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AND OTHER GUYANAS: No. 41.

REVIEW OF MARINE BIOLOGICAL STUDIES
ON THE GUYANA SHELF

by

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Until recently biological research in the sea off Suriname had not received much attention. There was no fishery in the open sea and there was no incentive to investigate this unknown world. But in the last twenty years, experiments have gradually led to serious study of the subject.

Before the second world war, schooner fishing in the open sea to catch red snapper fish, as already carried out off (British) Guyana, was tried by the Curaçao Trading Company in Paramaribo, but this experiment was not a success. During the war, a study of the local fisheries became urgent, to find out how far Suriname was able to supply the people with protein food.

Between the years 1942 and 1945 I had the pleasure of making a survey of the local fisheries established along the seacoast. At the same time material of the commercial fish species was collected. The fishing techniques employed were: long line fishing (cadell) and fishing with Chinese seines (fish traps) in the estuaries, whereas staked pin seines were used on the mudflats off the coast. Fishing with small seines in the brackish water lagoons and further inland in the freshwater swamps, proved to be well developed. Of this survey six reports were made for the Government, dealing with the methods of fishing and their results and the main ecological factors of the fishing grounds. An account of a lecture on this subject delivered to the Foundation for Scientific Research in Suriname and the Nether-

lands Antilles in Utrecht, a short study of the fisheries in Suriname was published in the Society's annual report for 1946-48 (GEIJSKES 1948). The results of a study of the collections of commercial fish species of Suriname was published by Dr. M. BOESEMAN (1948), curator of fishes in the Leiden Museum.

The publication of these data led to the founding of the Fishery Service in Suriname in 1949 by the help of the Welfare Fund. Mr. E. J. REIJNTJES, the first Director, propagated fishing in swamps and fish culture in lagoons. After him in 1953, Mr. H. LIJDING tried to trawl in the sea outside the estuary of the Suriname river. In spite of insufficient equipment and a too small boat, the hauls were encouraging. These experiments were continued in the following years, with a special look out for shrimps. It soon became evident that the fish fauna and that of the shrimps in deeper waters was different from those near the coast. Shrimping for seabob, a smaller species, proved to be possible the whole year around, but some times the catches were mixed with low percentages of larger shrimp species. These probably came from deeper waters, but the explorations were limited by the small trawler, powered only by a 40 h.p. motor. Nevertheless these trips brought in many species of sea fish not known before from Suriname. Some notes on these were published by BOESEMAN in 1956 and 1963.

In the meantime the promising shrimpfishing off the coast of Suriname became known in the U.S.A., where the new possibilities of getting this highly desirable seafood received great interest. At a somewhat premature stage the "Surinam American Industries Ltd." at Paramaribo was formed to work up the shrimps for export to the States. In fact the survey of the occurrence and the quantities of the larger species of shrimps in deeper waters on the shelf, had still to start. This was planned with funds from the Ten Years Project to buy a larger boat. At this proposal Mr. HENRY B. LEE III from Florida, owner of the shrimping trawler "COQUETTE," offered his boat. It was a standard boat, 68 ft long, powered by a 120 h.p. motor. A contract was signed for a period of 90 days trial fishing, to start April 1, 1957. The fishing was to be done along the coast of Suriname to a depth of 30 fathoms. This depth occurs at a distance off the

coastline varying from 54 to 81 miles, occupying an area of about 1100 square seamiles. Later on the survey was enlarged to include the international waters off the coast of British and French Guyana.

The results were satisfactory and the conclusion was: "that the edible fish in the inner strip and the large shrimp in the outer strip, taken in combination, can support a profitable commercial trawling operation of modest proportions" (LEE III 1958). Beside its economic success, this experimental fishing resulted in the scientific observation that "the ocean bottom off Surinam is divided into three distinct strips roughly parallelling the shore and with rather specific depths demarking one from another." These strips are characterized by the natural conditions of the sea bottom and by the population of the fish fauna. The inner strip ranges from the coastline to a depth of 19 fathoms, the middle strip from 19 to 23 fathoms and the outer strip from 23 to a not-yet-known distance over the shelf, but at least to a depth of 40 fathoms, being the maximum depth on which trawling could be done.

