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The life and work of Eugenie Clark: devoted to diving and science

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Synopsis

Eugenie Clark is an ichthyologist with a talent for communicating about marine life. Her life had three principal periods, (1) studies under Charles Breder, Carl Hubbs, Lester Aronson and Myron Gordon, (2) directorship of the Cape Haze Marine Laboratory sponsored by the Vanderbilts, and (3) professorship and inspired teaching at the University of Maryland. Genie proved that sharks have surprising learning abilities and that, contrary to popular opinion, none are vicious killers. During her studies on reproductive behavior, territoriality, and ecology of tropical marine sand-dwelling fishes of the Caribbean and Red seas, among many other phenomena, she discovered the cross-fertilizing hermaphrodite *Serranus subligarius*, the Moses and peacock soles producing toxins that repel sharks and other predators, and sharks 'sleeping' in underwater caves in Mexico and Japan. She combined a love for swimming and diving with the study of marine fishes – from hard-hat diving and snorkeling to using SCUBA and submersibles. Professor emerita since 1992, she has ridden whale sharks and participated in dives using submersibles to 3 600 m depths. She is a recipient of over 25 honors and awards, participated in 24 television specials, and the current IMAX film on sharks. She is the author of the *Lady with a Spear* and *The Lady and the Sharks* which are of considerable popular fame.

From childhood heroes to the blowfish incident

'When I was a child William Beebe was my hero', exclaimed Eugenie Clark after one of her recent deep-sea dives in a submersible, '. . . I used to read about him going down in the bathysphere and I wanted to do that too; I told my family I would like to go down and be like William Beebe. They said maybe you can take up typing and get to be a secretary to William Beebe or somebody like him. I said, I don't want to be anybody's secretary! I want to be like William Beebe going down . . . and I don't believe it, here I am doing just that . . . in the same place, the same place Beebe went down more than 50 years ago. It's so fantastic, it is a dream come true, it really is' (recorded on video *A Half Mile Down*).

Eugenie Clark has probably SCUBA dived longer than any woman and seen more whale sharks underwater than anyone. After 70 she rode whale sharks off Australia and Mexico and ridden one to 60 m depth. Like her hero William Beebe (Berra 1977) she became a good naturalist, writer and explorer.

Eugenie Clark, called Genie by most, was born in New York on 4 May 1922. After a distinguished scientific career of nearly 50 years, four husbands and four children, she still looks at least 25 years younger. (Sea water, the primordial brine of life and a cheerful disposition, preserve.) On 6 December 1993 she was presented with The Franklin L. Burr Award by the National Geographic Society for her work which has opened the world of life in the sea to

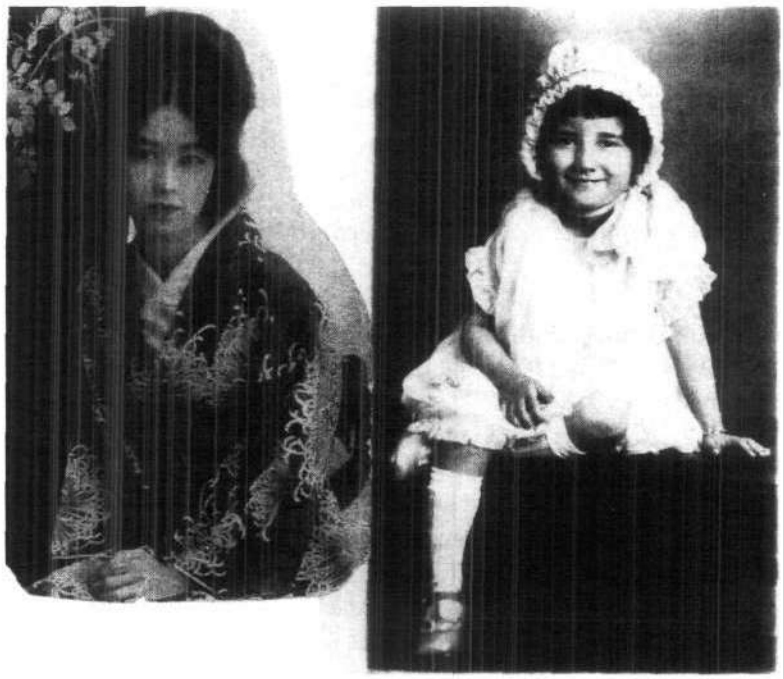

Fig. 1. Genie (right) and her mother Yumiko in 1926.

the general public; the most recent of many awards I will run out of space to mention.

It is not a simple task to write a short 'life and work' of someone who did it very eloquently herself previously in two famous autobiographical books (Clark 25, 58)*, whose profiles appeared in book chapters from 1967 to 1993 at least 30 times (e.g. Ellis 1975, Emberlin 1977, Stein 1982, Stacey 1990, Burns 1992, Samarrai 1992), and whose biography was produced for children by Ann McGovern (1978).

'My own interest in sea life began', wrote Genie in *The Lady and the Sharks*, 'when I was in elementary school in New York. My American father [Charles Clark] died when I was a baby, and my Japanese-born mother (Fig. 1) was working at the cigar and newspaper stand in the lobby of the Downtown Athletic Club. On Saturdays, while she worked, she left me nearby in the old New York Aquarium at Battery Park, where I spent many hours watching the fishes. Afterward we usually went to eat at a charming little Japanese restaurant, Fuji, and gradually become good friends with the owner and cook, Masatomo Nobu, who later became my stepfather (Fig. 2). I was brought up on the Japanese side of my family, but no one, except anthropologists who are quick to spot my Mongolian eyefold, ever thinks I'm part Japanese.

I knew more about produce from the sea than any of my schoolmates, and my reports in school, from kindergarten on, amused and shocked my classmates and teachers. I told them how we ate with chopsticks, had rice and seaweed for breakfast, raw fish, octopus, and sea urchin eggs for supper, and cakes made from sharks. I was the only student of Japanese ancestry in the school where I grew up, in Woodside, Long Island.

Nobusan often visited my family (Grandma Yuriko, Uncle Boya, and Mama) and always brought us some special Japanese delicacies from his restaurant. He already seemed part of the family when he became my stepfather, at the time I graduated from Hunter College. I had majored in zoology. Since my first visits to the Aquarium at Battery Park, I had wanted to be an ichthyologist . . .' (Clark 68, pp. 3–4). Her family, especially her mother, supported a

* See the 'Lifetime list of publications'.

Fig. 2. Genie and her stepfather Masatomo Nobu in his trailer in Sarasota, Florida where he lived during part of his retirement. Photograph by E.K. Balon, 1979.

child's dream they could hardly understand then (Clark 25).

She went to Hunter College in New York and during summers 1940 (Fig. 3) and 1941 she took field courses at the Biological Station of the University of Michigan on Douglas Lake. Her enthusiasm there and insatiable reading led to a letter to the editor of Natural History, her first publication (Clark 1). She graduated from Hunter College as Bachelor of Arts in Zoology in 1942, and the same year married 'a handsome pilot' Hideo (Roy) Umaki (Fig. 4). Her first marriage lasted seven years but Roy was drafted overseas most of the time.

While the Second World War was on, the only job she could find was as a chemist at the Celanese Corporation of America in Newark, New Jersey (1942–1946). After applying to Columbia University's graduate program and receiving a cold reception as a woman intruding into men's territory, she enrolled at New York University, and in the evenings

Fig. 3. Teenage Genie during the field course at Douglas Lake in 1940.

and weekends was a swimming instructor at the Shelton Hotel's Athletic Club in New York City. While 'flunking' her course in endocrinology that induced sleep rather than lecture notes, she never failed to sit wide awake in ichthyology. It was given at the American Museum of Natural History (AMNH) by Charles M. Breder, Jr. (Fig. 5), curator of the Department of Fishes and former director of the public aquarium at Battery Park. The exhibits and collections at AMNH added to the stimulating atmosphere in which Genie received her Master of Arts degree in 1946. Her thesis, supervised by Charles Breder, dealt with the 'puffing mechanism' of blowfishes. Breder considered Genie's 'results and anatomical drawings' of the plectognath digestive system worth publishing. 'Later when he combined my final Master's thesis with the publication of his own studies', wrote Genie (Clark 25), 'and my name appeared as co-author, my pride was as inflated as the blowfish' (Breder & Clark 2).

From the Hubbs phenomenon to her first book

Genie was introduced to Carl L. Hubbs at the an-

Fig. 4. Genie with her first husband Hideo on Oahu, Hawai'i in 1947. Photograph by Bertha Kon.

nual meeting of the American Society of Ichthyologists and Herpetologists in Pittsburg, and was invited the same year to join him at the Scripps Institute of Oceanography, La Jolla, as his part-time research assistant (Fig. 6). The jovial Hubbs, a good swimmer as well as entertainer, was dead serious about his work on fishes; Genie had to count meristic characters of hundreds of cottid specimens as part of a larger design to understand intraspecific variation and speciation. At the same time she took his course in Marine Vertebrates and other courses which required ship time and handling of oceanographic equipment.

Carl Hubbs caught a swell shark at sea and gave it to Genie to investigate, one of the rare other fishes outside plectognaths equipped with the ability to blow itself up. She found that the puffing mechanism of swell sharks is based on the highly distensible walls of the stomach, a part of the digestive

Fig. 5. Genie with Charles Breder and his wife Priscilla at their retirement home in Florida in 1979. Photograph by E.K. Balon.

