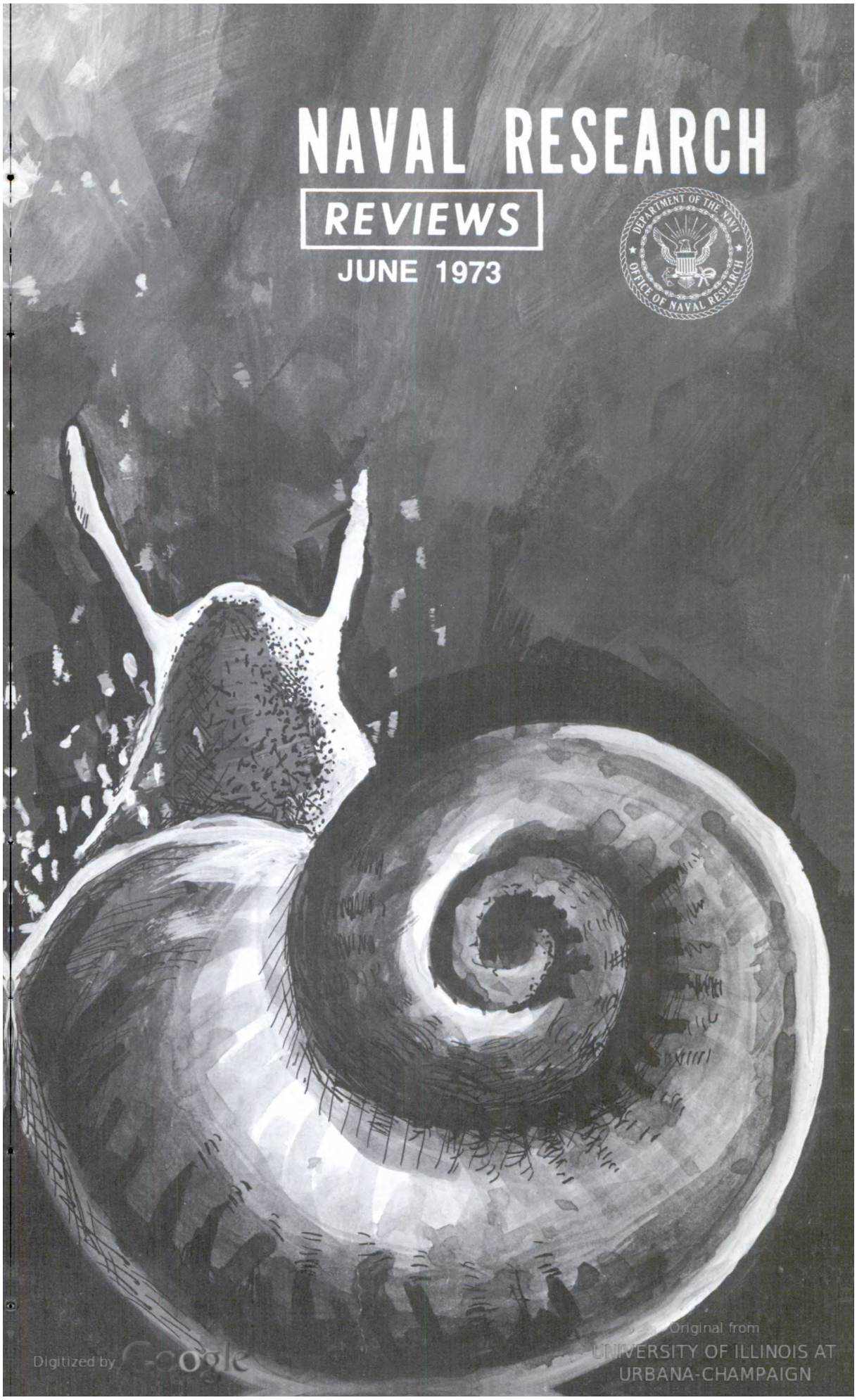

# PROFILES IN SCIENCE

*Dr. Donald Pritchard*

Dr. Donald W. Pritchard's first association with the Navy was as an advanced graduate student when he headed the Ocean Current Analysis Section at the Scripps Institution of Oceanography; and for a short time he worked at the U.S. Navy Electronics Laboratory, San Diego, on oceanographic research associated with submarine operations. For the last 25 years he has been at The Johns Hopkins University as Director of the Chesapeake Bay Institute, a research division of the University concerned with oceanographic research. For many years Dr. Pritchard has participated in ONR sponsored research projects with principal emphasis on the kinematics and dynamics of estuarine and coastal circulation, on the turbulent velocity spectrum in the ocean, and on turbulent diffusion processes.

Dr. Pritchard's classification of estuaries remains the most widely used classification system for these water bodier throughout the world. His description of estuarine circulation patterns, and his assessment of the dynamics of this circulation are classical references in this field. He was the first to describe and explain the three-layered circulation pattern which exists in some tributary estuaries. The presently widely used Rhodamine fluorescent dye tracer technique for studies of turbulent diffusion and for water quality studies was first developed and exploited by Dr. Pritchard and his associates at the Chesapeake Bay Institute. He and his students were also the first to measure the three-dimensional turbulent velocity spectrum over length scales of from a few centimeters to 10 meters. All of these studies were, in whole—or in part, supported by the Office of Naval Research.

# Will Pokeweed Extract Control the Number One Parasitic Disease?



**Akilu Lemma***
*Haile Sellassie I University*
*Addis Ababa, Ethiopia*

*The Office of Naval Research is supporting the field evaluation of the plant product Endod in the control of the snail-borne disease, schistosomiasis. The objective is to develop practical methods of using Endod for eradicating carrier snails in aquatic environments. Since snails are necessary intermediate hosts, their eradication would break the complex life cycle of the flatworm which causes schistosomiasis. The Navy is supporting this research in order to protect the health and well being of military personnel who are assigned to countries where this disease is endemic.*

Schistosomiasis, or bilharziasis, as it is also known, is now considered to be one of the most important parasitic diseases of man—more important than malaria in many countries. In tropical and subtropical regions of Africa, the Far East, the Caribbean Islands, and South America, where the disease prevails, it is spreading rapidly and causing a threat not only to the general well-being of the populace, but also to the economic development of the affected countries. It has been estimated that that about 200 million people in the world are affected by this disease (World Health Organization (W.H.O.), 1965), and the number is increasing rapidly.

Schistosomiasis is a disease caused by infection with parasitic blood flukes transmitted by aquatic snails. Adult male and female pairs of these parasites reside in small blood vessels, and the female has the capacity to lay large numbers of eggs. A single female schistosome is able to lay up to 3,500 eggs per day and has a life span of 3 to 30 years. An infected person may harbor a large number (up to 4,000) of such worms, which—along with the great mass of eggs they lay, and the host's reaction to such foreign material—cause a considerable destruction of the affected tissues.

There are three species of schistosomes affecting man. *Schistosoma mansoni,* widely distributed in Africa, the Caribbean Islands, and South America, causes intestinal schistosomiasis, affecting the liver and mesenteries. *Schistosoma haematobium,* distributed throughout Africa and the Middle East, causes urinary schistosomiasis, affecting bladder,

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ureters and kidneys. *Schistosoma japonicum,* found in the Philippines, Japan and in the subtropical regions of mainland China, causes a particularly severe form of intestinal schistosomiasis.

The life cycle involves the excretion of the parasite's eggs in human feces (*S. mansoni* and *S. japonicum*) or in urine (*S. haematobium*). When the mature egg comes in contact with water, it hatches, and the emerging free-swimming *miracidium* searches out and infects an appropriate fresh-water snail. In the snail, the parasite undergoes a complex series of developmental stages, and finally, from each parasitized snail there emerge great numbers of *cercariae,* the form that is infective to man. A single *miracidium* may multiply while in the snail intermediate host to produce many thousands of these larvae, and millions of *cercariae* are continuously released into water by infected snails. There *cercariae* swim about for a day or two in search of their next host—man. On coming in contact with human skin, they penetrate with the help of their proteolytic enzymes, enter the blood stream, pass through the lungs and the liver, and eventually find their way to the small veins in the mesentery or the pelvic region. There, male and female parasites form a semipermanent copulating pair and develop to maturity. Interestingly, female worms must have male mates in order to mature, though the males can develop independently. A schematic of the life cycle of the parasites is shown in Figure 1.

Owing to the slow development of tissue damage and the chronic nature of schistosomiasis, the extent of the pathology it imposes on infected individuals often is not fully recognized until irreversible liver and tissue destruction has occurred. Though the disease is chiefly a calamitous individual and social burden, shortening the life span but not killing outright, heavy infections can cause mortality, particularly in children. In addition to direct tissue destruction, especially in the liver, schistosomiasis may also reduce resistance to other infections and result in a substantial loss of energy, producing a state of lethargy that is an all too common sight in the Tropics.

Schistosomiasis is a typical example of a man-made disease. Most developing countries depend on agriculture for their economic development. Well-intentioned agricultural projects involving use of irrigation canals have, unfortunately, often resulted in creation of many new breeding habitats for schistosome-transmitting snails. Infected and uninfected people must drink from, bathe, and work in these canals; all too often, human wastes are excreted, dumped, or washed into the same water. This deadly combination is all that is needed for the rapid spread of schistosomiasis. Large scale agricultural schemes are urgently needed, but settlers and laborers must be healthy to realize their economic potential. The debilitating effects of bilharziasis may result in such heavy losses of manpower that economic gains may never be realized.