The scientific value of this survey was enhanced as a marine biologist was added to this first exploration of the sea off Suriname: Mr. JAMES B. HIGMAN, of the U.S. Fish and Wildlife Service. From 11 May to 18 July 1957 this biologist accompanied the "COQUETTE" on eleven of her eighteen trips. Mr. HIGMAN collected carefully the species of fish and shrimps trawled and as far as the circumstances permitted, also other animals such as crabs, echinoids, molluscs etc. In his report HIGMAN (1959) gave a more detailed division of the shelf, following LEE III, and he distinguished four natural zones:

(1) "Inshore zone" (0-4 fathoms) with mud banks and the sea like "creamed coffee."

(2) "Intermediate zone" (5-18 fathoms), bottom consisting of soft sticky, grey mud, sea water changes from brown on the inshore side to milky green offshore.

(3) "Shell ridge zone" (19-23 fathoms), rough bottom of dead encrusted shells, dead coral, gorgonids and sponges. This parallels most of the Surinam coast, narrow along the eastern and central coast, widening in the vicinity of the Coppename River but the ridge is disrupted in the vicinity of the Maroni River.

(4) "Offshore zone" (23-40 fathoms) hard bottom consisting pre-

dominantly of grey mud and fine shell and scattered extensive patches of soft blue and black mud. The grey mud bottom is covered with a fine mosslike gorgonid growth. Sea water deep blue, as in the open ocean.

Most of the fish were found in the "Intermediate zone" at a depth of 12-14 fathoms, where the following dominant species were taken: seatrout (*Cynoscion* and *Macrodon*), sea catfish (Ariidae), butterfish (*Nebris*), croaker (*Micropogon*), *Lonchurus*, *Paralonchurus* and many smaller species not utilized commercially at present. Drags in this area made with the 68 foot shrimp trawl, caught from 330 to 840 pounds of commercially-edible fish an hour. Shrimp catches in the "Inshore zone" consisted entirely of small numbers of seabob (*Xiphopenaeus kroyeri* (Heller)) and were obtained in this zone to a depth of no more than 16 fathoms. In deeper waters the blue coloured shrimp (*Penaeus schmitti* Burkenroad) and the brown shrimp (*Penaeus aztecus* Ives) occurred, the latter also entering the "Offshore zone", but here the pink spotted shrimp (*Penaeus brasiliensis* Latreille) dominates in the clear blue sea to a depth of at least 40 fathoms.

The results of the "COQUETTE" investigations have already been partly worked out and published.

Dr. L. B. HOLTHUIS, curator of the Crustacea in the Leiden Museum, described the species of shrimps, lobster and crabs trawled, as well as all the other data on these groups of Crustacea collected in Suriname in the foregoing years (1959). In his work the following numbers of species are noted: shrimps 35, lobster 4, hermit crabs 12, crabs 63. About half of these were represented in the "COQUETTE" material, and had not been recorded from Suriname before that date, whereas 9 species were described as new to science.

Dr. GILES W. MEAD (1959), ichthyologist of the Fish and Wildlife Service in U.S.A., described a new species of fish (*Lonchopisthus higmani*) in the second volume of the "Studies on the Fauna of Suriname". FREDERIK M. BAYER (1959) surveyed the Octocorallia collected. Among these, four new species were detected, while of the 44 enumerated species, many had not previously been recorded from this area. Dr. HOLTHUIS (1959) also described the Stomatopoda brought in by the "COQUETTE", mentioning three new species and three other species already recorded from the Caribbean sea.