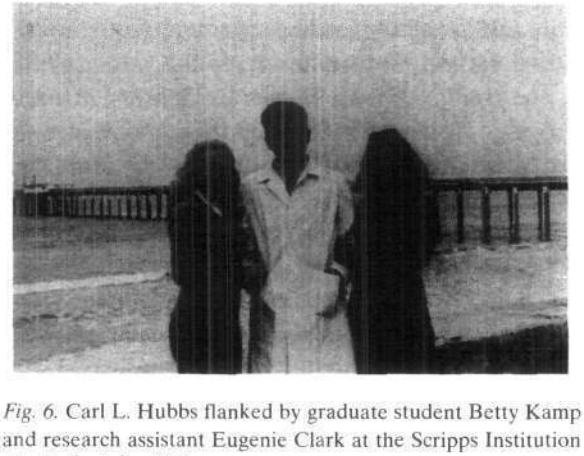

Fig. 6. Carl L. Hubbs flanked by graduate student Betty Kamp and research assistant Eugenie Clark at the Scripps Institution pier in La Jolla, 1946.

system, as in blowfishes. While it was easy to understand why a small puffer would pump itself full of water for defense, it remained a mystery for the swell shark to do the same thing (Clark 3).

Hubbs gave Genie her first opportunity to use a face mask for observing fishes underwater and to walk on the bottom of the sea in a diving helmet. This experience and the mishap with a faulty hose, as well as the advice never to dive in a hard hat after eating hamburger with onions, became a classic story picked-up by most of Genie's profile writers, none of whom, however, managed to convey the true tale the way she did (Clark 25, pp. 27–32). Next, via Hawai'i on an aborted expedition to the Philippines, Eugenie returned to New York. Myron Gordon at the AMNH offered her a research assistantship and the chance to work toward a doctoral degree. She stated later most succinctly: 'My research problem at the museum centered about the reproductive behavior of platies and swordtails, the same kind of fishes that were in my first home aquarium. In the next few years my project was supported by the Department of Animal Behavior (interested in the sexual behavior of these fishes), by the New York Zoological Society (interested in the genetics of these fishes), and finally by the Atomic Energy Commission (interested in sperm physiology of fishes in general). This took care of my needs for living material, laboratory space, and all my expenses. I was very lucky.'

During three years at the museum in collaboration with Myron Gordon and Lester R. Aronson, Genie developed a micropipette method to collect and transfer sperm into living virgin female platies, swordtails and guppies. Her meticulous studies on sperm competition in poeciliids led to her Ph.D. thesis in 1950 and a series of publications on this topic (Clark et al. 4, 5, 10, 27, Clark & Aronson 12, 13, Clark & Kamrin 14, Aronson & Clark 17). She kept in touch with marine fishes at the Biological Station in Woods Hole two summers, and later for several months at the Lerner Marine Laboratory on Bimini, West Indies. Charles Breder was now the director of Lerner Marine Lab, and he wanted her to study local plectognaths (Clark 9). In her spare time she (Fig. 7) assisted Roger Sperry, a visiting

Fig. 7. Genie at the Lerner Marine Laboratory on Bimini in 1948. Photograph by R. Sperry.

neuro-anatomist in his experiments on visual discrimination of gobies (Sperry & Clark 8).

As she finished the last experiments for her thesis, she was accepted for Scientific Investigation in Micronesia by the Pacific Science Board and the Office of Naval Research. They were especially interested in poisonous fishes and her studies of plectognaths and her chemistry background proved important assets. Genie took off on 17 June 1949. In Micronesia she perfected her skin-diving skills and learned spearfishing from the Palauan fisherman Siakong (Clark 26). The account of this four months trip forms the major part of her charming first book *Lady with a Spear*. Her next trip to the Red Sea is also included in this first popular book. To illustrate let me use just one incident I like most: In the Red Sea, rotenone collections occasionally made in shallow waters or tidal pools attracted her houseboy, Shehat, otherwise a sea-fearing non-swimmer, who usually ventured only to the shallowest edge. Amazed by the multitude of fishes chased out of

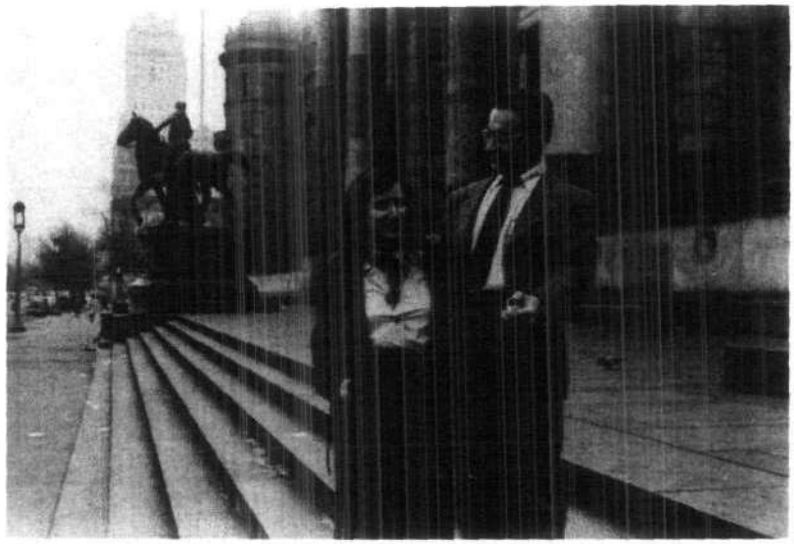

Fig. 8. Genie with her second husband Ilias on the front steps of the AMNH (May 1959) before her Ph.D. defence.

their hiding places by the piscicide, he called the others: 'Come here quickly. See what I've found – a creature Allah himself may not know about! Take it immediately to the *doctora* and be sure to tell her I discovered it' (Clark 25, p. 204).

In 1950 she married in New York's civil court her second husband, then an intern in orthopedics, of Greek origin, Ilias Themistokles Papakonstantinou (Fig. 8), later changed into simplified Americanized version Konstantinu. An article by H.A.F. Gohar, then the director of a lonely Red Sea Marine Biological Station of Fouad University at Ghardaqa, on clown fish and sea anemones caught her attention. She wrote Gohar and was offered all the station's lab facilities. She applied for and got a Fulbright Scholarship to study plectognaths and other poisonous fishes in the Red Sea (Fig. 9). She arrived in Egypt for Christmas 1950. Ilias Konstantinu came for an extended visit towards the end of this first Red Sea experience, and they married officially for the second time in 1951 in a Greek Orthodox church near Khan Khalili bazaar in Cairo. Ilias's mother, related to the well known Onassis family, arrived from Athens for this wedding. During their honeymoon at Ghardaqa, Ilias helped Genie with her work, became quite interested in sharks, and became an enthusiastic spearfisherman.

Ilias returned to the U.S. to take an internship in the Orthopedics Division of the Buffalo General Hospital in Buffalo, New York. Genie soon joined him and wrote her *Lady with a Spear*, during 1952, the same year their first child, Hera was born. The popular, autobiographical book published in 1953 about her resarch and adventures in the Pacific and the Red Sea went through several editions in English and Japanese, and Italian, Danish, German, Swedish, Norwegian, Arabic and Braille. A multitude of excerpts was published in school textbooks. 'I began to realise', said Genie later to one of her many interviewers (Samarrai 1992), 'I had a talent for communicating about the natural world. I came to see that it would be my life's work.'

The Vanderbilts and Cape Haze Marine Laboratory

After publication of her book, Genie became an instructor in the Biology Department of Hunter College, New York, where Ilias had moved to complete his medical training (Fig. 10). She officially became a research associate of the AMNH departments of Animal Behavior and Ichthyology (1954–1981), worked as pharmacologist at the Nepera Corporation in New York and travelled to give lectures at high schools, colleges and universities.

Let her tell you what happened next: 'My introduction to the west coast of Florida was in 1954 after

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Fig. 10. Eugenie Clark at Hunter College in New York City in 1954. Photograph by E. Hartmann.

I accepted an invitation from Anne and William H. Vanderbilt to give a lecture in Englewood, Florida. Mrs. Vanderbilt had read my book *Lady with a Spear* and talked her husband into reading it. Their ten-year-old son Bill, Jr., had a bedroom full of aquariums, as I did at his age, and his parents had become fascinated with their son's hobby. Their estate stretched across Manasota Key, from Lemon Bay to the Gulf of Mexico. Bill, Jr., and his school chums, like all children living near the water, explored the shore and brought home all kinds of strange sea life they found in shallow water or washed up on the beach. But many of these items they couldn't identify (. . .) There was no marine biologist in the area. William and his brother, Alfred Gwynne Vanderbilt, had bought a 36,000-acre tract of land near the fishing village Placida, southeast of Englewood, (. . .) on the Cape Haze peninsula'. As we know from previous sections, Genie had experience in marine biology as a visitor and researcher at many marine laboratories. As she wrote in her second book, 'I never dreamed I would have the opportunity to start a laboratory from scratch myself, but later on the evening of my lecture in Englewood I learned that the Vanderbilts had invited me to Florida for just this reason . . .' (Clark 68, pp. 2–4 and the insert of 4 maps).