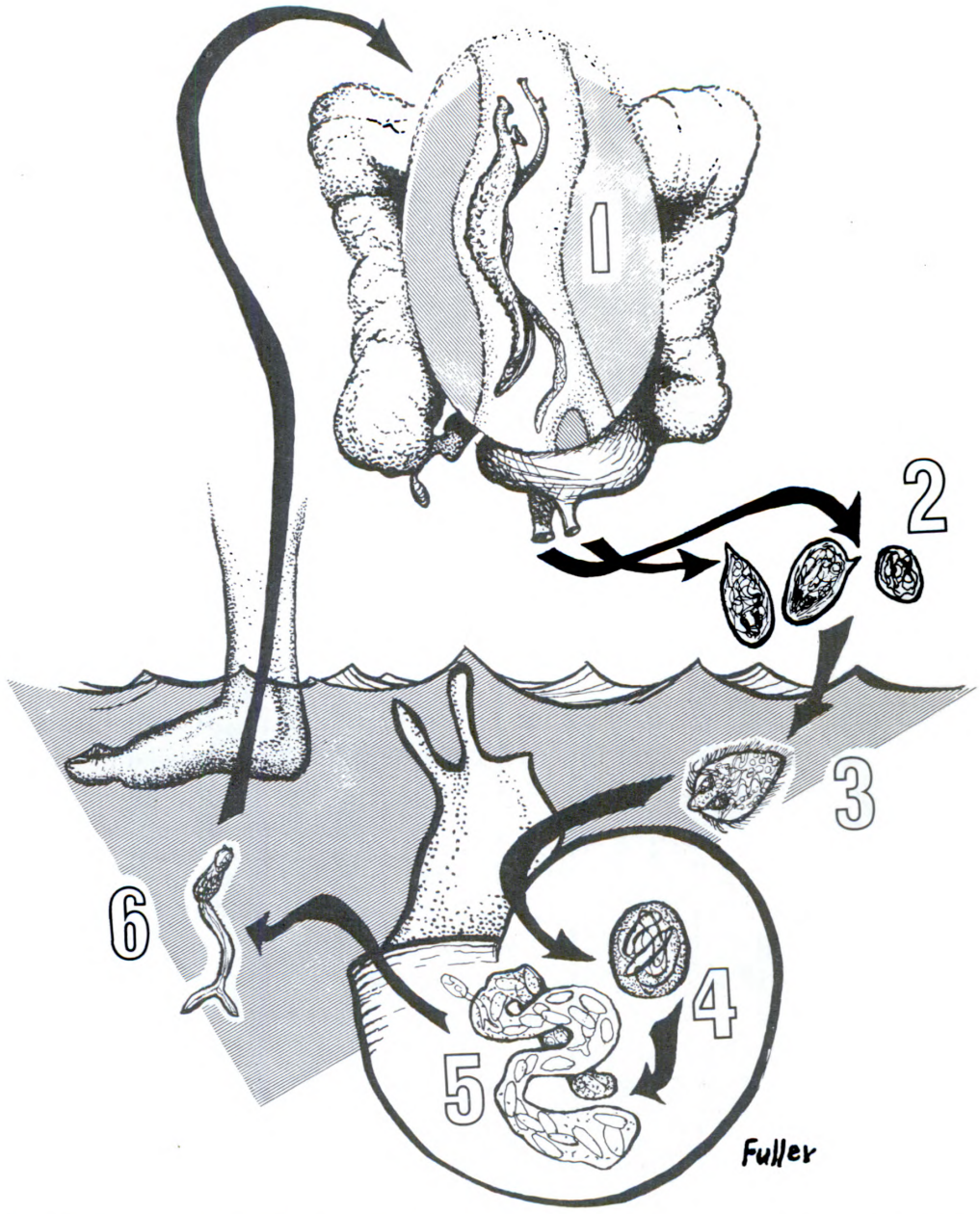


*Figure 1 — This diagram is a simplified life cycle of the schistosomes of man. 1. The adult male and female (*S. mansoni *in the illustration) live in portal vessels (*S. mansoni *and* S. japonicum*) and/or in the vessels of the urinary bladder (*S. haematobium*). 2. The eggs work their way through the bowel (*S. japonicum*-right, and* S. mansoni*-middle) or the bladder wall (*S. haematobium*-left) and are thereby excreted. 3. On reaching water, the miracidia are released and penetrate the soft parts of the snail. 4. Within the snail, mother sporocysts are formed. 5. These in turn produce the more elongate daughter sporocysts which release the infective cercaria. 6. The cercaria on bursting from the snail, swim about and invade the skin of the human host, migrate through cutaneous vessels, thus to the heart and blood vessels where the cycle is repeated as the young flukes mature in the vessels of the portal system or bladder depending on the schistosome involve.*

Conservative estimates of the annual economic loss due to schistosomiasis, based on the reduction of work-output by infected individuals and the general health damage it causes are as follows: in Egypt, about 80 million Egyptian pounds; in Iraq, 6 to 10 million Iraq dinars; in Japan, 18 million U.S. dollars; and in the Philippines, 13 million pesos (Farooq, 1964; Ansari and Junker, 1967).

There are many examples that illustrate the growing economic and public health importance of schistosomiasis. In the Aswan Province of Egypt, *S. haematobium* increased from four to forty fold within three years after introduction of perennial irrigation (Blair, 1964), and the prevalence has now risen to over eighty percent of the population (Malek, 1972). The "ecological nightmare" created by the Aswan Dam has been recently described by Heyneman (1971). About the same scale of increase in infection with schistosomiasis has also been shown for the Gerzera area in the Sudan. Another area where the disease is on the increase is the newly developing Awash Valley of Ethiopia (Lemma, 1969). When prevalence of bilharziasis began to reach alarming proportions in the Umshandige Irrigation Scheme in Rhodesia, the project had to be abandoned in 1949, after ten years of construction costing about 10 million U.S. dollars (W.H.O., 1965; Weir, 1969).

There is now no single effective way to control schistosomiasis. There is no suitable drug for mass treatment, as those available are of high toxicity and require sustained treatment and careful supervision of the patients. In any case, those treated would readily become reinfected as long as the source of infection remained. Health education and sanitary improvements would help immensely, but considering the low levels of education and standard of living of the 400-500 million people exposed to potential infection with this disease, along with the basic human dependence on water and demands made by the need for rapid agricultural development, control of schistosomiasis through education and sanitary improvements alone is unrealistic. Perhaps the single most promising approach for control of schistosomiasis is to interrupt the life cycle of the parasite by eliminating the vector snail.

Among the molluscicides developed over the past 50 years for the control of schistosomiasis and other snail-borne diseases, the oldest and most widely used are copper sulfate and sodium pentachlorophenate. New and much more effective molluscicides, Bayluscide$^{(R)}$ and Frescon$^{(R)}$, have been introduced to the market recently.

Practically speaking, any one of these molluscicides could be used successfully to control snails, and all have been so used. The key to successful use is repeated and carefully monitored use, made possible only by hard work and sufficient funds, necessitating the continuous purchase of large quantities of imported molluscicides. The hard currency needed for this is a critical matter for hard-pressed national budgets

of the affected developing countries. Hence, a molluscicide that could be locally produced and used as needed would be ideal. To this end, during the past eight years we have been studying and developing the potentials of a promising plant product molluscicide, Endod, for possible use in the control of schistosomiasis on a sustained "self-help" basis.

Endod is the Ethiopian name for the soapberry plant, *Phytolacca dodecandra,* berries of which are widely used as soap (Figure 2). In 1964, while making an ecological study of the distribution of schistosome-transmitting snails in a small stream in northern Ethiopia, the author observed large numbers of dead snails in areas immediately below the spots where people washed clothes with Endod. The areas up stream and further down stream from such spots had abundant live snails. This led to the discovery of the molluscicidal property of Endod. Since then, there have been numerous studies done on this subject (Lemma, 1965a; 1970a,b; 1971; Lemma and Duncan, 1970; Yohannes, 1970; King, *et al.* 1968).

Sun-dried, crude, ground Endod berries suspended in aqueous solution kill schistosome-transmitting snails at concentrations of 15-30 pounds per million within 24 hours. This molluscicidal potency remains stable over a wide range of pH (5 to 9) values, in the presence of various concentrations of organic and inorganic matter, and after irradiation with ultraviolet light. Its toxicity to mammals and plants is very low. The $LD_{50}$ (the concentration that kills 50% of test animals) is 2.6 g/kg body weight for mice, 6.5 g/kg body weight for sheep and 2.5 g/kg body weight for monkeys. Birds normally feed on the berries in the forest. Continuous application of highly concentrated solutions also appeared not to affect a variety of plants of economic importance (Lemma, 1970a; Yohannes, 1970).

Encouraged by the preliminary results, we undertook a relatively largescale field trial in Adwa, an agricultural community of 17,000 in northern Ethiopia. From previous investigations (Lemma, 1965b; Buck *et al,* 1965), it was known that approximately 65% of the population were infected with *Schistosoma mansoni.* The sources of infection are two relatively small and isolated streams. They originate from springs and run across the middle of the town and they are extensively utilized by both adults and children. Great numbers of *Biomphalaria pfeifferi,* the Ethiopian vector snail, breed in these rivers and up to 60% of them were infected. A program was developed to control those snail populations by systematic application of Endod over a five-year period. Beginning in 1969, we checked the effectiveness of these efforts by observing the incidence of disease in the human population, particularly among children one to five years old. To establish baseline data before applying the molluscicide, we determined the prevalence rate of infection in 10% of randomly picked inhabitants. We used aerial photographs to ensure

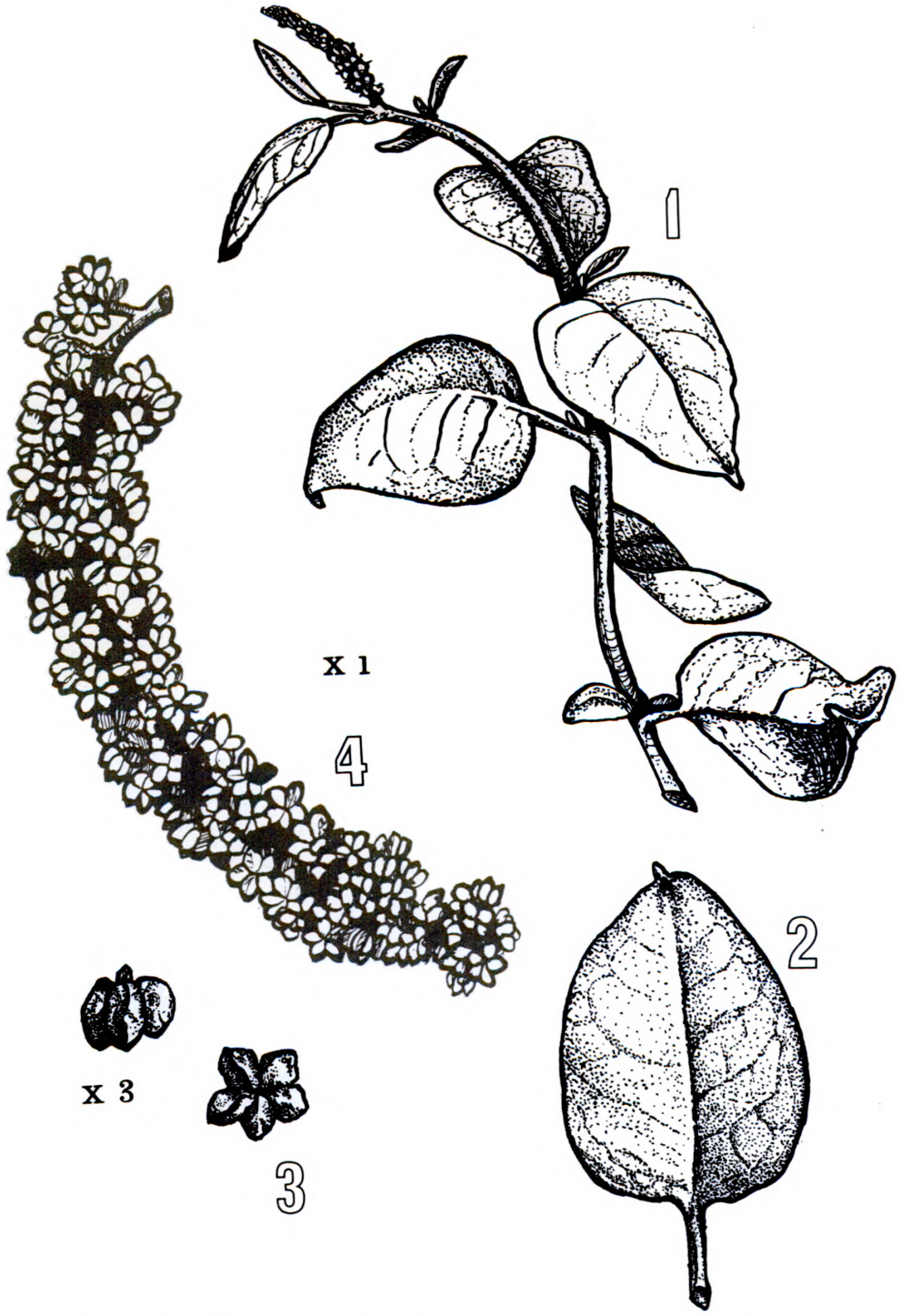


*Figure 2* — **Phytolacca dodecandra** *(Endod plant). 1. Distal portion of a branch showing the leaves and immature fruits. 2. Dorsal surface of an individual leaf. 3. Dried fruit of individual flowers (enlarged ×3). 4. Infructescence natural size.*

every house in Adwa was numbered and located. Houses were selected randomly; the families were identified, and stool specimens were collected and examined for eggs. About 70% of the total population had *Schistosoma mansoni,* and 48% of the children between the ages of 1 and 5 were infected.