STEWART SPRINGER & ROSEMARY H. LOWE (1963) described a new dogshark (*Mustelus higmani*) collected by HIGMAN during the shrimp trawling operations of the "COQUETTE". This species, the smallest member of the genus *Mustelus* of the family Triakidae, was later found frequently in trawl catches all along the coast off the Guyanas between Trinidad and the Amazon river.

In 1955 the "Caribbean Commission" organized a "Second Caribbean Fisheries Seminar" in Port-of-Spain, Trinidad. At this meeting it was proposed to make lists of identified species of commercial fish of the associated countries, for compiling these data into a catalogue of the Caribbean area.

With reference to this suggestion, LIJDING (1959) composed a preliminary list of shrimps, crabs and fishes in Suriname, giving the local and English names for them as far as was known. This list concerns mostly the commercial species, including some little known seafishes, of which it could be expected that their consumption would increase in the future. To the list nine plates were added, showing in somewhat primitive black and white figures three species of shrimps and twenty nine species of fishes.

Shortly after the arrival of the "COQUETTE", the American research vessel "OREGON" put into the harbour of Paramaribo. Two American biologists were aboard: Mr. HARVEY BULLIS, leader of the expedition and a specialist in Mollusca and Mr. LOREN P. WOODS, ichthyologist of the Chicago Natural History Museum. A trip was made between Trinidad and Cayenne to explore shrimping and fishing possibilities along the shelf, and to collect everything that the sea would yield. One year before, a first expedition had been made over the shelf from Trinidad to the Amazon. Off the Guyanas, most of the shrimps were trawled at a depth of 30 fathoms. A strong sea current, especially off the coast of Cayenne, interfered with trawling. The ignorance of the sea was also a handicap.

In the sea off Suriname, a few species of shrimps were dredged from deeper waters at the edge of the shelf. These belonged to *Solenocera vioscai* Burkenroad (95–160 fathoms) and a "large scarlet shrimp" (*Plesiopenaeus edwardsianus* (Johnson)) and the "royal red shrimp" (*Hymenopenaeus robustus* Smith) (185–400 fathoms), the last one found in many places in this area and common near Trinidad. Lists of the identified species of Crustacea, Mollusca and Pisces collected during the expeditions of the "OREGON", were published by BULLIS & THOMPSON in 1965.

Earlier and parallel with these American explorations in Suriname, French neighbours were active in Cayenne. Here Dr. J. DURAND, Head of the Fishery Service in Cayenne, made his exploration of the sea with the French boat "ORSON II" during the years 1953 to 1956, looking for possibilities in trawling fish and shrimps off the coast of Cayenne. This survey also led to practical and scientific results. DURAND distinguished three zones from the coast to the deeper waters, differing in the composition of their fauna and in the nature of the bottom deposits. Between the coastline and a depth of 25 m at about 20 miles offshore, lies an area with soft mud. Between this isobath and that of 50 m, stiff clay mixed with fine sand occurs with a ridge at a depth of 30–40 m, built up by pieces of dead

shells and coral. Outside the 50 m line, the bottom is a hard floor of fine sand. The edge of the shelf sinks to a depth of 200 m and falls abruptly to more than 1000 m in the deep ocean.

In his report for the year 1956, DURAND says after two years of exploration: "La mer bordant la Guyane étant pratiquement inexplorée et pratiquement inexploitée, les cartes marines elles-mêmes, anciennes et peu détaillées, ne donnant sur la nature du fond que des renseignements imparfaits, il m'a semblé que la prospection méthodique du Plateau Continental pouvait être intéressante au double point de vue, scientifique et économique".

The marine biological material collected during these trips, was sent to Paris for further study. DURAND himself published his general report in 1961, elucidating his views concerning the composition of the fauna of the sea above the shelf and its relation with depth. In this connection attention must be drawn to a publication by JOSEPH PUYO (1949) of the sea- and freshwater fishes of French Guiana, which deals with the species of fish caught by the local fishermen.

A practical result arising from DURAND's work was the establishment of an American base for shrimping at St. Laurent du Maroni, from where 15-20 trawlers now operate in the sea off the coast of French Guiana. The shrimps are exported to the U.S.A.