Eugenie Clark became the founder and executive director of Cape Haze Marine Laboratory, of course, not before she sought advice from her early mentor, Charles Breder, who knew these parts well as he had directed a small biological station of the New York Aquarium in the area in the 1930s. The timing was good. Ilias had just completed his medical training in New York City and liked the idea of opening his practice in Florida 'and of bringing up our young daughter Hera and an expected second child in a beach house in Florida rather than continuing to live in our twelfth-floor apartment on West End Avenue (. . .) In early January 1955, six months after my first visit to Englewood', writes Genie in *The Lady and the Sharks*, 'our family arrived in Florida. I opened the Cape Haze Marine Laboratory as soon as I arranged for a babysitter for two-year-old Hera and her month-old sister, Aya' (Clark 68, p. 10).

A local fisherman, Beryl Chadwick, whom the Vanderbilts recommended to her on her first visit was her co-worker. Beryl build a small wooden building 4 by 6.5 m to serve as a laboratory, a dock, and a 7 m craft was left at her disposal. The details

of Genie's 12-year long sojourn in Florida are given in her second popular book (Clark 68). The central activity of this laboratory, acquisition and maintenance of sharks for visiting scientists, and research on sharks, started nearly immediately.

The day after the Konstantinu family had arrived, Genie received a telephone call from John H. Heller, the director of the New England Institute for Medical Research, who needed fresh shark livers for his research and could not find any. Beryl made a shark long line. The Heller's arrived on 24 January, and the next morning they had two large sharks. A week later Genie, John Heller and his wife Terry dissected twelve dusky and sandbar sharks and the reputation of the laboratory was established in the local newspapers.

However, the laboratory's initial mandate was to study the local marine fauna which, as Genie found later, had been well utilized as educational material and shipped all over the States in the 1930s. She soon met Johnny Bass and his wife Barbara who inherited the Bass Biological Station in Englewood from his father. This biological supply house, by then closed, was Florida's equivalent to Ed Ricketts' laboratory on Cannery Row in Monterey, California (Steinbeck 1960). One day the Basses opened the old building for Genie who discovered valuable books and journals, laboratory glassware, chemicals and instruments under cobwebs and dust. Johnny's mother even offered Genie old records her husband had kept. Genie started to understand how useful the supply house had been to scientists, teachers and students while it operated. When she realized that others had been there before, she started to have doubts about the contribution she could make. Even sharks had already received attention here when Stewart Springer was the last manager of the Bass Station before its closure in 1940 (Burgess 1991). During her first mask and snorkel dives offshore she discovered, among other things, a number of small, large-bellied groupers full of eggs with no males around.

During Genie's first year in Florida her parents moved their Japanese restaurant *Chidori* from New York to Grove City, nearly halfway between the Konstantinu residence and the Cape Haze Lab. Idyllic life set in at their beach house in Englewood. By the end of the first year of its existence the laboratory at nearby Placida entertained 28 visiting scientists, hordes of school children and associates. The building expanded, a shark pen was built. Genie started to share a secretary with the Vanderbilts as the Laboratory became a nonprofit organization and the paper work mounted.

On 25 May 1956 Themistokles Alexander Konstantinu was born. When Tak, as he would later be called by his family, was a few weeks old Genie tried out the Cape Haze Marine Lab's new aqualung. She went SCUBA diving to solve the puzzle of the small grouper, *Serranus subligarius*. The fish produced activated eggs without males. The large ovaries full of eggs had white pieces of tissue Genie thought to be fat. Charles Breder on one of his visits suggested she put a piece of that 'fat' in sea water under the microscope. Wriggling multitudes of spermatozoa were revealed. The fish was a functional, self-fertilizing hermaphrodite!

Genie persisted in observing the fish in aquaria and in the sea and discovered a most fascinating style of reproduction: The hermaphroditic grouper spawns in pairs each day from April to September at receding tide and released eggs at each S-curved mating snap. The fish which leads before the mating snap plays the role of a female and is unbanded, dark colored, whereas the fish which follows is strongly banded and performs as a male. At the apex of the snap the unbanded individual becomes banded but in reverse, negative-like banding and soon the banded one becomes unbanded and leading, thus reversing roles. The fish is a simultaneous hermaphrodite all right, but normally cross-fertilizes.

Genie published these findings in 1959 (Clark 35) and exactly 20 years later we arranged to meet at the Mote Marine Laboratory in Sarasota, the successor of her Cape Haze Lab, to try to resolve the last puzzle of this unusual reproductive behavior. She arrived from College Park, Maryland, where she has been professor of zoology for some time, and I from Guelph with two carloads of equipment, technician Marilyn White and graduate student Joan Cunningham (Fig. 11). After setting the incubators and special microscopes (as described in Balon & Flegler-Balon 1985) for detailed studies of

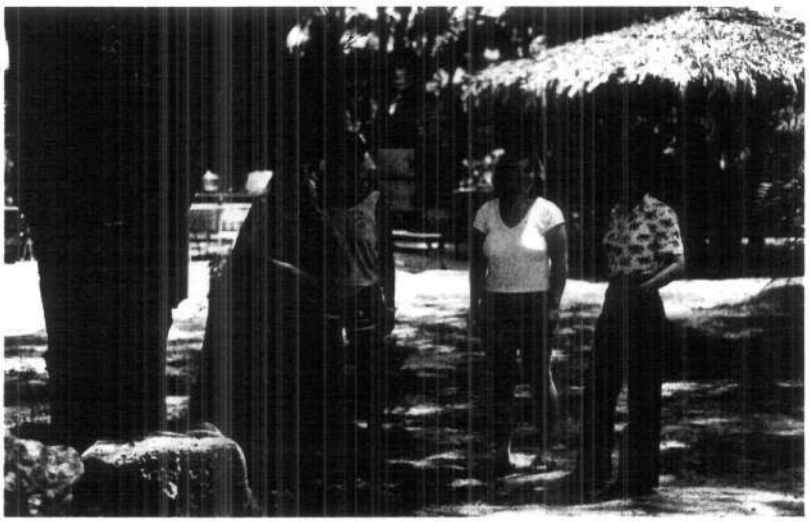

Fig. 11. Genie, her daughter Aya, my technician Marilyn White and graduate student Joan Cunningham at the Mote Marine Laboratory on 27 April 1979. Photograph by E.K. Balon.

development of the self-fertilizing *S. subligarius* compared to the cross-fertilizing one, Genie failed to find any of the previously so abundant fish. We SCUBA dived in all places known to her but no *S. subligarius* were found. Thus the puzzle how the progeny of cross-fertilized individuals differ from those of self-fertilizing ones remained unsolved. But a new mystery was added by the absence of this most abundant fish from the waters in that particular area and year; our only chance for the two Eugenes to co-author a paper was lost.

From Placida to Sarasota

Because of the continuous success in keeping various sharks in captivity and the publicity that followed, Genie was soon known as the 'shark lady', even before her experiments with them started. The Cape Haze Marine Laboratory expanded with the additional financial help from the National Science Foundation, the Office of Naval Research, the American Philosophical Society, and the Selby Foundation. Many foreign visitors arrived in addition to Americans interested in studying sharks.

When Lester Aronson came for a visit, Genie designed with his help the first experiments on learning behavior in sharks. In the midst of these shark conditioning experiments, on 20 October 1958, after her SCUBA diving until the last moments, Nikolas Masatomo Konstantinu, the last child of Genie was born. She later wrote that except for feeling like a 'Lady with a Sphere' she was comfortable and believes that because of her swimming and diving all her labor and births were easy.

Along with raising the four children, Hera, Aya, Tak and Niki, in which she was much helped by her mother and stepfather who ran a Japanese restaurant *Chidori* nearby, Genie continued to work with sharks and took part in frequent distractions. For example, she attended meetings (Fig. 12), went on lecture tours and participated in deep scuba dives into Florida's sinkholes where in Little Salt Springs bones of humans 7 000 to 10 000 years old were discovered (Royal & Clark 41).

The first experiments with sharks had proven that these animals can learn to press an underwater target to obtain food (Clark 36). Now they were trained to visually discriminate between targets of different shapes and colors (Clark 44, 47). Clearly sharks can learn like other vertebrates and are not 'stupid' because they are so-called 'lower vertebrates' (Fig. 13).

Ilias' growing orthopedic practice required him to be close to the Sarasota Memorial Hospital. The family moved to a two-story, Spanish-style house on

Fig. 12. Genie meets for the first time Jacques-Yves Cousteau (on her right) and Ed Link at a shark seminar of the Zoological Society of Florida in Miami (1959).

Siesta Key in Sarasota (Fig. 14) and Genie had to drive one hour in each direction to the Cape Haze Marine Laboratory. 'When the path of the Intercoastal Waterway was plotted next to our shark pens, we knew we would have to move the site of the Lab', writes Genie later. 'My mother died from a brain hemorrhage in the summer of 1959. I lost much interest in my work, felt I could no longer handle a full-time job, and thought I should stay home with the children and help my stepfather . . . He had never mastered the English language, and with no other Japanese people around, as there had been in New York, he depended on my mother not just as a wife but as his only close verbal companion . . . I thought it would be better for him to move his restaurant to Siesta Key, within walking distance to our house. He agreed and we busied ourselves redecorating a rented store in Oakes' Plaza on Siesta Key into a Japanese restaurant. Even Ilias, who was busy with his medical practice, helped with the painting' (Clark 68, pp. 191–192).