Application of the molluscicide involved very simple procedures, so that the local residents could continue the program. The dried berries were ground and suspended in water. Proper concentrations were poured from buckets along the shores or made to flow at a constant rate from barrels placed above the river. Using a concentration of about 100 pounds per million (ppm) for a 4 to 6 hour exposure time, in a few days almost all the snails were killed and washed downstream.

An interim evaluation of the Adwa project made two-and-half years after its start, revealed the following: (1) Endod is effective in controlling the snail population; (2) continuous application of this molluscicide did not have any apparent effect on the flora and fauna of the rivers; (3) the control program resulted in the reduction of the incidence of schistosomiasis from 48% to 15% among the 1- to 5-year old children in Adwa, while the incidence of disease among untreated children in the nearby control village of Intitcho increased by 10%; and (4) rates of infection with other parasites (intestinal worms) in both Adwa and the control village of Intitcho remained the same, thus showing the specific control of schistosomiasis (Flemings and Goll, 1971).

During 1970-72 at the Stanford Research Institute in California, we undertook the following interdisciplinary chemical and biological studies:

1. to determine the structures and functions of the active principle in the Endod berry.
2. to develop an extraction procedure to concentrate the active components,
3. to determine fish and mammalian toxicity of the purified material, and
4. to develop a chemical assay for these components when in aqueous solutions.

Our studies to date indicate that one of the main active components in the berries may be an oleanolic acid with three glucose units attached to it. The exact location and relationship of these sugars to the oleanolic acid is now being determined (Parkhurst, *et al,* in preparation).

A simple and effective procedure to extract and concentrate the molluscicide material from the berries has been developed. This involves butanol extraction of an aqueous solution of the berries, followed by an ether wash to remove inactive, fat-soluble impurities. The butanol extract is a light tan powder, about 20% of the original berry weight.

Its potency ($LC_{90}$* for 24 hours) against different species of snails is 2-3 ppm as opposed to 15 to 30 ppm of raw berries (a seven to tenfold increase in potency). We have made a considerable effort to simplify the extraction procedure to make it amenable to inexpensive utilization in the field (Lemma *et al,* 1971).

Since Endod is a natural plant product, the berries can be grown and harvested locally and, with proper genetic studies, strains with increased molluscicidal potency can be selected and cultivated for largescale use. Purification of the berries is simple. The major solvent necessary for the extraction, butyl-alcohol, can readily be produced locally by microbial fermentation of molasses (an industrial waste-product in many developing countries).

Unlike other molluscicides, Endod has an important added advantage in that it is a useful detergent. It has no deleterious effect on colour or fiber of delicate fabrics. It is also locally believed that clothes and human hair washed with Endod become free of lice and ticks, and there is, in fact, some experimental evidence to support this. Thus, Endod might be developed and processed for wide-scale use as soap.

Endod will also kill the larval stages of the schistosome parasite at very low concentrations; 1 to 2 ppm of the butanol extract is sufficient to kill *schistosome* miracidia and cercaria. Human waste and polluted water can be treated with Endod and rendered free from these larval stages of the parasite, thus interrupting its life cycle at yet another important stage. Also, a 5% concentration of the extract with an ointment base may be topically applied to the skin to prevent cercarial penetration.

Another advantage of Endod is that it is highly toxic to the aquatic and land leeches that are important pests of domestic animals and man in the tropics.

Unlike some of the other molluscicides and the chlorinated hydrocarbon pesticides, Endod has the advantage of being rapidly biodegraded. This has been shown to be primarily due to bacterial degradation of the sugar components of the active principle. In a comparative test, 0.2 ppm of Bayluscide, another molluscicide, remained active for more than three months.

In view of the encouraging results and promising potential of Endod, additional studies should now be undertaken. One of the most important would be to determine the short- and long-range ecological effects of continuous application of the molluscicide on the flora and fauna of the treated bodies of water. The development of improved strains of Endod by controlled genetic selection should be undertaken, and agronomic studies to determine the environmental factors that affect the growth

*Lethal concentration of Endod necessary to kill 90% of test organisms.

and production of the plant should be encouraged. Adequate methodology should be developed for preparation of the purified product at the village level, along with a program to encourage its use as soap, and as a chemoprophylactic for protection against cercaria. The possibilities of developing synthetic analogs of the glucoside of oleanolic acid for a more effective biodegradable molluscicide not toxic to fish should also be explored.

The organic chemistry, biochemistry, and pharmacology of the triterpenoid spaonins of Endod berries should be fully studied. For example, the roots of the Endod plant, which contain saponins, are widely used for medicinal purposes in Ethiopia and elsewhere, and are believed to be highly toxic to mammals, including man. But these roots do not have any effect against snails, even in a concentration as high as 1000 ppm, whereas the berries, which are not toxic to mammals, kill snails at 15-30 ppm. Furthermore, saponins from the berries of a closely related species, *Phytolacca america* (*P. decandra*), have no activity against snails. The relationships and specificity of these saponins should be investigated.

Studies to determine the basis for the specificity of the saponins from Endod and its mode of action against snails, may provide further valuable information that may in turn enable us to improve the molluscicidal potency of Endod and to reduce its toxicity to non-target organisms. This may also guide future searches for alternative sources of such a product.

The ultimate goal of our studies is to develop an integrated program of schistosomiasis control on a community self-help basis. Schistosomiasis involves interaction and activities of humans, their communities, and their developmental programs. Any effective control will depend on cooperative participation by the affected communities. A multiple approach to the problem must be sought. Development of a health education program, based on local cultural and behaviorial aspects, and water-contact and sanitation habits of the people, is essential. Mass treatment of infected individuals, when an appropriate drug becomes available, must also be on the program. The elimination of vector snails by use of chemicals such as Endod, perhaps tied to carefully planned biocontrol systems to disrupt the snail host and/or the schistosome parasite, is another important aspect.

Community involvement through health education, active participation by the people involved, and the systematic application of locally grown and processed Endod should become routine. These activities by individuals, families, and villages, when developed into a long-range control of the disease, become truly a self-help form of health control by the people themselves. The work in Adwa has already pointed the way, a path we shall actively pursue.

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# Improved Aircraft Capability Through Variable Camber

**Doug Miller***
*Boeing Aerospace Company*

*Over the years the Office of Naval Research has been sponsoring research to improve aircraft wing design. This research will provide future Navy fighter and attack planes with improved capabilities in maneuvering, buffet margins, effective cruise speed, and low altitude penetration. The most promising design seems to be the flexible skin variable camber wing concept. Variable camber means that the airplane wing changes its shape for different flight situations. A flexible skin covers the leading and trailing edges of the wing and stretches to allow for the change in wing curvature. The objective of this study is to demonstrate conclusively, by a comprehensive wind tunnel test program and analysis, the degree of performance improvement that variable camber flexible skin technology can provide when applied to wing design.*

## History of Variable Camber Design

Aircraft became practical when they achieved the ability to takeoff, and land within limitations imposed by operational and economic considerations and deliver a payload of significant economic, volumetric or mass characteristics more effectively than any other means. All this is to be done by an aircraft capable of manned control which must be maintained over a useful lifetime. World War I initially directed this new found practicality towards reconnaissance over land armies and coastal patrol duties. However, these same pioneer coastal patrol aircraft were soon demonstrating combat capabilities never contemplated by their most visionary designers.

In one daring mission just five months after the beginning of hostilities, on Christmas Day 1914, the Royal Naval Air Service (RNAS) launched a raid against the Zepplin hangars at Cuxhaven. The raiding force of seven seaplanes was carried across the North Sea by Royal Navy seaplane carriers. The raiding aircraft had, under good conditions and depending on type, top speeds of 60 to 76 mph. When loaded with bombs and fueled for their hundred mile radius missions, some of these aircraft could not be coaxed to climb higher than 600 feet and were on later operations downed by rifle fire from the ground.

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The persistence of such prewar designs in the RNAS was typified by the single-seat Sopwith BABY seaplane. The Sopwith BABY fighting scout was a production version of the airplane that won the 1914 Schneider Trophy race with an average speed of 86-75 mph (this airplane was in fact basically a 1913 landplane design with a float undercarriage). By early 1916, a strike load for a BABY might consist of: two 65-lb bombs, a Lewis gun, ammunition, emergency rations, a sea anchor and—a pigeon. Due to the common practice of overloading the aircraft, they were somewhat dangerous to fly. A number of modifications subsequently, contributed to improved flying performance.

"Brute force," a 30 hp increase to 130 hp, was one answer. In another modification, the BABY's flat, thin wing was replaced with a highly curved or cambered wing that produced much greater lift but at the expense of some speed (77 mph *vs* 87 mph). The most radical and most successful approach to improving the BABY's performance, was the incorporation of the Fairey Aviation Companys' "Patent Camber Gear." This contribution to improved flight consisted of full-span, hinged, trailing edge flaps (Figure 1) that were used either as ailerons or as devices to increase lift. Performance trials were successful and some of the 180 aircraft that were subsequently built with the variable camber feature were still operational at the end of the war.