In (British) Guyana, in addition to fishing with pin seines on the mud flats and with cadells in the estuaries, fishing in the open sea was developed since the manufacture of ice was started in Georgetown. This kind of fishing with long hand lines from a schooner near the edge of the shelf at about 60 miles offshore in a depth of at least 30 fathoms, was employed to catch red snappers. However there was no trawling or shrimping between these two extreme fishing grounds. Dr. H. H. BROWN describing the situation of the fisheries in British Guyana in 1942, points to the fact that the sea was practically unexploited. A few years later T. A. C. HEPWORTH tried to find new possibilities of fisheries in the sea near the coast. This provided the opportunity for Miss V. E. GRAHAM to study the marine animals collected, of which a report appeared in 1949, and this stimulated the preparation of a popular booklet by her in 1955, illustrated with many ink drawings, under the title: "*Sea shore life of British Guiana*".

An intensive and careful investigation was undertaken by W. G. MITCHELL & R. H. MC CONNELL (née Rosemary H. LOWE) with the R/V "CAPE ST. MARY" from April 1957 to March 1959 in trawling fish from the sea off (Br.) Guyana. The shelf was explored from a depth of 8 fathoms to 40 fathoms. The most productive places for

trawling fish were found inshore of a depth of 20 fathoms in the eastern area and 30 fathoms in the western part of the shelf, 30–40 miles offshore.

An average of 300 lb commercial fish were trawled per fishing hour. The haul was made up of *Sciaenidae* (75%), with three dominant species: the croaker (*Micropogon furnieri* (Desmarest)), in Suriname known as "zoutoewatra koebi" (43%), the "bangamary" (*Macrondon ancylodon* (Bloch & Schneider), in Suriname known as "dagoetifi" (19%), and the "seatrout" (*Cynoscion virescens* (Cuv.)), in Suriname known as "kandratiki" (11%).

The collection of fishes was worked up by ROSEMARY H. LOWE (now Mrs. Mc CONNELL) and their publication appeared in 1962. The total number of species of fish trawled during this exploration, amounted to 190, and a further 23 species were taken from these waters by other methods. About 50% of 213 species were known to occur from Panama to Brazil, about 10% were only known north of Guyana in the Caribbean and 5% were formerly limited to Brazil. About eleven species of fish proved to be new to science. Sharks were mostly encountered in the shallower waters along the coast, forming only 3% of the hauls. Shrimping was not attempted because the nets were not suited to this purpose.

Mrs. Mc CONNELL has differentiated the shelf into four zones, after the dominant colour of the species of fish, living in these zones. They are: the "brown fish" zone (0–10 fathoms) with skinfish and rays; the "golden fish" zone (10–30 fathoms) with species yellow and white in colour; the "silver fish" zone (20–40 fathoms) with mackerel; the "red fish" zone (40 fathoms and deeper) with snappers. The fish moved inshore from the deeper waters to the coast during the calm seas in the months June to August, but returned outward during the windy months January to March. The notes on the composition of the sea bottom, the observations made on the society of animals living there together, their food and the time of propagation of the fishes, make this publication one of the best of its kind.

At the same time Mrs. Mc CONNELL has analysed the fishes brought to the markets in Georgetown during the years 1958 to November 1961. The results were published in Bulletin 4 of the Dpt. of Agriculture, Fisheries Div. Georgetown Br. Guiana, in 1962. An

attempt was also made to elucidate the seasonal trends in the catches.