Genie went through a difficult period, tried to resign as director but ultimately found a fine housekeeper and returned to the Laboratory. It had to be moved. With luck and the help of enthusiasts, '8½ acres of the most choice real estate on the south end of Siesta Key' was leased, only a five-minute drive from the Konstantinu residence. With grants from the National Science Foundation and funds from the Vanderbilts and the Selby Foundation modern buildings, docks, and shark pens were built for the Cape Haze Marine Laboratory at its new site on Siesta Key, Sarasato. The Lab moved in the winter of 1960.

The laboratory in its new position attracted even more visiting scientists than before. In spite of the Vanderbilts doubling their contribution, the institution was now constantly short of money. 'As Ilias's medical practice grew, I no longer needed a full salary, and as I found I couldn't balance the Lab's budget any other way, I started cutting my own salary', Genie explained later. Luckily an early-retired executive in Sarasota volunteered as adminstrative assistant.

New discoveries and contributions to science started to come to fruition from visiting scientists working at the Lab. For example, John Heller from the New England Institute for Medical Research and his ever larger teams 'had discovered a remarkable substance in shark livers he named 'restim'

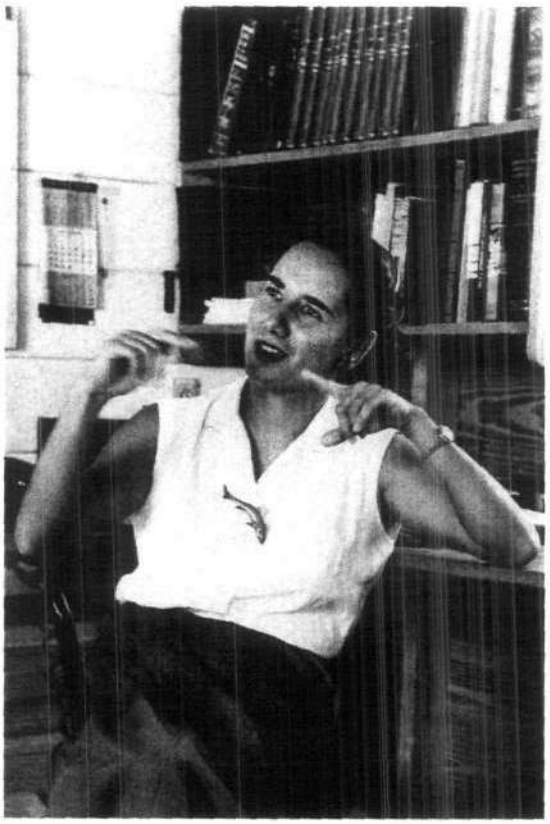

Fig. 13. The executive director of the Cape Haze Marine Laboratory in her office (1958) once again defending sharks.

(short for RES stimulator), which stimulates the body's reaction to fight and resist diseases many times above its normal ability (. . .) to cause an alleviation and even regression in some types of cancer . . .' (Clark 68, p. 197).

During that time Genie went with her diving children on trips to many Caribbean islands and had some remarkable adventures. In 1964 she introduced them to the Dead Sea and Red Sea. She captured garden eels by squirting formalin into their tubes, to the amazement of other divers who thought it impossible. Next day she dived past the garden eel colony and spotted a strange little fish above the sand holding its position by undulating movements. 'When I approached closer, it dived into solid sand and was gone with no hole to mark where it had entered. It was a rare type of sand diver belonging to a family of fish never reported from the Red Sea (. . .) I put my hand net over what I hoped were the peeping eyes of the fish, plunged my free hand into the sand below, and the fish, *Trichonotus*, jumped into my net. Niki was at the shore and we filled his face mask with water and put the fish in it until we located a bucket. It turned out to be a new species of fish (. . .) I named it *Trichonotus nikii* (Table 1), after the youngest member of our expedition to the Red Sea' (Clark 68, pp. 206–208).

In the fall of 1965 Genie went to Japan, and being invited by the ichthyologist crown Prince Akihito, she brought him a small, trained nurse shark in a hat box, including a portable testing apparatus, as a gift. I advise you to read the amusing story towards the end of her *The Lady and the Sharks*. She was even assigned a geisha girl who later in the evening asked: '«Is it really true that sharks have twice as much fun as we do?» I had to think a moment before I could explain that as far as we ichthyologists knew, it is physically impossible for the male shark to insert more than one clasper at a time during copulation' (Clark 68, p. 223).

While the Laboratory grew and things became more complex, the media attention grew as well, and the fact that a woman was studying the 'fearsome' sharks added spice to the publicity. Ilias in the meantime developed a lucrative orthopedic practice in Sarasota but started to be more and more interested in business, buying oil tankers which were given names of their children. Ilias' obsession with money disturbed Genie greatly. When Chandler Brossard, the first American existentialist and author of 17 books came to interview her for his magazine *Look*, the stage was set and Genie left Ilias. She married Chandler in 1967 and moved north with her children to live again in New York City.

Genie wondered what would become of the Cape Haze Marine Laboratory and felt the best successor in the directorship would be Perry Gilbert, then head of the Shark Research Panel of the American Institute of Biological Sciences and professor at Cornell University, Ithaca. Additional support for a director's salary and for the expansion of the laboratory under such distinguished directorship was needed. William R. Mote, who had become wealthy in the transportation business, wanted to establish a marine laboratory and had consulted Genie earlier about co-operation with the Cape Haze Marine

Fig. 14. Genie and Ilias Konstantinu with their four children, from left to right, Aya, Tak, Hera and Niki, on the beach in front of their new home at the Point of Rocks in Sarasota (1959).

Laboratory. Eventually, Perry Gilbert became the new director in 1967. Bill Mote moved to Sarasota from New York, acquired new land for expansion (Fig. 11) and gradually 'the Cape Haze Marine Laboratory evolved into the Mote Marine Laboratory'.

The University of Maryland years

Somewhere between the brief marriage to Chandler Brossard, and her appointment as associate professor at the Department of Zoology, City University of New York (1966–1967), visiting professorship at the New England Institute for Medical Research (1966–1968) and joining the Department of Zoology, University of Maryland in 1968, Genie wrote her second popular book *The Lady and the Sharks* (Fig. 15) which was published in 1969. After her fourth (and last) marriage to Igor Klatzo of the National Institute of Health in 1970, dissolved in a

Table 1. Fish species described by Eugenie Clark.

Order	Family	Species and subspecies	Reference
Tetraodontiformes	Aluteridae	*Paraluteres arqat*	Clark & Gohar 23
		Brachaluteres baueri fahaqa	
	Tetraodontidae	*Lagocephalus suezensis*	
Perciformes	Trichonotidae	*Trichonotus nikii*	Clark & von Schmidt 63
	Malacanthidae	*Asymetricus oreni*	Clark & Ben-Tuvia 79
	Tripterygiidae	*Helcogramma steinitzi*	Clark 100
		Norfolkia springeri	
		Enneapterygius altipinnis	
		Enneapterygius destai	
		Enneapterygius obscurus	
		Enneapterygius pallidus	
		Helcogramma vulcana	Randall & Clark 143

few years, she settled in Bethesda where she has lived happily alone ever since in a charming house within a picturesque neighborhood of tall oak trees (Fig. 16).

At the University of Maryland, Genie's talent as a communicator had a chance to bloom further and she became 'one of the most popular teachers on the campus', Craig Phillips agrees. 'In 1969 he was Clark's first graduate student. "I remember her classes as being very exciting", Phillips says. "Her enthusiasm shined through with every lesson. Eugenie radiates energy when she talks about fish and her fervor carries over to the student. She's also one of the most gracious and natural people I've ever known." Phillips eventually earned his master's degree in zoology' (Samarrai 1992, p. 18), was director of the National Aquarium in Washington, D.C. for a while and is the illustrator of Genie's latest book, *Desert Beneath the Sea* (McGovern & Clark 138). Genie, after teaching *Ichthyology* (incidentally taught there many years ago by another scholar we honored, Vadim Vladykov, see McAllister 1988) and *Vertebrate Zoology*, introduced her most popular course, *Life in the Oceans* which she presented from 1974 until her retirement in 1992. She also taught *Ecology of Oceans, Marine Vertebrate Zoology*, and just before retirement she started to offer an honors course, *Sea Monsters and Deep Sea Sharks* which she still teaches as professor emerita.

At the University of Maryland she became a full professor in 1973, and along with her teaching career developed an exciting research program carried out in more than 20 countries. Each of her major research discoveries was popularized in an article of National Geographic magazine, 12 in total. She developed close rapport with the executive staff and photographers of the National Geographic Society of which she is justly proud. I guess that the National Geographic articles compensated for the lack of a third popular autobiographical book. She once told me with some aversion that no third 'Lady . . .' book is planned. Some of her recent major scientific papers appeared in the National Geographic Research & Exploraton, and when I tried to solicit some of these papers for this journal she claimed allegiance, free artwork and color reproductions as unbeatable advantages. No wonder that she had been featured on the covers of both National Geographic publications (Fig. 17). She is nevertheless a founding Advisory Editor of *Environmental Biology of Fishes*.