The variable camber flaps were pilot controlled and were used to improve off-design-point performance. They permitted, for example, the BABY, a single seat fighter scout, to carry a significant bomb load while maintaining flying qualities that could be tolerated by the average, marginally trained pilot of that era. Deflecting the flaps provided the highly cambered section with an increased lift capability, required for

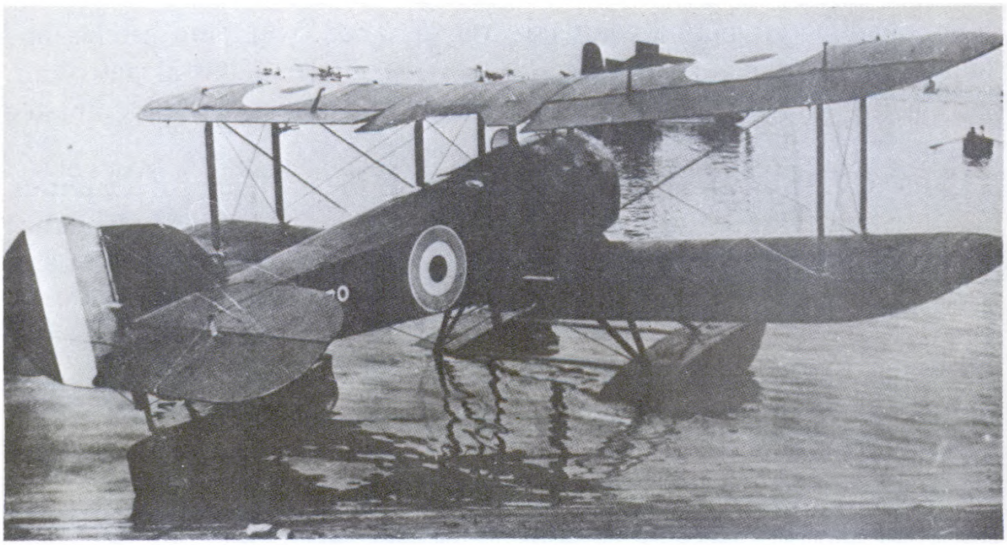

*Figure 1 — Sopwith Baby with Fairey Aviation Company Variable Camber Trailing Edge Flap*

carrying "heavy" bomb loads and for "high altitude" Zepplin interception. This improved lift capability could be obtained without sacrifice of the "high speed" performance required of a fighting scout by simply moving the flap to its undeflected position thereby obtaining the relatively flat airfoil of the Schneider Trophy winning racer. In a sense, the camber system ungraded the BABY's 1913 aerodynamic technology in a manner that allowed the airfrace to keep pace with military requirements and engine developments. The result was one of the earliest multi-mission fighter-attack aircraft.

The operational success enjoyed by the Fairey Camber Gear resulted in its being utilized in 1917 for the biplane Fairey III which appeared with both float and wheeled undercarriage. (In excess of 600 Fairey III's were built through 1932 and the aircraft was not declared obsolete until 1940.) The patented Fairey Camber Gear was far more than just a takeoff and landing high lift device; it was directly controlled by the pilot to tailor the wings' airfoil sections to provide a desired level of aerodynamic performance. Typically, trailing edge settings for the Fairey III were: minus 2° for best speed, plus 4° for takeoff and plus 8° for landing (Figure 2).

While the perspicacity of the Fairey Company in applying variable camber to continuing production aircraft will be appreciated, the role of the Royal Aeronautical Factory in developing this technology should not be overlooked. It was this latter organization that developed and flew the forerunner of the Fairey variable camber system on the SE4 and SE4a as full scale manned technology demonstrators, (at the factory the SE4a was succeeded by the immortal SE5). The SE4 had overall clean lines as well as the trailing edge flap (Figure 3).

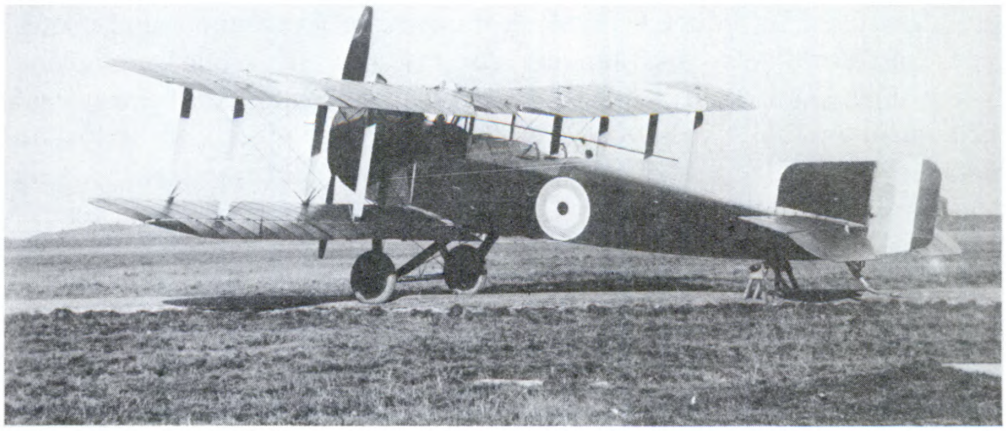

*Figure 2 — The biplane Fairey III*

*Figure 3 — The SE 4a*

Whether the French benefitted from this work, or whether they developed their variable camber approach independently is uncertain. They did in 1916, initiate work on the design of the Brequet Type XIV, the early bomber versions of which had, on their lower wings, trailing edge flaps capable of limited depression angles. These were not controlled by the pilots as was the case with the British systems but utilized an automatic deployment system consisting of rubber bungee cords which pulled the flaps into their lowered position as airspeed dropped. At speeds above 70 mph, airloads raised the flaps to conform to the airfoil section. These flaps were eventually abandoned when changes were made to the wing platform, wing structure and wing mounted bomb racks. The number of war time Brequet 14's produced probably approached 5500 but the portion employing variable camber is unknown (Figure 4).

During the 1930's, advances in airfoil and wing design, powerplants and structures, introduced the sleek monoplane forerunners and prototypes of World War II's famous combat aircraft. While monoplane speeds increased, their wing loadings also increased significantly and their maneuverability reduced compared to the agile, lightly loaded biplanes. This decreased maneuverability was accepted to varying degrees by all of the major powers with the exception of the Japanese. Japanese Army aviators adamantly refused to consider further degradations in maneuverability as they test flew their second generation monoplane fighter, the Nakajima Ki. 43 OSCAR. As a result, a major redeisgn of the "OSCAR" was undertaken in 1939. In addition to slight increases in wing area, and some weight reductions, Nakajima introduced so-called "combat" or "battle" flaps. When extended during combat maneuvers, the flaps provided additional lift with a minimum increase in drag,

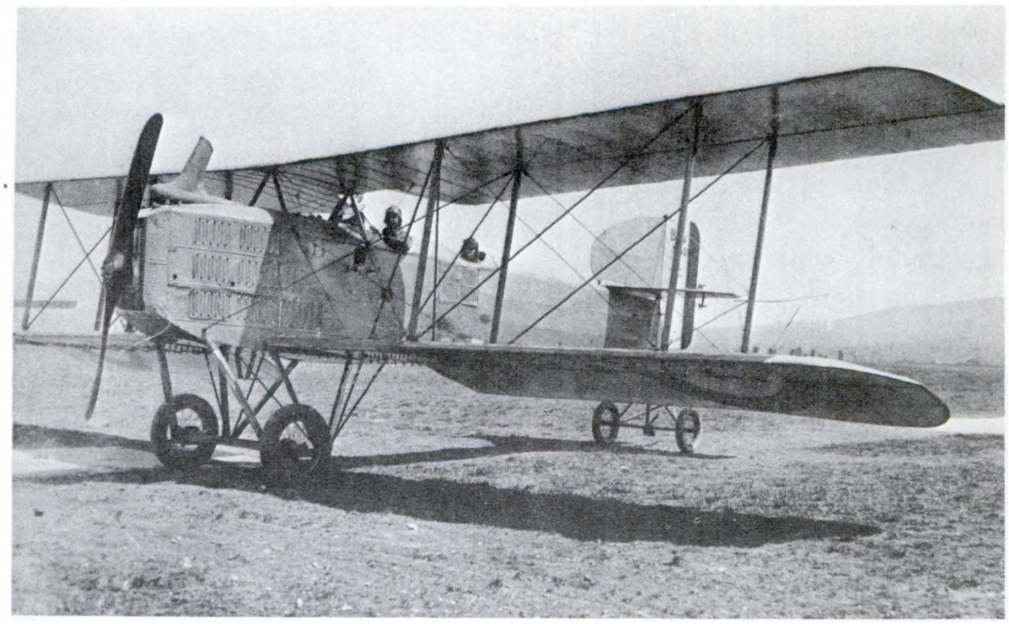

*Figure 4 — The Brequet Type XIV*

increased turn rate and very important, improved control response. While all controls were extremely sensitive, the OSCAR was very pleasant to fly and completely devoid of vicious flight characteristics. Because of the innovative combat flaps, the Ki. 43 may have been the most maneuverable fighter used in World War II and J.A.A.F. pilots switched from rejection of their new fighter to enthusiastic acceptance.

Because of this success, Nakajima included combat flaps in each of its subsequent fighter designs. These included the highly loaded Ki. 44 TOJO interceptor and the Ki. 84 FRANK. The FRANK could out maneuver, out climb and was marginally faster than the P-51H and the P-47N. The FRANK was even able to fight the F6F Hellcat on fairly even terms. In its combat debut, at Leyte, one damaged FRANK, with canopy gone and one landing gear partially extended was able to outmaneuver and escape from four F4U CORSAIRS.

The traditional Japanese Navy suppliers, Kawanishi and Mitsubishi also adopted combat flaps into the design of their NIKI-J GEORGE and J2M2-7 JACK fighters. The GEORGE possessed outstanding maneuverability due to its combat flaps which changed angle *automatically* as a function of maneuver g's (the gravitational pull). GEORGE pilots looked on the F6F HELLCAT as a relatively easy "kill."

Unlike the Japanese, the Europeans and the American manufacturers did not develop combat flaps in World War II although they anxiously pursued improved maneuverability. The P-51 MUSTANG however, when in RAF squadrons, was frequently flown in combat with a ten degree setting of its takeoff and landing flaps in order to improve its already excellent maneuver capability.

While these World War II maneuver flaps were not truly variable camber systems, they did address directly the classic airplane design compromise between maximum flight speed at relatively low lift coefficient and buffet free flight at high lift coefficients. As with the Fairey built version of the Sopwith BABY, the World War II maneuver flap was a variable geometry device which increased lift by adding effective camber only when needed so that the drag penalties of a large amount of built-in camber could be avoided to obtain maximum speed.

### How Valuable Camber Design Effects Flight Problems

The interactions between drag and airfoil camber and between lift capability and airfoil camber are depicted in Figure 5. The lift-drag polars shown in Figure 5A describe the manner in which increasing camber increases the lift coefficient at which minimum drag will occur. When power was limited, as was the case with World War II piston engines, it is necessary to select an airfoil camber that will provide minimum drag at the lift coefficient corresponding to the design weight and altitude conditions. Camber, greater than this value, will limit speed capability.

More camber is needed to improve maneuverability. As can be seen in Figure 5A, a highly cambered airfoil will significantly reduce drag at the high lift coefficients required for air combat. Thus, high camber permits higher "g" maneuvers which in turn allow quicker, tighter turns without literally losing the speed advantage and "falling out of the sky."