The sources from where the fish came, expressed as percentages of the total landings, were: schooners (38%), trawlers (35%), pin seines (27%), while others were under one per cent. Later on in 1961 the proportion of fish from pin seines increased to 35%. In the schooner catches, red snapper (*Lutianus aya*) accounted for 86% of the weight of fish; next came groupers (*Serridae*) 13%. In trawl catches the croaker (*Micropogon furnieri*) formed 39%, bangamary (*Macrodon ancylodon*) 22%, seatrout (*Cynoscion virescens*) 9%. In the pin seines catches queriman (*Mugil liza = brasiliensis*) 47%, grey snapper (*Cynoscion acoupa*) 9%, snook (*Centropomus undecimalis* and *C. ensifer*) 8%. Many others were caught less abundantly in the trawl, except skinfish, but very few of these were purchased by the Government Fish Market. Brackish water fish from the Government experimental ponds at Onverwagt comprised mainly snook (27%), queriman (19%), *Tilapia* (10%), grey snapper (9%), mullet (9%) and croaker (7.5%).

Snapper catches varied considerably from year to year, but were generally higher in mid year (the calm months) and lowest in the early part of the year (Jan.–March). Seasonal variations in pin seine catches reflected mainly those of the queriman, of which there was a general tendency for good catches at the beginning of the year to fall off in April or May just before the rains came in, and to increase again steeply in Nov.–December. Tarpon and pargée (*Lobotes surinamensis*) showed great increases in numbers during the rains in June–July in certain years. Snook catches were highest between June and October.

Catches from the inshore fishing methods (Chinese seines, cadells and freshwaters, as well as from pin seines) show greater seasonal changes in composition and amount, related to the rains and amount of freshwater coming down to the sea. Catches are on the whole better during the rains when it appears that many fish move into the area fished to feed or spawn.

As a second contribution based on the material from the trawl fisheries, a detailed study of the sciaenid fishes was made by Mrs. Mc CONNELL (LOWE 1966), provided with a field key to the species and with records of all that is at present known about the natural history of 25 species, collected in (Br.) Guyana.

Over 75 per cent of the weight of fish trawled on the shelf, belonged to this family represented by about 20 species. Most of them live in zone II, the "golden fish" zone in a depth of 8 to 20 fathoms (in the southeast) or to 30 fathoms (in the northwest). Some of the species are also important elements in the catch of the long pin seines on the tidal mud flats and in the channel bag seines (Chinese seines) staked in the estuaries. Other species predominate in the brackish swamps along the coast. Several species run up the rivers into fresh water, wherein are found two wholly freshwater species. In all at least 26 species are now known from Guyana.

During the rainy seasons a number of sciaenids move inshore and some species into the estuaries, but when northeast tradewinds are blowing strongly in February–March, they move offshore and to the northwest.

Competition between species is probably lessened by the fact that: (a) different sciaenids predominate in different areas; (b) by seasonal movements; (c) by changes

in habits and food niches at different stages of the life history. Mrs. Mc CONNELL found that the marine sciaenids here fall into three feeding groups: (1) bottom feeders with a diet of Polychaete worms, tiny Crustacea (shrimps and crabs), small fish and small Molluscs; (2) pelagic (sergestid) shrimpfeeders and (3) predators feeding on penaeid and *Mantis* shrimp and fish. Spawning was found to be much less seasonal than was thought by Puyo (1949) from French Guiana. Some species breed throughout the year, in other species ripe fishes were taken only in certain places and at certain times of the year, whilst in others no ripe or ripening fishes were ever caught in the trawl. Attempts to determine growth rates of the commoner species have not yet been successful. The growth of certain species appears to come to an abrupt halt once they reach maturity, in others growth continues long after maturity.

All the trawl-caught specimens of *Micropogon furnieri* (Desmarest) carried numbers of cestode worm larvae in the body cavity. These cestodes were identified by Mr. S. РУДНОЕ (Brit. Mus. N. H.) as *Pterobothrium heteracanthum* Diesing. They were found too in the seatrout *Cynoscion virescens* (Cuv.). The final host is said to be an elasmobranch and the earlier host a Crustacean.