By now she has been to the Red Sea 46 times (Fishelson 1993), with her work beautifully photographed by diver-photographer David Doubilet (Fig. 18) and National Geographic staff photographers. Her teams of highly competent volunteers and students, most of them expert SCUBA divers and underwater photographers (such as David Shen and Ruth Petzold), videographers and observers, even some of her children, study the behavior and ecology of sand fishes with Genie, add valuable documentation to her field studies and are often her co-authors. She has made some wonderful discoveries thanks to her great observational talent and a 'naturalist's nose' I used to tease her about. Her observation talent is complemented by a mastery of SCUBA diving techniques (Fig. 19) and her ability to organize teams of SCUBA divers who assist in her underwater work.

During three diving trips to the Bahamas in February 1986, July 1986 and January 1987 she studied the sand tilefish, *Malacanthus plumieri*, and observed some unusual reproductive behavior (Clark et al. 126, 130). Similar studies on sand fishes were consistently pursued in the Red Sea from 1964 to 1991. Genie observed that the rare tilefish *Malacanthus latovittatus*, in contrast to the polygynous *M. plumieri*, lived in closely bonded pairs, in a monogamous social system (Clark & Pohle 141). In another study on sandfishes, Clark et al. (137) described another social system of a spotted sandperch. *Parapercis hexophtalma* live in social units of one male and two or three females in a stable, guarded territory. Each unit is also a mating group. In one of the many notes to me, Genie complained that «Jane Goodall was allowed to use nicknames for her chimps in scientific papers but I had to call the wonderful 'Boom Boom' as 'fish B'». She rectified this in her book for children with Ann McGovern *The Desert Beneath the Sea*, by naming fish B, what else, *Boom Boom* and his friends *Uncle Albert, Charlie, Fast Freddie, Mr. T.*, and *Elusive Eddie. Fast Freddie* is so fast, he mates with his 3 females in less than 4 minutes (Clark et al. 137, Fig. 11).

Fig. 18. Genie with David and Ann Doubilet at the Aburatsubo Marine Park Aquarium in 1979 during the National Geographic assignment to dive for 'sleeping' sharks in Japan's southern islands.

Herold & Clark (144) describe close pair-bonding with a monogamous mating system in a tiny Red Sea seamoth, *Eurypegasus draconis*. These rare sand-dwelling fish solved the problem of meeting the opposite sex by staying with a sexual partner for ever. These unusual fish are encased in a skin armor (carapace) which is shed whole every 1 to 5 days. The one page story 13 in the children's book *The Desert Beneath the Sea* describes the creatures admirably.

During these studies on sandfishes, 19 colonies of garden eels *Gorgasia* were observed. One colony on a steep, sandy slope was estimated to contain about 10 000 eels. Mature individuals were in the center and juveniles on the periphery of the ca. 3840 m^2 colony at Râs Mohammed in a density of up to 7 adults eels per m^2 and 14 juveniles eels per m^2, respectively (Clark et al. 134).

Genie's first paper published in this journal was on the toxic Moses sole, *Pardachirus marmoratus* from the Red Sea and the peacock sole, *P. pavoninus* from Japan and adjacent seas (Clark & George 98). During the study of the garden eels in the Red Sea in 1972 Genie discovered the shark-repelling property of the small sole and returned in 1973 to study this in detail. The Moses sole, as it is called locally, releases from glands in the base of fin rays a milky fluid that repels sharks and other predatory fishes (Clark & Chao 78, Clark 80, 88). She later dis-

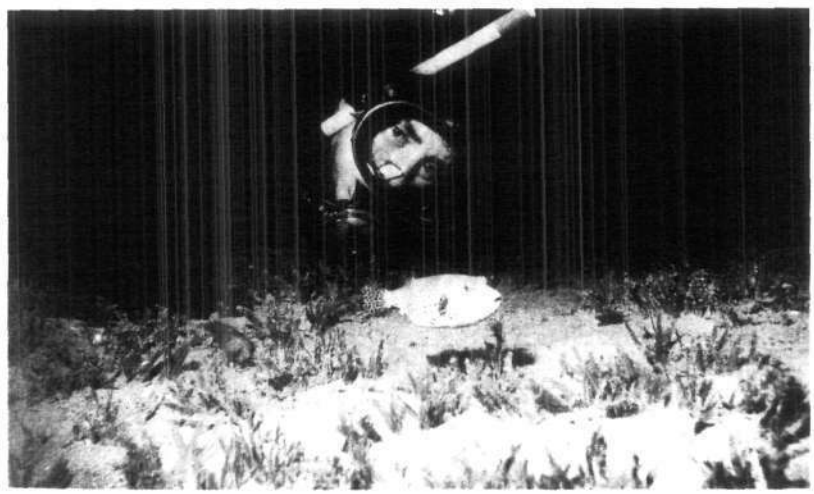

Fig. 19. Genie watching a sand-dwelling pufferfish in the Red Sea (1982). Photograph by D. Doubilet.

Fig. 20. Genie came to Toronto in February 1993 to open the shark exhibit at the Royal Ontario Museum. After her lecture she came to my favorite restaurant for a tuna sashimi. Photograph by E.K. Balon.

covered the same ability in the peacock sole (Clark 91). Moses sole on a line were observed to have an unusual effect: 'First the sharks swam toward the Moses sole with their mouths open, ready to gobble the little fish. Then, with their jaws still wide open, the sharks jerked away. They thrashed and leaped about the tank, shaking their heads wildly from side to side. All the while, the Moses sole kept swimming, as if nothing unusual was happening' (McGovern 1978). Genie concluded that if the poison can be synthesized a shark repellent may eventually become available that will protect swimmers and divers in 'shark-infested waters'. (Later she realized that such a protection is not practical or needed.) When I first visited Genie in her office at College Park, a telephone interrupted our conversation as someone was inquiring when the shark repellent will be available. I heard her answering that since it took about 40 years to synthetize insulin after its discovery, how can anyone expect the Moses sole toxin to be available in a synthetic form so soon, bearing in mind the much greater significance of insulin. I was very impressed by her answer and even more by her patiently answering such queries day after day.

The 'sleeping' shark story is equally captivating. Reacting to some local divers tales transmitted by an old acquaintance Ramon Bravo, Genie went in 1974 to Mexico but saw none. In 1975 she returned to Isla Mujeres off the Yucatan Peninsula with her 19 year old daughter Aya, student Anita George and David Doubilet to investigate again. The 'sleeping' sharks had been discovered in a cave 20 m below the sea surface. Ultimately, after 99 dives she has seen many open water sharks, mainly requiem, lying motionless on the bottom of caves. They permitted Anita, Aya and Genie close inspection and even handling. Until this discovery, streamlined sharks were thought to need non-stop swimming in order to stay alive. It was energetically

UNIVERSITY OF MASSACHUSETTS DARTMOUTH

Citation for the Conferral of the Degree

Doctor of Science

Honoris Causa on

Eugenie Clark

Eugenie Clark, explorer, chronicler, passionate student and teacher of marine mysteries, you have courted our curiosity, quickened our imaginations, and feasted our minds on intriguing facts and startling images of life in deep waters.

Out of your affinity for all the sea's inhabitants, particularly sharks, you have made astonishingly real your childhood's fantasy of living in their world. Indeed, an eager diver of 40 years' experience, you have literally dived into it, on one occasion to a depth of 12,000 feet in a submersible while searching for deep-water sharks. Known appropriately as the "Shark Lady", you have undertaken projects that have shown this fearfully beautiful but often wrongly feared creature to be much more intelligent than previously supposed. Incredibly, you have even sailed underwater on the dorsal fins of whale sharks bringing to breathtaking life the magic deeds of myths and dreams.

A pioneer of watery frontiers, you have discovered types of fish we never knew existed and have had several new discoveries named in your honor. Author of many fascinating books and articles, sailing mate of Jacques Cousteau aboard the Calypso, consultant, narrator and co-director of numerous television documentaries on marine life, you are a true and devoted citizen of the realm of Neptune.

For revealing to us the infinite variety of miracles beneath a surface most of us never penetrate, and for transmitting to us a reverence for all life that teems in the kingdom under the sea, the University of Massachusetts Dartmouth joyfully confers upon you the degree of Doctor of Science, honoris causa.

Commencement Exercises · North Dartmouth, Massachusetts

May 31, 1992

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Fig. 21. The citation for the conferal of the Doctor Honoris Causa degree from the University of Massachusetts.

too costly to pump water over gills. She concluded that freshwater coming out of the bottom of certain caves attracted the sharks. The grip of their ectoparasites loosen and enable the accompanying remoras to do a better cleaning job (Clark 77, 84, 108). This must be worth the higher energy price incurred by pumping water over the gills. She later went to study the same phenomenon in the caves of southern Japan with Anita (Clark 92).

Table 2. Fish species named after Eugenie Clark.

Order	Family	Species	Reference
Perciformes	Gobiidae	*Callogobius clarki*	Goren[1]
	Clinidae	*Sticharium clarkae*	George & Springer[2]
	Tripterygidae	*Enneapterygius clarkae*	Holleman[3]
	Sciaenidae	*Atrobucca geniae*	Ben-Tuvia & Trewavas[4]

[1] Goren, M. 1978. A new gobiid genus and seven new species from Sinai coast (Pisces: Gobiidae). Senckenbergiana biol. 59(3/4): 191–203.
[2] George, A. & V.G. Springer. 1980. Revision of the clinid fish tribe Ophiclinini, including five new species, and definition of the family Clinidae. Smithsonian Contributions to Zoology 307: 1–31.
[3] Holleman, W. 1982. Three new species and new genus of tripterygiid fishes (Blennioidei) from the Indo-West Pacific Ocean. Annals of Cape Provincial Museums Natural History 14(4): 109–127.
[4] Ben-Tuvia, A. & E. Trewavas. 1987. *Atrobucca geniae*, a new species of sciaenid fish from the Gulf of Elat (Gulf of Aqaba), Red Sea. Israel J. Zool. 34: 15–21.