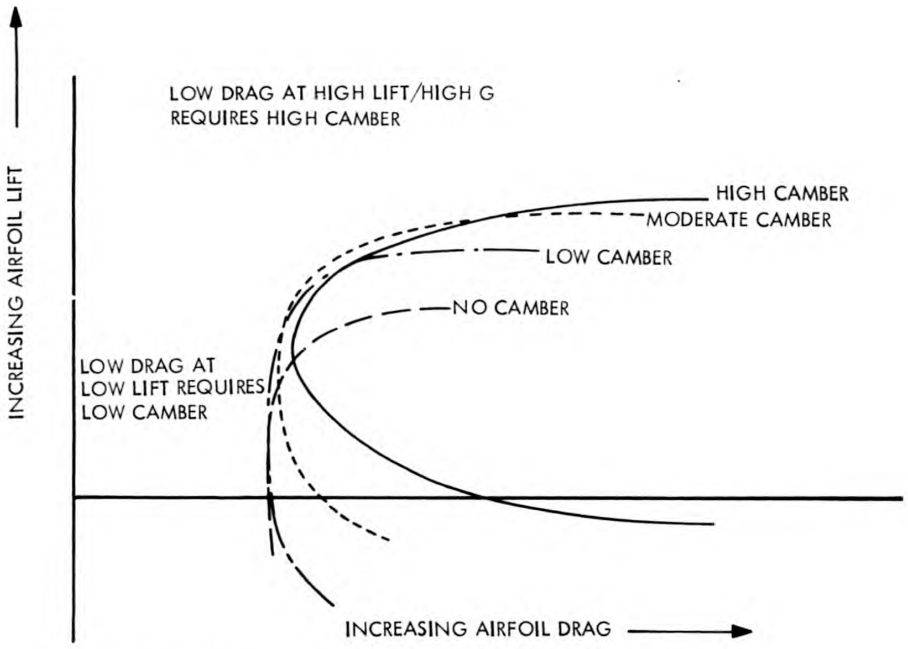


*Figure 5A — Camber requirements for best performance*

As high lift coefficients, the airfoil, with relatively low camber, will also "stall out." To the fighter pilot, the approach to the high speed stall is felt as a severe buffeting in the airframe. This buffeting results from the rapid fluctuations of the separating boundary layer over wing. Generally, as full stall is approached, the intensity of the buffet increases, and based on the airplanes configuration, oscillatory motions will buildup to the point where they could prohibit tracking capability. Figure 5B illustrates the manner in which camber will influence the onset of buffet or initial stall as a function of flight Mach number. Figure 5 shows that as Mach number increases, less and less camber can be tolerated before buffet onset occurs. The reason is that the cause of the boundary layer separation is rapidly changing from a classic low speed stall to a shock induced separation.

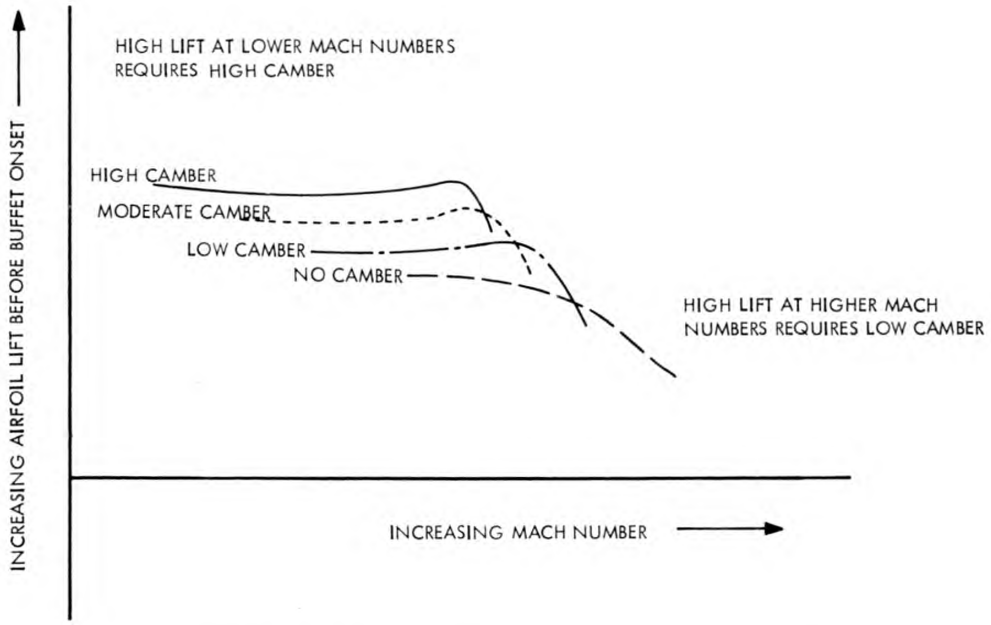


*Figure 5B — Camber requirements for best performance*

**Overcoming Buffet Problems**

This shock terminates a region of local supersonic flow over the airfoil. The supersonic flow can occur even through free stream Mach numbers are subsonic. These locally supersonic velocities results from flow over the airfoil accelerating over the curved upper surface. At some point a shock will occur, re-establishing subsonic flow so that necessary trailing edge pressure relationships can be satisfied. When airfoil curvature and free stream Mach numbers combine in a manner yielding a strong shock, a shock across which a strong pressure rise occurs, boundary layer separation and buffet can occur.

The shock and resulting boundary layer separation also cause large increases in drag which increase quite rapidly with small increases in the subsonic free stream Mach number. Of possibly even greater consequence are the potential substantial deteriorations in stability and controllability which are caused by the changes in the wing pressure distribution and by the tail possibly operating in fluctuating low energy wake. Wing-to-wing fluctuations will cause rolling and yawing oscillations of significant magnitude. Up to a point, the classic cure for these situations have been to thin down the airfoil thus reducing surface curvature, moving the point of maximum thickness aft and, as noted, reducing camber. In the span of some five years, that elapsed between the F6F (first flight in 1942) wing root thickness dropped from 16 percent to 11 percent of the local chord. The wing root thickness of the F-8, which first flew in 1955, was a mere 6 percent of the local chord. The thickness of the F-8 was dictated primarily by consideration of supersonic wave drag, which increases approximately as the square of the wing thickness, and not by transonic buffet considerations. The thin airfoil, however, has very poor lifting capability at subsonic and transonic conditions, generally experiencing a sharp pressure peak and resulting boundary layer separation near the leading edge.

Because the thin wing high speed stall and buffet problem is associated with leading edge separation, the leading edge slat has been used to alleviate the problem. F-86/FJ-2 slats improved high speed stall and buffet characteristics up to about .85 Mach number. (A leading edge slat is a piece of wing which can be extended and protracted at the end of the wings for better maneuverability in different flight situations.) Asymetric opening and closing of the air-pressure-actuated F-86 slats caused many difficulties during the F-86 *vs* MlG-15 engagements. The slats also increased drag when extended. One of the combat fixes to upgrade the F-86's high altitude combat performance included wiring the slats shut. Slats subsequently disappeared and reappeared on the leading edges of various F-86s, FJs and SABRES. Finally, slats made their most recent appearance as a retrofit fix for the thin winged F-4Es stall and buffet problems. (Thus, slats have come full circle, having been invented by Fredrick Handley-Page, and G. V. Lachman, to fix the leading edge stall problem of the thin winged World War I biplanes).

Leading edge flaps represent another means of fixing the leading edge stall problems of thin wings. (The leading edge flaps are hinged sections of the wing which can be flipped a number of degrees for better maneuverability in different flight situations.) They have generally been favored over slats because their drag is less than that of slats. The F-8 and F-105 are examples of thin winged supersonic aircraft using leading edge flaps. For takeoff and landing, these leading edge devices are deflected 20-25 degrees and operate in conjunction with trailing

edge flaps. Both aircraft use a partial deflection of the leading edge flap, to about 7 degrees, to improve cruise drag and delay buffet onset in the transonic combat arena. However, recent analytical work and wind tunnel tests have shown that, if the leading edge could be adjusted over a wider range of deflections, matching requirements of various maneuver Mach numbers and angles of attack, then substantial improvements in maneuver performance could be achieved. This is especially true when trailing edge flap deflection can be employed in conjunction with the leading edge.

Some of this effort has been accomplished on a wing planform that is virtually identical to that of the F-8 permitting direct comparisons to be made of the advantages of variable camber maneuver flaps. This planform could also meet the anticipated requirements of future VF/VA aircraft. The basic airfoils of the advanced technology wing studied were designed to provide improved performance over the 1940-1950 developed NACA airfoils used on the F-8.

The application of advanced airfoil technology and improved wing design techniques results in a delay in buffet onset lift coefficient of approximately two tenths in the important combat maneuver region between 0.70 and 0.90 Mach number, as shown in Figure 6. Use of variable camber, in the form of "simple hinge" maneuver flaps, adds another large increment of buffet-free flight, an increment which provides a buffet-free lift capability twice that of the state-of-the-art F-8 wing.

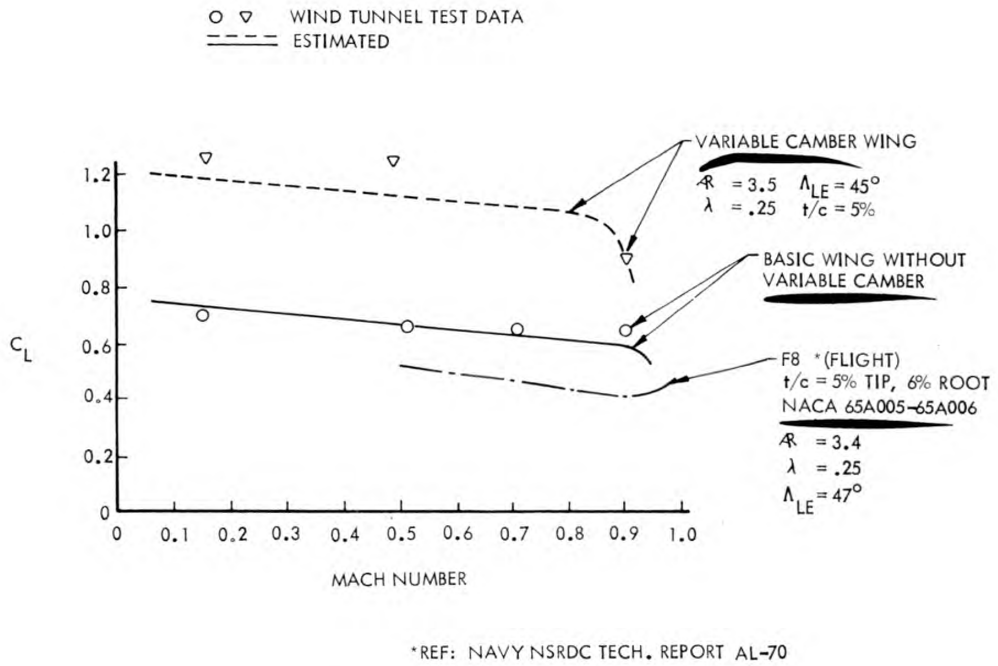


*Figure 6 — Separation onset boundaries for thin wings are improved with variable camber*

As noted in Figure 6, both wings have essentially the same planform and thickness ratio, the only significant differences being in the application of a new and advanced airfoil and in the use of variable camber.