The practical result of all these activities is the increase in interest in trawling and shrimping in the sea above the shelf of Guyana with trawlers and schooners. Ir. H. LIONARONS, Head of the Fishing Service in Suriname, studied the fishmarkets in Georgetown in 1961 and reported the following situation. At that time American fishermen were shrimping with 32 boats from Florida mostly N and NE off the coast of Suriname. Eight motor schooners were fishing N of Georgetown for red snappers to provide the local market with this excellent fish and with groupers. On the mud flats along the coast fishing with long pin seines occurred just as in Suriname, while different methods were employed to catch fishes in the estuaries and in the lagoons and swamps. For particulars of these attention is drawn to the publications of W. H. L. ALLSOPP (1958, 1960).

Apart from the explorations made in aid of the fisheries, a few other marine biological subjects have been studied. The lightship anchored eight miles out of the mouth of the Suriname river, suffers severely from an overgrowth of algae and sessile sea animals on the ship's hull. The ship had to go every year to the dock in Georgetown, to be scraped clean. At the request of the Head of the Harbour Service at Paramaribo, I had an opportunity to study the animal communities and the distribution of algae on the surface of the boat when in dock at Georgetown. In July 1950 one month after the

inspection, a report was made for the Government of Suriname, from which the following points are of scientific interest.

The overgrowth formed by algae, barnacles, oysters, mussels, Bryozoa and Polyps was not evenly distributed, but it was divided into three zones. At the contact zone, the algae consisting of *Enteromorpha flexuosa* (Wulfen) J. Ag. (det. Dr. E. YALE DAWSON, Univ. South California) were growing, forming a green belt 50–90 cm wide. The second zone below this was formed by a small species of barnacle, probably belonging to *Balanus improvisus* Darw. (det. Dr. L. B. HOLTHUIS, Leiden Mus.) covering the surface in large numbers from 90–110 cm. Lower down and extending to the keel of the boat, a very rough surface, 5–10 cm thick formed by a large species of barnacle and some oysters and mussels, was present. This barnacle, *Balanus tinnabulum* (L.) (det. HOLTHUIS), occupied the surface at a density of 28 to 35 specimens per square meter. The remaining space was occupied by oysters (*Crassostrea rhizophorae* (Guilding)) and mussels (*Mytella charruana* (d'Orb.) (det. Dr. C. O. VAN REGTEREN ALTENA, Mus. Leiden), Bryozoa and nicely branched Polyps. Between these some Gastropoda (*Thais haemastoma floridana* (Conrad)) (det. v. R. ALTENA), a small crab (*Menippe nodifrons* Stimpson), the crustacean *Ligia exotica* Roux (det. HOLTHUIS) and a few Polychaetes were found.

The species of seaweed and the large barnacle had not been recorded before from Suriname, probably due to the fact that no rocks or other solid substrata are present here in the sea. They apparently used the hull of the anchored boat as a substrate to start their sessile life, favoured by the green sea water, outside the muddy stream along the coast.

In connection with this study, the opportunity was taken to collect watersamples from the sea around the lightship. From September 1950 to September 1953, every week two samples were taken and these were analysed by Ir. V. K. R. EHRENCRON, chemist of the Agricultural Experiment Station at Paramaribo, who measured the salinity (mg Cl'/1) and the pH. From these analyses it became evident that during a year two periods of brackish water pass the lightship, one at the beginning of the year (January to March) and one in the middle of the year (June to August). These periods do not correspond with the rainfall data in the basin of the Suriname river. The sea must be influenced more to the east and probably by the Amazon river.

This is in agreement with observations made by Dr. A. REYNE in 1922 and 1924 (published in 1961). In a watersample taken 20 km off the coast of Suriname, the salinity was much lower than in normal seawater and further offshore at a distance of 85 and 172 km off the coast, a zone 25 km wide was found with brackish water.

Attention to the marine Mollusca of Suriname was first given by the geologist F. VOLTZ (1853–1855), who studied the subfossils in

the shellridges in the coastal belt. This collection was later described by SCHEPMAN (1887). In the years 1946–1955 I sampled the ridges again, collecting and studying the Mollusca in a qualitative and quantitative manner. A total of 97 species were found, divided among 43 Gastropoda, 53 Bivalvia and 1 Scaphopoda. Most of these proved to be still present along the beaches as recent species, but 13 species (6 Gastropoda and 7 Bivalvia) were found only in the ridges.