Instead of a conclusion

By her own admission Genie became a diver first and scientist second. She graduated from hard-hat diving and mask-snorkeling with Carl Hubbs in 1946 to one of the best SCUBA divers. In 1986 she received the Lowell Thomas Award for Undersea Exploration by the Explorers Club, New York, and in 1993 the DEMA (Diving Equipment Manufacturers Association) Hall of Fame Award. She evolved in the sea into an aquanaut who needs half as much air than other top divers. Her aspirations go, however, beyond SCUBA. Remember her childhood hero?

Genie's status as a favored scientist of the National Geographic Society and her long collaboration with David Doubilet, a contract photographer for National Geographic, and with staff photographer Emory Kristof led to the realization of her childhood dream. She became the chief scientist on

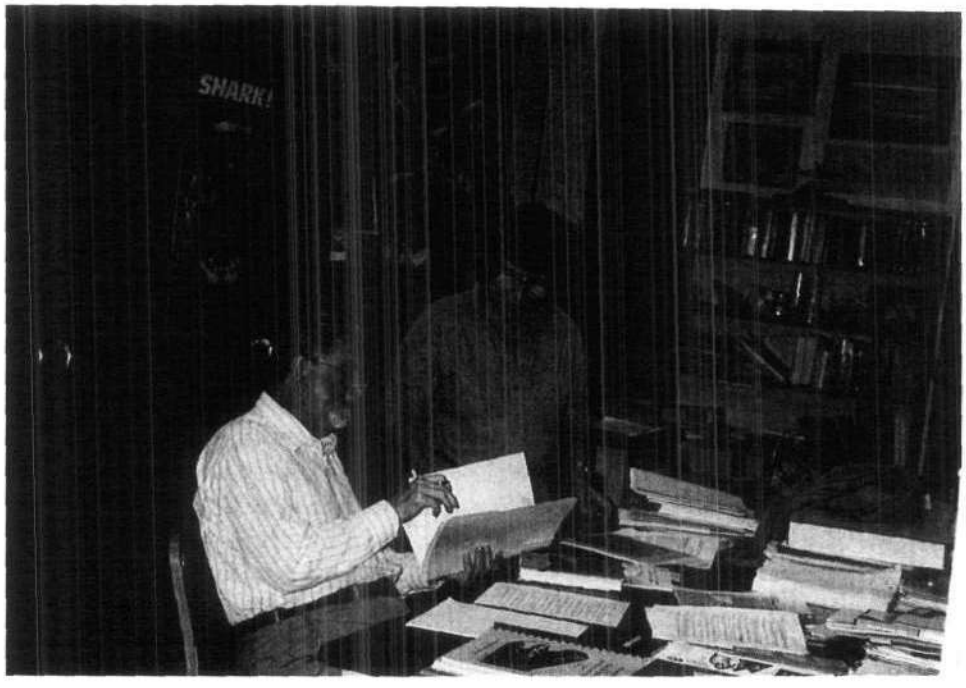

Fig. 22. During revision of Genie's lifetime list of publications in her laboratory at College Park in November 1993 I had the opportunity to see some of the unfinished manuscripts. Photograph by C. Flegler-Balon.

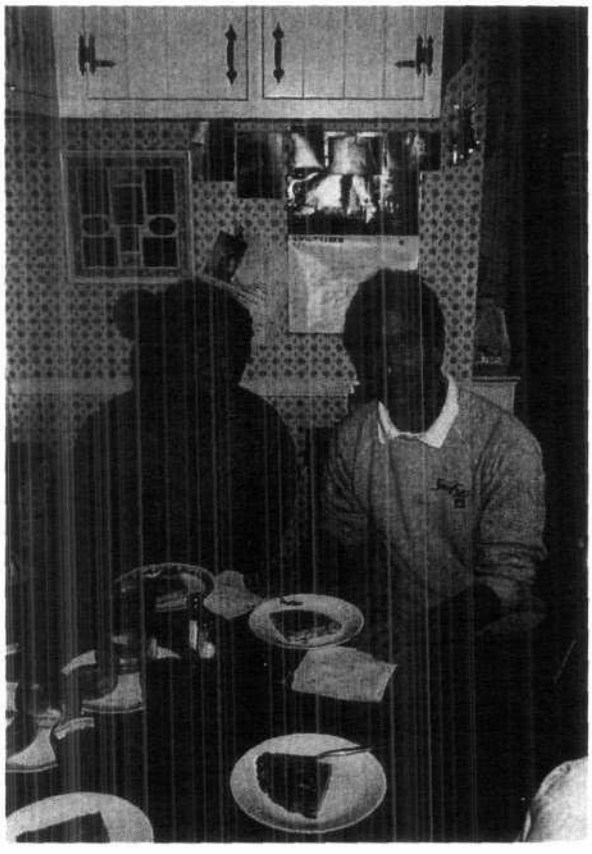

Fig. 23. Genie and her youngest son Niki at lunch in her kitchen at Bethesda, November 1993. Photograph by E.K. Balon.

many expeditions and 71 dives in seven submersibles of the Beebe Project (Beebe 1934) of Emory Kristof's program in deep-diving manned submersibles. Many other agencies participated to support this ambitious program which started in 1987. 'In these dives', write Clark & Kristof (139, p. 79), 'we lured deep sea sharks with bait to observe and photograph them in their natural habitat (. . .). With the submersible settled on the bottom during dives of 1,000 to 12,000 feet [303 to 3636 m], we set out bait and waited. The long (up to $17^{1}/_{2}$ hours), quiet dives and baiting technique have been successful in bringing in as many as 21 individual sharks in one dive. Our dive sites have been located off the coast of Bermuda, Bahamas, Grand Cayman, California's Monterey Canyon, Japan's Suruga Bay, and near the Chagos Archipelago in the Indian Ocean. Through an international effort, we have made dives down as far as 12,000 feet in the U.S. *Alvin*, the Soviet *Mir I*, the French *Nautile*, and the Canadian-made *Pisces II* and *VI*. For shallower dives of 980 to 1,200 feet we used the PC 1802 and the Johnson Sea Link'.

One of the remarkable findings of these deep dives was the prevalence of the pineal eye in the three types of sharks encountered up to 2000 m, the sixgill shark *Hexanchus griseus*, gulper sharks of the genus *Centrophorus*, and lantern sharks of the genus *Etmopterus* (Clark & Kristoff 133). Probably the pineal eye, so large that they call it rather a pineal window, can sense the amount of light penetration. No sharks were seen below 2000 m depth, but numerous bony fishes, skates and chimeras came to the bait of the deepest dives. 'The largest creature ever seen in the deep sea lumbered in front of the view ports of the submersible *Nautile* on September 13, 1989. Four thousand feet deep [1212 m], the Pacific sleeper shark, *Somniosus pacificus*, crashed into the two-by-two-foot bait cage and pushed it into the mud . . .'. Genie estimated its size as 7 m. Cam-

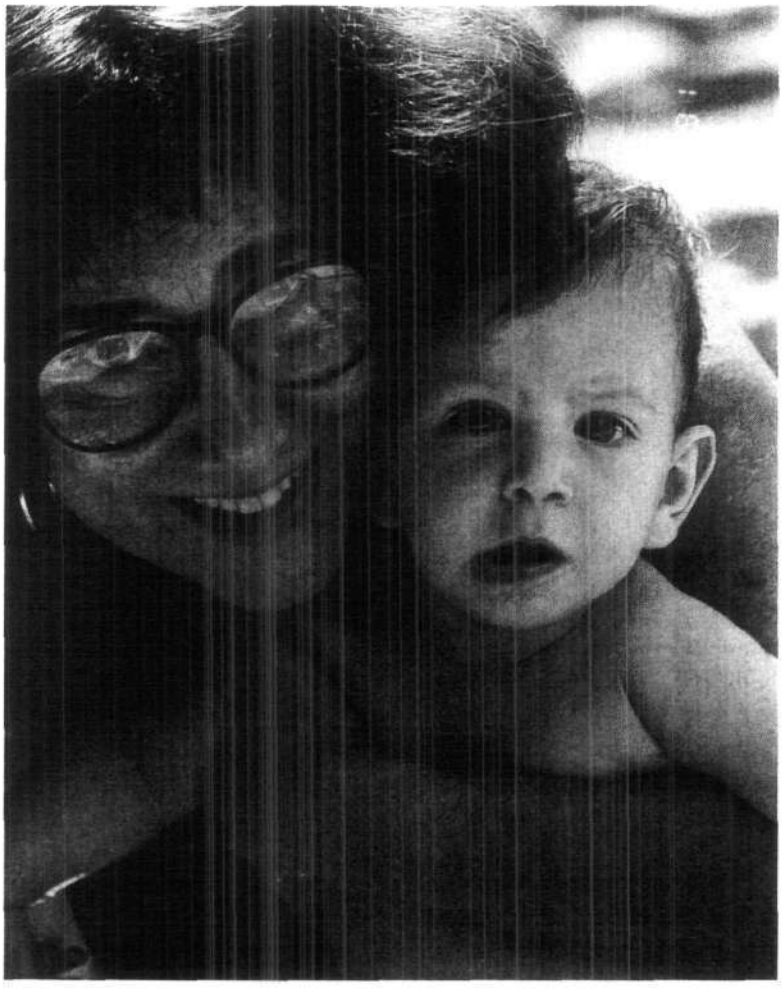

Fig. 24. Eugenie Clark and her first grandchild Eli Weiss in the summer of 1991. Photograph by Aya Weiss.

eraman Ralph White recalls: '«We saw a fish bump into a wall, and then the wall moved. The sub shook. On the shark's second pass we saw the head. Parasites hung from fluttering gills. As it left, we saw enough of the underside to determine it was female. All we could think was holy mackerel!»' (Doubilet 1990, p. 11).