### Variable Camber Design Reduces Drag

Figure 7 illustrates the dramatic reduction in maneuvering drag that can be obtained through the use of the advanced wing design utilizing variable camber. In Figure 7, the drag due to lift (including trim drag) of several aircraft is compared for a Mach 0.90 maneuvering condition at a lift coefficient of 0.70 (corresponding to a 4.3 g maneuver load factor

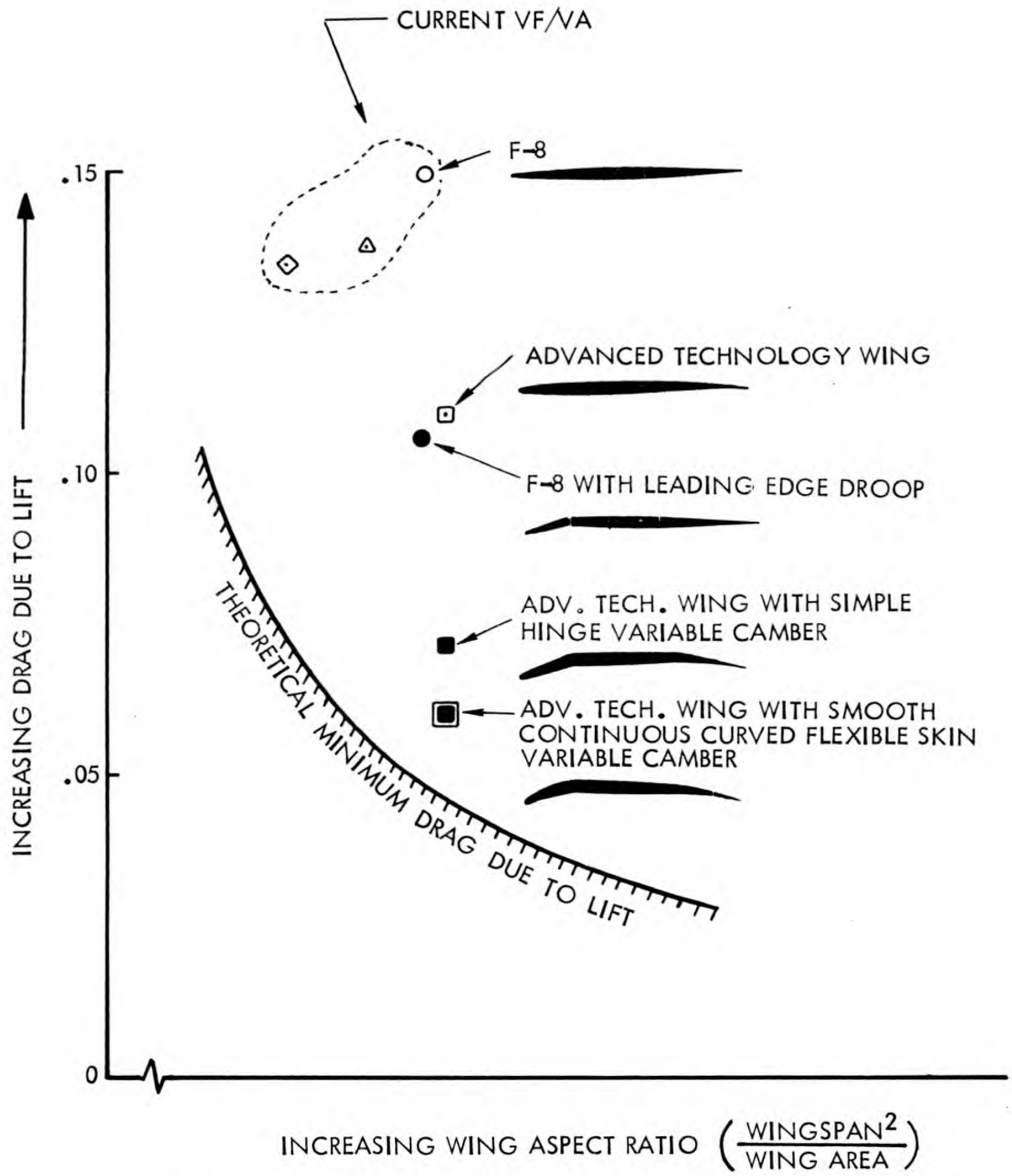


*Figure 7 — Reduction in maneuvering drag obtained by using variable camber*

at a 60 psf, 30,000 ft altitude flight condition). Again, when comparing the F-8 and the advanced technology wing, because of their geometric similarity, it can be seen in Figure 7 that drag due to lift can be substantially reduced through use of improved wing design and reduced even further, to about half the level of the F-8, through the use of simple hinged variable camber flaps. Also shown in Figure 7 are the reductions in drag due to lift obtained on the F-8 using its leading edge flap in a cruise droop position (LE = 7°). It can be seen that the two wings benefit about equally in reducing drag due to lift through use of high lift devices. However, the variable camber flaps on the advanced technology wing provide the best performance by improving on the inherent basic drag due to lift advantages of this wing.

It is expected that further significant drag reduction due to lift improvements could be achieved throughout the flight envelope by using a flexible skin variable camber concept to eliminate the relatively abrupt changes in upper surface contour that occur when simple hinge flaps are deflected. The drag reduction expected for a Mach 0.9, coefficient of lift equals 0.70 flight condition is estimated to be at least 20 percent as shown in Figure 7. It is also expected that the use of the flexible skin variable camber to provide smooth, continuous upper surface curvature will improve buffet characteristics, increase maximum usable lift coefficients and improve handling qualities at high lift conditions as well as reduce drag due to lift.

The performance improvements will be made possible by using a flexible skin variable camber concept to eliminate the very abrupt surface slope changes that exist when the "simple hinge" flaps are deflected to the large angles necessary to obtain maximum lift.

Many of the variable camber benefits already determined in wind tunnel tests of the advanced technology wing with a "simple hinge" flap system are summarized in Figure 8. This figure compares drag polars for the wing without flaps deployed and for the flaps deployed to their optimum deflection at each lift coefficient. The geometry of basic wing and its simple hinge variable camber flap system are described in Figures 6 and 7.

### Test Results of Variable Camber Wing Design

Variable camber reduces drag by 1,000 drag counts (coefficient of drag equals 0.100) at a lift coefficient corresponding to the maximum usable lift of the basic wing without variable camber. However, at the same thrust limit, variable camber provides a 40 percent increase in usable coefficient of lift. Further, onset of buffet is delayed substantially. An important additional advantage of variable camber is the significant reduction in angle of attack or body attitude required to produce a given

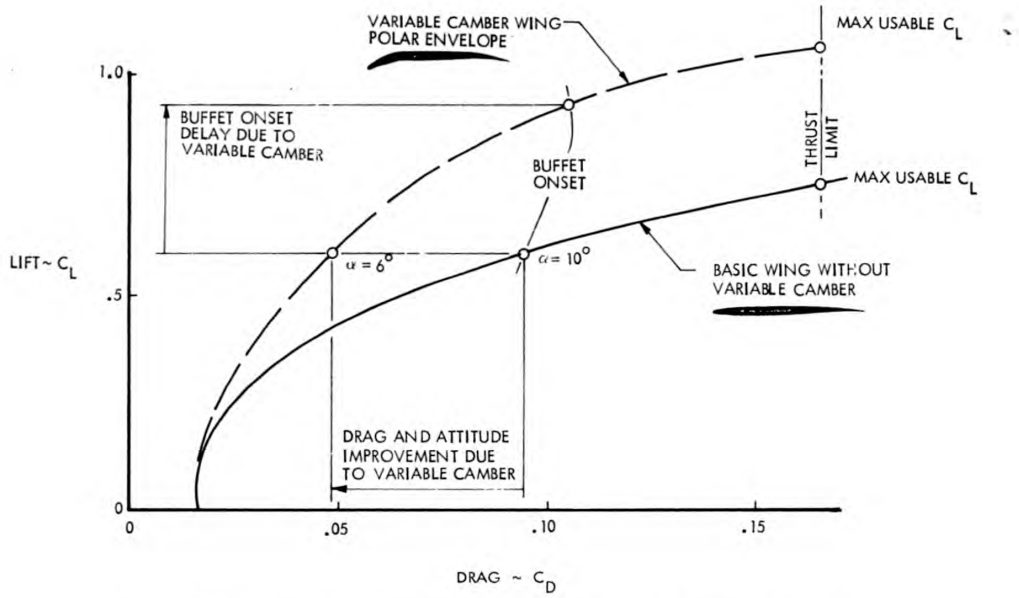


*Figure 8 — VF/VA variable camber wing improves combat capability*

lift coefficient thus improving vision over the nose, inlet conditions, *etc*. Supersonic performance improvements can also be expected from variable camber through the reduction of trim drag. Trim drag is generally a major contribution to the total supersonic drag due to aft shifts in the wing center of pressure. Deflecting the trailing edge flap nose down will change the wing pressure distributions so that trim drag is reduced while the basic wing is little changed.

A flexible panel design has been developed based on background information and testing developed in the course of preparing the 747 flexible skin variable camber Krueger flap for commercial operations.

The weight of the 747 flexible skin variable camber Krueger flap is actually somewhat less per square foot of flap area than the non-flexible, metal Krueger flap used just inboard of the 747's inboard engines. Extrapolation of this experience to fighter flexible skin variable camber concepts does not show any weight problems but this will be evaluated further under a current ONR contract.

Variable camber control concepts have been developed with a principle requirement that there must be an automatic flap actuation mode which will not require additional pilot attention. For different maneuvers there will be a wing setting that is computer-actuated once the particular mode is selected. Controls will be provided for mode selection and for pilot use if the automatic system should fail in the maneuver mode.

Piloted, fixed base simulations of variable camber control concepts have indicated that performance of precision tracking tasks may be improved through use of a direct lift control concept which increases lift with minimum changes in angle of attack. In this simulation, the flap configuration was commanded automatically through normal pilot

movement of the control column, thus satisfying the basic criterion of no increase in pilot workload.

In summing up the history of variable camber we find variable camber flaps first applied to Naval Aircraft in 1916 to improve the lift capability of thin, "high speed" relatively flat airfoils. Nearly sixty years later we have the capability of achieving, through the use of flexible skin technology demonstrated by the commercial 747, a true variable camber where leading and trailing edge flap contours will smoothly and continuously contour the airfoil shape desired for a given flight condition. However, unlike the early RNAS pilot who had to manually set flap angles and then retrim his aircraft, modern flight control systems couple flaps and horizontal tail controls so that maximum performance is obtained for any flight situation.

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## Composition and Origin of Cosmic Rays

Where are cosmic rays born—in remnants of exploding stars? in young "flare" stars? in the core of our galaxy? in distant, active galaxies? These and other models of cosmic-ray origin will soon be subjected to discriminating tests thanks to new results on the composition and metamorphosis of cosmic-ray nuclei.

Nature's most energetic particles, the cosmic rays consist mostly of atomic nuclei—but partly of electrons—streaking through space at prodigious speeds. They occur universally, pervading not only our own stellar system but other galaxies as well, a fact revealed by modern radioastronomy. Like light and X-rays and radio waves, the cosmic-ray particles even propagate across the vast regions between the galaxies.

Our own "galactic" cosmic rays—those bombarding the solar system from all directions—seem to originate mainly in sources within the Milky Way. Among the suspected sources are the remnants of supernova explosions—spectacular catastrophes that befall certain stars late in their lifetimes. The early models of cosmic-ray origin in supernova, developed mainly by Soviet and Japanese scientists, theorized that the expanding gaseous nebula expelled from the exploding star, provides a favorable environment for speeding up charged particles to high energies.