When exploring the fisheries along the coast of Suriname and later on in the years 1945–1959, I collected also the marine Mollusca present along the beaches and on the mud flats. During this survey it became obvious that the distribution of the species along the coast, was dependent on the position of the mouth of the rivers, from where the sea current, running from E to W, transports the freshwater from the rivers along the coast to the West. This explains why the marine Mollusca fauna is so poor on the western side of the mouth of the rivers. But as soon as this freshwater is eliminated, the number of species increases.

A total of 134 recent species of marine Mollusca occur on the coast of Suriname, divided into 61 Gastropoda, 72 Bivalvia and 1 Scaphopoda. Of these 21 are not found back among the subfossils of the shellridges. Furthermore it was noticed that the composition of the mollusc fauna on the coast in the eastern part of Suriname (Marowijne-Commewijne) was somewhat different from that present in the western part of the country (Coronie-Nickerie).

Publication of this study on the shells is not yet possible, because the identification of a number of species is not certain. For many years Dr. C. O. VAN REGTEREN ALTENA, curator of the Mollusca in the Leiden Museum, has been engaged in sorting out the systematic difficulties of the Surinam species. For this reason he visited Suriname in spring 1963 and made collections at many places along the coast and on the rivers, as well as in the shellridges of the coastal plain. On his way back to Europe, he also visited some museums in U.S.A. to compare types and to clarify many doubtful questions. It is a pleasure to note that his first preliminary report on the marine Bivalvia is now published at the same time as this paper. It is my intention to give my observations as a "follow up" of the studies made by VAN REGTEREN ALTENA, as soon as his second part on the Gastropoda is ready.

Still another subject of importance and interest has been studied recently in Suriname, viz. the sea turtles. Dr. J. P. SCHULZ (1964) and his collaborators have made an intensive research on the activi-

ties of the turtles when laying eggs on the beaches. This study was made in relation to the work of the Forestry Department concerning the inspection of the nature reserves in Suriname, one of which, the Wia-Wia reservation, is designated with special reference to the breeding grounds of the turtles.

SCHULZ et al. concluded that four species of turtles use the Suriname beaches for breeding: (1) *Chelonia mydas* (L.), the green turtle or "krapé"; (2) *Caretta c. caretta* (L.) "warana"; (3) *Eretmochelys imbricata* (L.) caret turtle; (4) *Dermochelys coriacea* (L.) the leathery turtle of which two forms are distinguished in Suriname: "aitkanti" with 8 ribs and "siksikanti" with 6 ribs on its carapace.

In 1961 Prof. Dr. L. D. BRONGERSMA mentioned *Lepidochelys olivacea* (Eschscholtz) based on one juvenile specimen in the collection of the Leiden Museum, collected in 1911 at Braamspunt beach on the mouth of the Suriname river by W. C. VAN HEURN. When visiting Suriname in September 1963, BRONGERSMA found another young specimen at "Tijgerbank" on the mouth of the Marowijne river and he was able to buy another one in Albina. These observations pointed to the presence of nests of this species, known to occur in the Indo-Pacific and South Atlantic oceans, in Suriname. Its presence in Guyana was shown by a skull of an adult specimen, found along the coast in the N.W. District and presented by P. PRITCHARD to the British Museum in London. Dr. A. CARR in Florida, a well known specialist of sea-turtles, concluded after studying the photographs taken by SCHULZ from the Surinam "warana," that this species must be *Lepidochelys olivacea* instead of *Caretta c. caretta*. CARR arranged an expedition to Suriname in June and July 1966 to take films and pictures of *Lepidochelys* in the Wia-Wia reservation. During this trip and assisted by PETER PRITCHER and TH. STUBBS, his suspicion was confirmed.