Genie officially retired in 1992 but did not slow down. As professor emerita she retains her office and laboratory in the Department of Zoology, University of Maryland, continues to give her honor's course, organizes and leads expeditions to the Red Sea, Mexico, Caribbean, Australia and Papua New Guinea, and is invited to give more lectures than she can accept (Fig. 20). Genie has been a consultant, commentator, co-director or principal in 24 television specials about marine life. *The Sharks*, a National Geographic film (1982) holds the highest Nielson rating on PBS; *Reef Watch* was the first live underwater TV documentary to the U.S. with narration also from underwater. It is no surprise that lately she received the Governor's Citation of the State of Maryland, the medal of the President of the University of Maryland and Doctor of Science honoris causa from the University of Massachusetts (Fig. 21). Four species of fishes were named after her (Table 2). In February 1995, she will receive the Doctor of Science honoris causa from the University of Guelph in Canada. Having been the recipient of over 25 medals and awards and the subject of over 100 profiles in magazines and newspapers, she feels that it all far exceeds the significance of her work

and that being a female actually gave her unfair advantage over more deserving male colleagues.

Genie witnessed destruction in her favorite reef areas of the oceans and became a conscientious conservationist. Largely through her lobbying efforts, the Rās Mohammed area of the Red Sea, with coral reefs of magnificent beauty, was declared the first Egyptian national park in 1983. When I last visited her she was working on six new manuscripts (Fig. 22). Nobusan died in 1992. She keeps in close touch and dives with all her children (Fig. 23) and is enormously proud of her first grandchild Eli, son of Aya (Fig. 24).

Genie Clark contributed significantly to the exploration and public awareness of underwater life. Her popular books and articles in National Geographic reached children and adults alike, many of whom chose marine biology or related professions because of her. Her scientific papers contributed significantly to the knowledge of fishes and the sea far beyond her native America. Most of all, her radiant personality brought joy of life to all of us who are privileged to know her. Her decision for going on diving, exploring and publishing as long as she lives (Samarrai 1992) is a fascinating challenge. Looking at her willpower, form and appearance at 72, I believe she will achieve it. When the interviewer for Omni (Stein 1982) asked her what was the wildest thing she had ever done, the answer was: 'My ride on a huge whale shark. I was crazy. We wanted to study and photograph her. She was well over forty feet long. Once I got on her, I just couldn't let go. And I went far away from the photographers and the boat. The shark was cruising along steadily at three knots, and, after a while, I thought to myself, Why am I still holding on to the shark, getting farther away from the boat? And I finally let go. I did not ever want to let go'.

I am going to conclude with the words Giles Mead wrote in Tim Berra's (1977, p. 9) bibliography of Genie's hero William Beebe, for these words apply to her as well: Genie 'is best known as a popular writer, but as this work amply demonstrates, [her] popular accounts were well anchored fore and aft in scholarly work of importance'.

Acknowledgements

When I was a young ichthyology graduate, sealed in a communist cage and only dreaming about diving in tropical seas, Genie, then already the executive director of Cape Haze Marine Laboratory, supplied me with pamphlets, reprints and kind words she knows so well to scribble over any blank spaces on mailed material. She became my heroine I never hoped to meet. When we finally met in 1977, it was impossible for Eugenie and Eugene not to become friends. Many thanks to Genie for being here for me, for allowing me to raid her family albums and for correcting the clumsy attempt to present once more her life and work. My wife Christine was the first controller who constrained my temptations to write even more, and David Noakes and Mike Bruton read and corrected the first draft. Many thanks to all.

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Genie Clark (center) collects in Miami *Bathygobius soporator* with Japan's then Crown Prince, now Emperor Akihito (at her left side). With the help of Dick Robins and two graduate students they cornered finally the first specimen in a discarded beer can (29 May 1967).

Environmental Biology of Fishes **41**: 121–125, 1994.

An interview with Eugenie Clark

Eugene K. Balon
Institute of Ichthyology and Department of Zoology, University of Guelph, Guelph, Ontario N1G 2W1, Canada

Eugenie Clark who now lives in Bethesda, U.S.A. was interviewed at my residence near Guelph on 15 February 1993. The interview provides some revealing insights into the development of Genie's personality.

EB = Eugene Balon **Genie** = Eugenie Clark

EB: Many lifetime contributions to science are encouraged and inspired by personal relationships and friendships rarely identified or explained in most short biographies. Having just finished compiling an account of your 'life and work' for this volume, am left with some unanswered questions to complete the historical record. Would you allow me, therefore, some more personal questions as concerns their effects on your work, choice of taxa, location of study, etc.? The questions are not meant to be condescending but, in view of this volume's purpose, of quite some interest to communicate to others. Let us start with a conventional one: What is the most memorable event from your childhood?

Genie: At the age of nine I visited the old New York Aquarium at Battery Park on the southwestern end of Manhattan. My mother worked half a day on Saturdays at the nearby Downtown Athletic Club taking care of the cigar, cigarette, magazine and newspaper stand in the lobby of this tall building. I used to sit behind the counter all morning until she was free. Then we went to lunch at a Japanese restaurant 'Fuji' where the owner (who fell in love with my mother and later became my stepfather) showered me with presents and exotic gourmet dishes. After lunch was treat time when I had the undivided attention of my mother and she suggested various things we could do, the movies, the zoo, shopping etc. But when she took me to the aquarium I was 'hooked' on fishes. Every Saturday afternoon I wanted to watch the fishes. Her attention span was not as long as mine and I couldn't get enough of peering into the fish tanks, especially the big tank that held the sharks (sand tiger sharks) in water slightly murky green, where I could press my face against the glass by hanging over the railing. I couldn't see the back or sides of the tank and I pretended I was on the sea bottom with sharks swimming around me. I thought the sharks were beautiful, graceful, and magnificent. It was my dream to learn more about them and all the other beautiful and wondrous smaller fish.

I convinced by mother to drop me off in the aquarium in the morning and pick me up at noon instead of sitting behind her work counter at the Club. It became our regular Saturday routine. On rainy days the bums from Battery Park came into the free Aquarium and I made friends with them. Soon they came in to meet me on sunny Saturdays and I would tell them what I had learned from reading about the different fishes we watched together alive. On Saturday afternoons my mother took me to nearby aquarium supply stores and soon I had aquariums in my bedroom at home with my own living pet jewel fishes – but no sharks, of course. My dream to be underwater with sharks and swim with fishes came many years later. [**Note**: I wrote about the above in more detail in the first chapter of *Lady With a Spear* and Ann McGovern rewrote it for children in the first chapter of *Shark Lady*.]

I have mixed feelings about keeping fishes in glass 'cages' today but I realize my exposure to this as a child set the course for my life.

EB: You are now retired but still active, diving and

publishing. Can you identify a person who shaped your early career and especially your attitude to science, or who most affected your life and work?

Genie: When I was a child, William Beebe was my hero. I loved reading his books: *Jungle Days, Edge of the Jungle, Galapagos: Worlds End*, but above all his books and National Geographic articles about diving under the sea – walking on the sea bottom wearing a diving helmet set on his shoulders connected to a hose that pumped air from a boat, and diving deep into the sea in a bathysphere. I loved the way he wrote about animals and his great understanding about them.

My biology teachers and my family encouraged my enthusiasm for fishes even though my family suggested I also study typing so that I might get a job as secretary to someone like William Beebe. They were convinced I could never make a living studying fishes. But they loved me and wanted me to be happy so they bought me the books I wanted and fishes for my aquarium and enjoyed my fascinating 'hobby' themselves, thinking this was enriching my childhood, keeping me off the streets, and would evolve into something more practical as a way of life and earning a living.

After majoring in Zoology at Hunter College I started graduate school with Dr. Charles M. Breder who became my mentor, my greatest inspiration as a teacher and confidant in ichthyology. He saw nothing wrong about a young woman wanting to spend her life studying fishes. I dedicated my second book, *The Lady and the Sharks*, to him (the first was dedicated to my mother and stepfather). In the preface to the second edition of this book (published by the Mote Marine Laboratory) I express in detail what it meant to me and my children to know this brilliant ichthyologist, whose life was devoted to studying the behavior, morphology and ecology of fishes. He introduced me to plectognath fishes.

EB: How did you come to specialize in research on fishes?