More recently, following the discovery of pulsars, which are believed to be dense neutron stars, it was realized that these rapidly spinning objects must possess enormous rotational energies. Soon these compact residues of stellar collapse were identified as likely, powerful cosmic-ray accelerators. The theories of pulsar origin have been spearheaded by American physicists.

Other candidates for the role of cosmic-ray generators are active stars whose major eruptions outstrip the most violent solar flares. Additional source models which have been considered are white dwarfs, the massive core of our galaxy

(which is shrouded from our view by clouds of dust), and the exploding nuclei of external galaxies. In order to be acceptable, any model of cosmic-ray origin must successfully confront a wealth of well-authenticated observations. Among the most valuable data are the relative abundances of the cosmic rays that reach the vicinity of the earth. These arriving particles have by no means all come from the sources. Some of them were generated in interstellar space as products of heavier, primordial cosmic rays that broke up upon collision with the interstellar gas—mainly hydrogen. That these secondary particles are an important component of the arriving cosmic radiation has been well established by observations and by calculations based upon well-known principles of high-energy physics.

Recently our growing knowledge of the arriving cosmic-ray composition has emboldened scientists to probe the nature of the cosmic ray at the *sources*. This depended critically on studies of the transformations of the primordial atomic nuclei in their tortuous travels through the magnetic fields and the tenuous gases of inferstellar space. Progress in these studies made in the Laboratory for Cosmic Physics of the Naval Research Laboratory, and by other groups, has provided a detailed source composition. This was based upon analysis of the multifarious modes of breakup that the cosmic-ray nuclei undergo en route from sources to earth.

Revealing comparisons have been made of the source composition of cosmic rays with the element abundances in the solar system and in nearby stars. These suggest that certain nuclear processes occurring on an exceedingly short time scale during the explosion of a supernova play an important role in the production of cosmic-ray nuclei, and especially of the heavy ones. Among these nuclear processes are the so-called r-process (rapid neutron accretion) proposed fifteen years ago, and the processes of "explosive nucleosynthesis" investigated in the last few years.

Parallel studies of nuclear fragmentation, leading to the production of radioactive species of cosmic rays, have made it possible to estimate how long cosmic rays are trapped in the disk of the galaxy before they escape. This "dwell" time has been estimated to be less than six million years.

Recently, laboratory beams of heavy ions have for the first time been speeded up to cosmic-ray energies at the Princeton Particle Accelerator and the Berkeley Bevatron. These new beams of man-made "cosmic rays" have made it possible to measure some important nuclear reactions, and have brightened the prospects of understanding the origins of the cosmic rays observed in our local region of the Milky Way. As a remarkable "spin-off" from the cosmic-ray studies on nuclear fragmentation, the knowledge thereby gained is already being applied to radiation biophysics and it may soon be helpful in experimental cancer therapy.

It will probably take some years before the tantalizing riddle of cosmic ray origin is solved, but studies of cosmic-ray composition, energy spectra, and their transformations are already paving the way toward a solution. Advances in our understanding of other astrophysical phenomena—as desperate as pulsars and solar flares—can also be expected to help clear up the mystery.

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Note: Abstract of paper presented by Dr. Maurice Shapiro at the American Physical Society Meeting, New York, New York, 1973.

# On the Naval Research Reserve

### Promotion Selections

Congratulations are extended to officers listed below who were selected for promotion by the FY 73 Reserve Selection Boards.

### Lieutenant Commander

There were 1,647 naval reserve line officers selected for promotion to the grade of Lieutenant Commander Ten were members of the Research Reserve Program:

| | NRRC | | NRRC |
|---|---|---|---|
| COVAN, James P. | 8-3 | NAPP, Edward T. | 4-4 |
| FERGUSON, Lawrence A. | 5-4 | O'NEIL, Stephen R. | 9-6 |
| GREGG, Llelwyn P. | 8-3 | REDFORD, Thomas G., Jr. | 4-4 |
| HERDER, Dale M | 9-16 | VANHOOSIER, Michael E. | 5-9 |
| HING, Dale L. | 13-4 | WIRTH, Milton J. | 12-3 |

Nine of the Officers were from the new field and one from the old. Other statistics based on the records of the Research Reservists selected for promotion:

| Date of Birth | | Date of Rank | | Designator |
|---|---|---|---|---|
| Earliest | 9-6-38 | Earliest | 10-1-65 | 1105 - 6 |
| | | | | 1315 - 2 |
| Latest | 11-24-42 | Latest | 8-1-68 | 1325 - 1 |
| | | | | 1615 - 1 |

### Lieutenant

Eight hundred and fifty-eight (858) naval reserve line officers were selected for promotion to the grade of Lieutenant. Five were members of the Research Reserve:

| | NRRC |
|---|---|
| BROTHERTON, Thomas J. | 9-28 |
| HALL, James L. | 8-4 |
| JELLISON, Gerald E., Jr. | 1-2 |
| MOORADIAN, Roger G. | 12-3 |
| VENETTE, James R. | 9-6 |

Statistics based on records of the Research Reservists selected for promotion to Lieutenant:

| Date of Birth | | Date of Rank | | Designator |
|---|---|---|---|---|
| Earliest | 9-26-44 | Earliest | 10-25-69 | 1105 - 5 |
| Latest | 9-24-45 | Latest | 9-12-70 | |

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## Navy Oceanographic Operations Supported by ONR

### Pacific Operations

R/V WASHINGTON, operated by Scripps Institution of Scripps Institution of Oceanography and supported by the Office of Naval Research, conducted oceanographic measurements near Pago Pago.

The Research Platform FLIP, operated by Scripps Institution of Oceanography and supported by the Office of Naval Research, conducted internal wave studies southwest of San Diego, California.

### Atlantic Operations

R/V ATLANTIS II, operated by Woods Hole Oceanographic Institution, and supported by the Office of Naval Research, conducted geological and geophysical studies off the continental rise of the United States east coast.

R/V CHAIN, operated by Woods Hole Oceanographic Institution, and supported by the Office of Naval Research, conducted hydrographic and ocean buoy work in the northwest Atlantic.

R/V CONRAD, operated by Lamont-Doherty Geological Observatory (Columbia University) and supported by the Office of Naval Research, conducted geological and geophysical studies of the northeast continental margin of South America.

R/V MELVILLE, operated by Scripps Institution of Oceanography, and supported by the Office of Naval Research, conducted oceanographic measurements in the south Atlantic.

R/V NORTH SEAL, operated by Texas Instruments, Inc., and supported by the Office of Naval Research, conducted acoustic surveys near the Bahama Islands.

R/V TRIDENT, operated by the University of Rhode Island and supported by the Office of Naval Research, conducted chemical and optical studies in the Gulf of Mexico.

R/V VEMA, operated by Lamont-Doherty Geological Observatory (Columbia University) and supported by the Office of Naval Research, conducted studies in the western Atlantic of the transition between the oceans basin and the continents.

# Research Notes

## Expedition Tasaday

Tasaday, a multi-disciplinary oceanographic expedition, will start June 1973 and continue through February 1974. Studies will include water microstructure measurements off the California coast and in the central North Pacific Gyre, biology of the Central North Pacific Gyre, physical oceanography of the Kuroshio Current off Japan, and geology and geophysical studies of the interarc basins of the western Pacific and the Bengal Fan in the eastern Indian Ocean. Support for scientific investigations on the expedition comes from the National Science Foundation and the Office of Naval Research.

Expedition Tasaday has been named for the Stone Age cave dwellers recently discovered in the Mindanao rain forest of the Philippines. Dr. Anderson, Cruise Coordinator, "May our expedition be as successful in exploration and discovery in the oceans as the Tasadays were in escaping civilization for so many years."

### Expedition Tasaday Legs

LEG I (San Diego to Honolulu) will concentrate on biological and chemical studies of plankton population dynamics and an investigation of the temperature and salinity microstructure in the water column.

LEG II (Honolulu to Honolulu) will continue the studies begun on Leg I in the North Pacific Gyre. In addition, another continuing series of studies will examine the oligotrophic (deficient in plant nutrients, but usually having abundant dissolved oxygen) benthic community from deep unproductive central gyres of major oceans.

LEG III (Honolulu to Yokohama) will provide information on the westward extent of the central gyre water mass. There will be continuous monitoring of surface chlorophyll and temperature.

LEG IV (Yokohama to Tokyo) will study the flow of the Kuroshio Current over the Izu Ridge (near Japan). The ridge presents a major topographic obstacle to flow and by tracking selected isotherms (a line on a map connecting points having the same temperature at a given time), the current's path over the ridge will be determined.

LEG V (Tokyo to Singapore) will cross the northern half of the Philippine Sea and the South China Sea. The primary goals are (1) dredging and surveying along the Bonin Arc in search of silicic rocks symptomatic of early sea-floor spreading processes behind oceanic trenches, (2) investigations of the central basin fault in the vicinity of Taiwan, (3) studies off the northeast coast of Luzon where a reversal of the downwelling slab of oceanic crust is suspected and, (4) heat flow of the Philippine Sea and Bonin Arc.

A three-week cooperative effort with two Japanese research vessel will be conducted at the beginning of Leg V. The Japanese scientists will be from several Japanese universities and the Japan Science Museum.

LEGS VI and VII (Singapore an Rangoon to Djakarta) proposes a geological and geophysical evaluation of the Andaman Sea (south of Burma), and the Bay of Bengal (southeast of India), and the southwest side of Sumatra (Japan).

Previous geophysical work in the Bay of Bengal has shown that the sediment column is over 16 km (9-1/2 miles) in thickness at the northern end of the bay, one of the thickest sediment sections in the world. During these legs, seismic work will be continued farther to the southwest in the Bay of Bengal to delineate thicker parts of the sediment column for purposes of relating to geological history. Much of that sediment was derived from continental India prior to its collision with southern Asia.

After the collision of the India continent with Asia occurred in early Tertiary time, some of the thick sediment column was scraped off and folded into the Indo-Burman ranges, the Andaman and Nicobar Islands, and the islands off the coast of Sumatra. Those regions of deformed sediment will be investigated to attempt to evaluate the process of scraping of a thick column of sediment from a subducting plate or downgoing, and thrusting and uplifting into a mountain range.

LEG VIII (Djarkarta to Guam) will measure acoustic properties in the Sulu Sea (between Sabah, Malaysia, and the Philippines). The water temperature is unique in that is is extremely warm to a depth of 2.5 km (1-1/2 miles). Heat flow, magnetic, topographic, and reflection profiles will also be run from the western Philippine Sea across the Parece Vela Basin and into Guam at 15 degrees North latitude.