Of the four species known to occur in the sea off the coast of the Guyanas, the green turtle and the warana appear in great numbers at their breeding time. They deposit their eggs on the beaches high enough not to be flooded during spring tide. This mostly happens a few days after new moon and after full moon, when high tide arrives in the late afternoon or in the early evening. During heavy rains, the turtles do not land.

The green turtle appears every year from March to May and the warana (*Lepidochelys*) from May to July. It is believed that the female of the green turtle comes into breeding condition every three years and then deposits 120-150 eggs in one nest

at several times. In making the nest, first a "fox hole" for her body is dug and after that a small but deep "egg hole", in which the eggs are deposited. The green turtle works for about two hours in making her nest, the warana half this time. Only one observation was made of the leathery turtle in making its nest. The construction of "false" nestholes afterwards was typical. Often nests were found at places too low on the beach, with the result that they were destroyed by the sea at high tide.

The incubation of the eggs of the green turtle and those of the warana, took on average 58 days, but in those of the leathery turtle 61 days (aitkanti) or 64 days (siksikanti) were observed. The number of young animals that are raised from one nest varies in the green turtle from 124-153, and in the warana from 76-129, whereas in aitkanti (in 4 nests) from 46-81 and in siksikanti (in 3 nests) from 19-128 specimens. For the protection of the juveniles a "hatchery", as has proved successful in Borneo, is recommended, from where they are set free by boat in the open sea.

The number of turtles as indicated by the number of nests found in 1964 in the Wia-Wia reservation, amounted to for *Chelonia* 400, *Lepidochelys* 1000, *Dermochelys* 50, *Eretmochelys* still less. It is not known from where these turtles come. A study of the migration of the specimens is recommended, for which they should be marked. This should be done in connection with measures taken to prevent their hunting.

Summarizing we may say that marine biological research in the sea on the shelf along the coast of the Guyanas, was taken up since the war. During this time shrimping and trawling has been developed; the shrimp-trade is supported by Americans with export to U.S.A., while fishes trawled or otherwise taken are processed for local markets.

The practical efforts have considerably stimulated zoological research on the seafauna. The commercial species of fish, shrimps, crabs and lobsters are being studied intensively and other groups, such as molluscs and corals etc., are partly revised or receiving the attention of specialists. Remarkable progress is being made in the biological and ecological division of the shelf, recognizing four different zones. Each of these shows characteristics of the fauna dependent on depth, kind of seawater and structure of the bottom. Detailed studies have been made of the organisms fouling the Suriname light-ship, of the composition of the recent marine molluscs along the coast of Suriname and of the subfossils present in the seabeaches (shellridges) further inland. The sea turtles have come under special observation since a nature reserve to protect their breeding grounds was designated along the eastern coast of Suriname.

Much of the material collected has, however, still to be studied and steps must be taken to ensure that this material does not dis-

appear for years in the museum collections. The development of the fisheries and other practical aspects have to be based on scientific data. It is necessary to know what happens in the sea before problems of overfishing appear. Here biological research and oceanographic and marine geological work have to go hand in hand.

In this connection the proposal of Prof. Dr. J. VELDKAMP, Director of the Royal Meteorological Institute at De Bilt (Netherlands) was welcomed to carry out renewed scientific research of the shelf off Suriname in 1966, in cooperation with the Foundation for Scientific Research in the Netherlands, with the aid of the Royal Marines aboard H. M. "SNELLIUS." Among the staff of six members was Dr. W. VERVOORT, marine biologist of the Rijksmuseum of Natural History in Leiden. By sampling a great number of stations in the western part of the Surinam shelf, he collected the elements of the sea fauna as comprehensively as possible. In this work he was assisted by Mr. C. CORNET, also connected with the Leiden Museum. After this survey was completed, VERVOORT and CORNET explored the fauna of the mudflats, travelling along the coast by boat and over land. It is with great interest that we are looking forward to the results of this scientific expedition.

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