Genie: When I graduated, World War II had started and there was a shortage of chemists. I worked four and a half years as a chemist, while going to night school to start graduate studies, before I was qualified for grants to study fishes. In 1948–1950 I made three grant applications as I was finishing my Ph.D. on the genetics and behavior of freshwater poeciliid fishes: to the Atomic Energy Commission to study sperm physiology and competition in fishes; to the Pacific Science Board to study poisonous plectognath fishes in Micronesia; and for a Fulbright Scholarship to study plectognath fishes in the Red Sea where I first used SCUBA. All three grants were approved and these field and laboratory studies combining my love for studying fishes and swimming, together with my basic experiences studying fishes under great teachers (Breder, Myron Gordon, Lester Aronson) at the American Museum of Natural History in New York, launched my career in ichthyology.

EB: As a young woman scientist you joined a male-dominated profession. Can you recall some relevant details?

Genie: Betty Kamp and I were the first women students in graduate school at Scripps Institute of Oceanography (1946). The great oceanographer, Harold Sverdrup was the Director. He was charming and gallant but did not allow Betty and me to go on overnight trips in our oceanography class. All day trips were OK. So we missed the trips on the high seas and to the Galapagos but in all other major aspects we were treated as equals. We had to work extra hard, expecially on field trips, to prove we could keep up with males; except with Carl Hubbs, who was married to Laura, and took it for granted that females could carry the same loads as males and do the cooking and dishwashing as well. It amused me that when I did do some of the things (e.g. diving in caves with 'sleeping' sharks) considered 'macho male accomplishments' that I was given *more* credit than males for doing the same thing they did. It helped to balance some of the prejudices against females.

When I applied to graduate school at Columbia University, the Chairman of the Zoology Department (a famous geneticist) told me, 'Well, I guess we could take you but to be honest, I can tell by looking at you, if you do finish you will probably get

married, have a bunch of kids, and never do anything in science after we have invested our time and money in you'. I went instead to NYU where the Chairman, Harry Charipper, welcomed enthusiastic zoologists, regardless of sex and where I had the good fortune to come under the magical wing of Charles Breder and the wonderful professors and students there, so many of whom became part of my lifelong friends in ichthyology. I took William King Gregory's great course in the evolution of vertebrates, as a special student, and that was enough of Columbia University for me.

EB: Can you remember any unpleasant events which occurred because you were a female in competition with males?

Genie: I already answered this but might add that early in life, perhaps because of my intense desire to be an ichthyologist, I somehow sensed that it was not wise to ever play up my role as a female or to encourage flirtations, no matter how attractive, with people I studied fishes with. It made it easier and less complicated to concentrate on my desire to learn more about fishes while keeping the respect of my colleagues. To take advantage of my femaleness, would be disrespectful to the great men I have held in awe and loved as ichthyologists. Perhaps I was just lucky that in my formative years my consuming love of ichthyology did not coincide with an ichthyologist as the great love of my life.

EB: On the other hand, which are the most touching moments you remember from your early days as a scientist?

Genie: When Dr. Breder came to visit me in Placida, Florida (1955) to see how I was coming along as 'Executive Director' of the tiny, new Cape Haze Marine Lab and I asked him about this strange little grouper colony I found where all the individuals were females, their bellies swollen with ovulated eggs and no males were around to fertilize them. I showed him a female, I had just dissected, with a big bilobed ovary full of eggs, some oozing out of the oviduct. The ovary had a white wavy band around it which on my drawing I labelled 'fat?'.

'You make good drawings', Breder commented, 'Why don't you look at a pinch of that 'fat?' under a microscope in a drop of sea water?' It was swarming with spermatozoa. I discovered where the 'males' were, as Dr. Breder continued to be my teacher in his gentle way that pointed out my errors, as always, in a most complimentary way that made me feel good while still learning. His great insight into the ways of fishes and his humble informal way of teaching and encouraging me always touched me. I worshipped him.

I was once called to examine a sea monster, a strange creature that washed up on an out of the way sand spit. It proved to be a rare beaked whale, the only one of its kind ever reported from the Gulf of Mexico. Dr. John Moore at the Smithsonian identified it from photos I sent him of the skeleton we were cleaning and asked if I'd give the rare specimen to the Smithsonian. The only thing missing was the pair of enlarged ivory teeth. We searched in the sand in vain, then advertised in the local newspaper for them and learned a fisherman had found them and given them to his 12 year old son who considered them the greatest treasure in his collection of animal oddities in what his parents (they lived in a crowded trailer) called their son's 'Junkorama'. I asked the boy to bring in the teeth so I could photograph them. Dr. Moore had authorized me to try to buy them for any reasonable (even unreasonable) sum of money so the Smithsonian could have the complete skeleton.

I showed the boy and his parents around our Cape Haze Marine Lab and explained the work we did studying marine life and showed him the skeleton of the beaked whale we had carefully cleaned – complete except for the pair of ivory teeth. He told me how much he loved and was fascinated by all the strange animals and how delighted he was to own the rare teeth I had photographed. With some misgivings I told him about the offer from Dr. Moore and asked if he would consider selling them and what he would charge.

He conferred with his parents, then came back to me. 'I don't want to sell them' he stated firmly 'but I'd like to donate them to science'. He put the 2 precious treasures in my hands and smiled proudly as he left with his parents.

Dr. Moore was as touched as I was and told me to find out if there was anything they might have in surplus at the Smithsonian that the boy might like to have as an exchange, 'thank-you' gift. There was no hesitation when I phoned the boy. 'I'd like to have a grizzly bear skin' and Dr. Moore saw to it that a skin was soon hanging in the Junkorama.

EB: Did some papers you co-authored reflect more than a working relationship?

Genie: Yes, deep friendship and on my part love and admiration for many of my co-authors. Only once did I co-author a paper with a scientist who was not an ichthyologist and get involved to a point where we became engaged. I was recently divorced from a handsome pilot, my first great love affair and I thought, the only one of my life. So I decided I should make an intelligent second marriage with someone I admired. Then I met the second great love of my life who ultimately became the father of my four children. I broke off the calculated engagement, probably best for both parties. My co-author went on to be very successful in his own field of science, winning a Noble Prize, and took a wife who wasn't absorbed in looking at fish.

EB: You published numerous scientific papers and books. Which of these are your absolute favorites?

Genie: My first book because it was easy (based in large part on letters to my family which they fruitfully saved) and was a joy to reminisce the delightful experience of my formative years as an ichthyologist, and because it surprisingly made a lot of money, was a Book-of-the-Month selection, and I could dedicate it to my mother and stepfather. My first major scientific article (on plectognath fishes) together with Dr. Breder in 1947. My paper on instrumental conditioning of sharks in Science (1959) because it showed that sharks were not stupid, mindless, man-eaters.

EB: I presume that those you mentioned contributed significantly to human knowledge. Would you mind explaining in what way?

Genie: Not really. I don't consider any of my published books or articles to be significant contributions to human knowledge. In total my popular and scientific articles have helped dispel some of the myths about sharks that are so unfair to sharks, added a piece to the puzzle here and there towards our ultimate understanding about fishes, and inspired young people, especially girls, to study sciences.

EB: Scientists often dream, at least I do, about publishing a widely read popular book, a bestseller, which would reveal also to the non-scientists the excitement and joy of our work. What did you do about such dreams?

Genie: I feel my first book *Lady with a Spear* did this in a way that has been very satisfying. I did not dream it would be as successful as it was but was especially pleased that, after I was criticized for accepting a contract that would 'prostitute science', it got good reviews and is generally respected.

EB: Did you ever have contemplative ideas which go far beyond ichthyology? Did you join any philosophical school?

Genie: No, not like you, Eugene. I'm a simple ichthyologist who tries to get the facts straight, analyze my data as carefully as I can but I don't get philosophical. Love fish. Love sharks. Keep the water and their habitats as clean and protected as possible.

EB: If it were possible to rewind the tape of life, which part would you choose to replay once, or over and over again?

Genie: None. What's done is done. I don't like repetitions. A repetition is never as fresh and delightful as the first time. It's fun to write about it but not to replay any part. There is still so much to learn and experience. Even at 71. I look forward to my next experience. And time is getting short. I don't want to replay any one part of it. So much of it has been wonderful to live through. Thinking about it is enough and there is not enough time for all of this. It is almost more fun to discuss and analyze the past

with friends and family. To rehash it exactly as it was, no thanks. I'd rather think ahead even to death and the remote possibility of 'life' after death. Wouldn't that be a surprise? It's tantalizing but how could heaven be happy with 4 ex-husbands? And would there be whale sharks to ride? And how can you ever recapture the thrill of the first time.

EB: In light of what you have just said, are you content with most of your life or would you like, given the opportunity, to edit some parts out and add some new parts?

Genie: I wouldn't want to change any of it.

EB: Would you advise young women to become ichthyologists?

Genie: Sure. I can't imagine a better life. But it's not as easy as it seems to many. There's a lot of hard work, many years of schooling, but it is worth it. Don't give up the full life – marriage, kids, for science. You can have it all if you choose a mate that is equally busy and not jealous of your work.

EB: Maybe you would like to add and answer some important questions I failed to ask?

Genie: No, I'm bushed.

EB: Thank you most cordially for your delightful cooperation.

Genie: Any egotist would cooperate for such a complimentary cause.