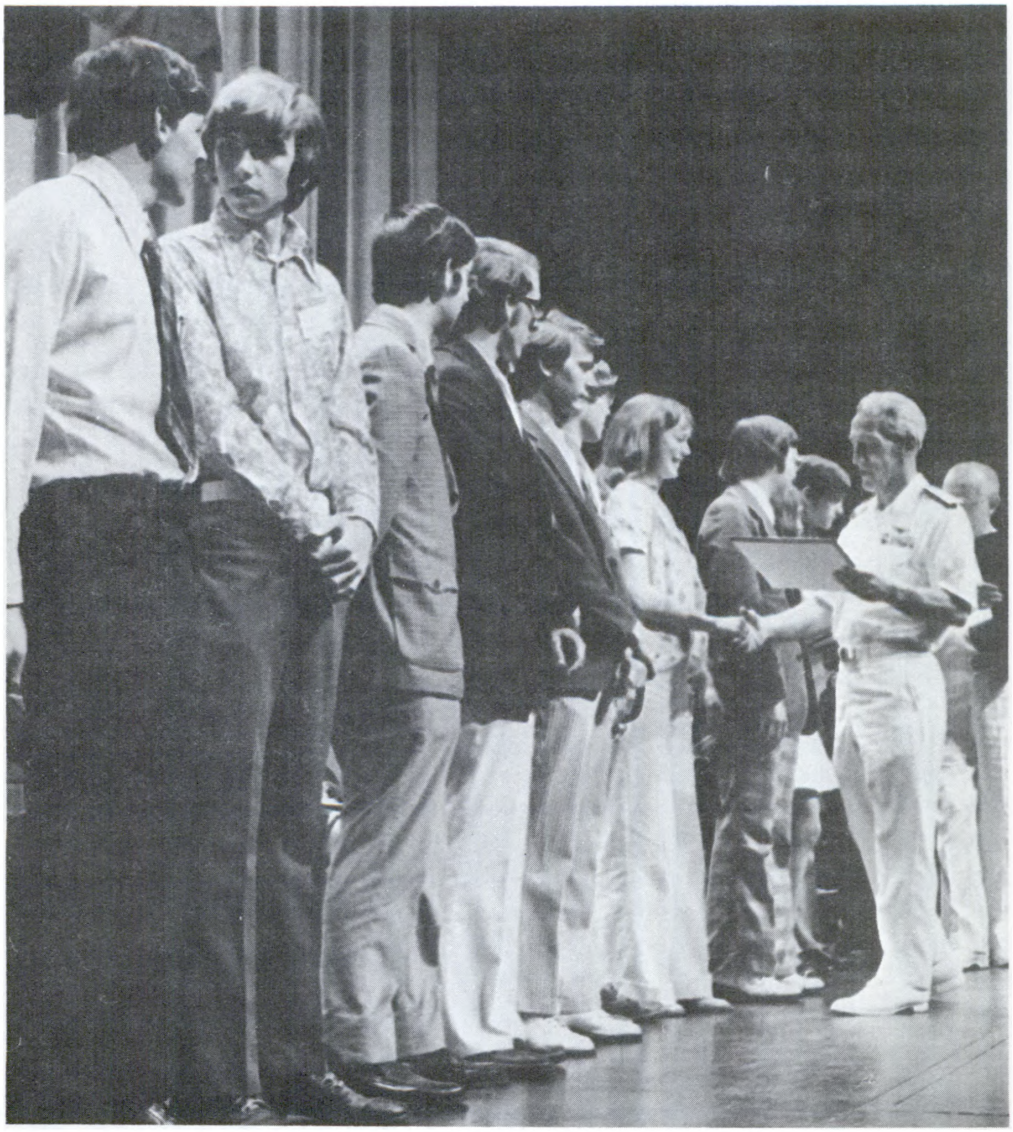
LEG IX (Guam to Honolulu) will spend nine days in the Mariana Trough (Philippine Sea) doing a detailed heat-flow survey to examine the high heat flow and elevated topography. The heat-flow distribution in the basin will produce confining boundary conditions which, hopefully, will clarify the formation mechanism of the basin. In conjunction with this survey, magnetic, seismic reflection, and dredging work will also be done in the Trough.

LEG X (Honolulu to San Diego) is part of the continuing central gyre research program at Scripps. Hydrographic, productivity, nutrient, plankton, necton, and temperature microstructure measurements will be made.

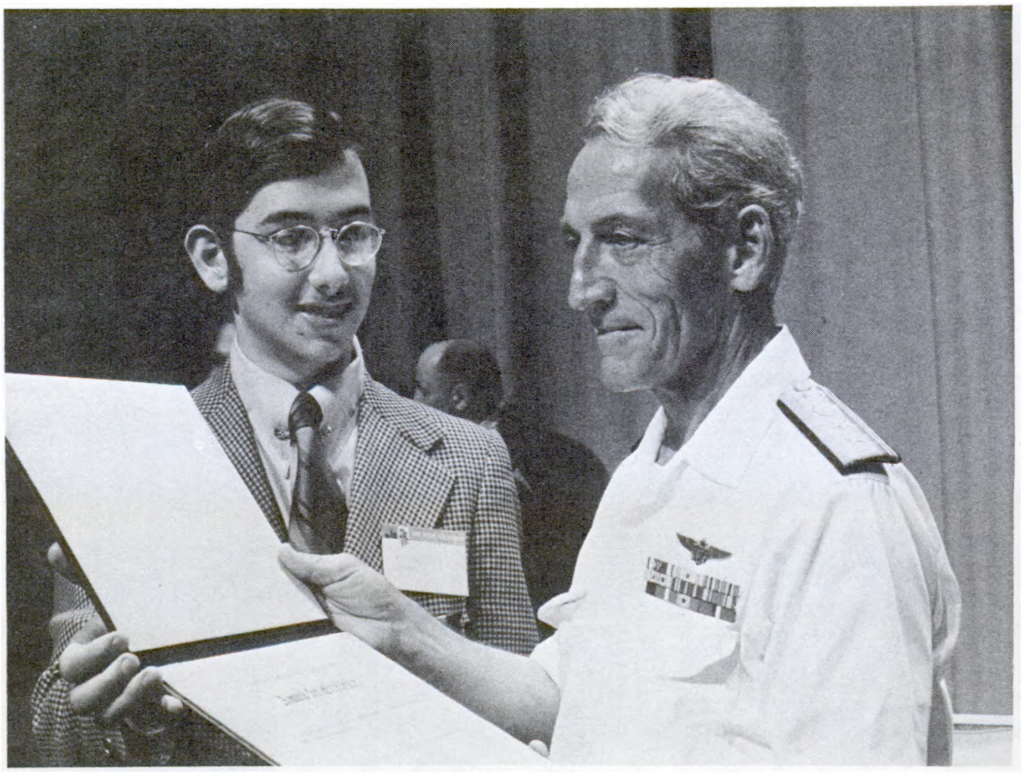
## Navy Makes Award at International Science and Engineering Fair

The Navy through the Office of Naval Research participates annually in the International Science and Engineering Fair (ISEF) sponsored by Science Service, Inc. with two types of special awards. In the Navy Science Cruiser Award program Navy judges select ten students with outstanding science projects as Navy Science Cruisers along with ten alternates. The ten winners spend an all-expense paid week in San Diego visiting Navy laboratories and other scientific facilities. The judges also select from the ten Navy Science Cruiser winners one grand award winner who attends the Nobel Prize Ceremony in Stockholm on December 10. The Navy selection is accompanied by the Army and Air Force winners in a tri-service program managed by the Office of Naval Research.

The ISEF this year was held in San Diego in May where approximately 380 finalists previously selected at regional and state science fairs competed. (ONR presents special awards at these fairs as well.) The ten Navy Science Cruiser winners were: Marvin J. Slepian, Brooklyn, New York; Charles Mantel, Jr., Chaffee, Missouri; Joni L. Baeke, Leawood, Kansas; Deborah L. Birx, Carlise, Pennsylvania; Richard M. Busch, Lititz, Pennsylvania; Frank Thomson Leighton, Arlington, Virginia; Claude R. Lebrun, Jr., Dallas, Texas; David A. Fish, Holden, Massachusetts; Charles K. Childs, Jr., Trumann, Arkansas; and Marshall Allen Talbot, Trumann, Arkansas. Marvin Slepian was selected for the grand prize and will go to Stockholm along with Robert D. Silverman, Chelmsford, Massachusetts, chosen by the Army and Glenn J. Greene, San Diego, selected by the Air Force.



*RADM Carl Holmquist congratulates the 10 Navy finalists at the ISEF*



*RADM Carl Holmquist Chief of Naval Research presenting the Navy's top prize at the ISEF to Marvin J. Slepian of Brooklyn, New York for his exhibit "Bacteriophage T5 Pseudovirons."*

## The Nobel Prize Ceremony and Banquet*

December is a cold and rainy month in Stockholm with occasional snow. The sky is almost always overcast and darkness sets in about 3:30 p.m. in the afternoon. It is hardly the "ideal month for tourists," but every year for the last 71 years, a small contingent of visitors from various places in the world are very pleased to come to Stockholm to receive a Nobel Prize. This year's distinguished group of 11 winners were eight from the U.S., two from England and one from Germany. They gathered on 10 December, the anniversary of the death of Albert Nobel, at St. Erik's International Fair on the outskirts of Stockholm before 3000 guests to receive their Nobel Prizes from Prince Carl Gustaf who represented 92 year old King Gustav VI. This elegant audience, consisting of members of Swedish government, diplomatic corps (some dressed in colorful native costumes), men in white tie and tails, women in beautiful evening gowns, and the excited families of the laureates anxiously waited.

At 4:15 p.m. trumpet calls signaled everyone to rise as the Royal party entered and took their places at special seats facing the podium, decorated with flowers, flags and TV cameras. The King's special song was sung by the standing audience

*Note: The following description of the 1972 Nobel Prize Ceremony and the banquet that follows was written by an Office of Naval Research Staff Scientist of the London Office.

who on taking their seats, were summoned again to their feet by a second set of trumpet calls. This time from parted curtains behind the raised platform, the designated laureates entered accompanied by men who were to describe their respective contributions in a series of formal speeches. They they proceeded to a semicircle of chairs on one side of the lectern while the speakers took seats on the opposite side with members of the Nobel Foundation.

Following a short musical interlude, the first speaker described in Swedish the work of the physics laureates; fortunately these formal talks had been translated in English in the program booklet. The speaker concluded with words of congratulations in the laureate's own language. Finally the physics laureates stepped down a flight of stairs and, to an applauding ovation from a standing audience, received from the Crown Prince a gold medal, a handsomely engraved diploma, and an envelope containing their share of the Nobel Prize. The next speaker began his speech describing the contributions of the chemistry prize winners; and so it continued through the award for physiology, medicine, and literature, until the economic science laureates received their prizes. This last award has been given only since 1968 in honor of Albert Nobel. The Peace Prize, which was not given this year, is awarded in Oslo on the same day. At the end of this impressive ceremony, the audience rose for the last time, sang the Swedish national anthem and watched the Royal party depart.

We then departed by waiting buses to Town Hall in Stockholm for the famous banquet. The walls of the giant banquet hall are covered with gold mosaic depicting scenes of Stockholm. At a 150-ft. raised table along one wall sat all the Nobel Prize winners, their wives, and the most distinguished guests. The remainder of the 800 guests were seated at small tables perpendicular to the main table. An orchestra played while fresh turbot, roast lamb, Champagne, and brandy were served, each course arriving with military precision at all tables at the same time.

After desert one of the laureates for each prize gave a short speech. The combination of excellent food, drink and many "skols" made it difficult to recall much of what was said. However, the comments of Professor John Bardeen, one of the trio of 1972 physics winners, were sufficiently succinct to be remembered. