for the coming year to explore the profound boundary between this parent current and the Central Pacific water mass.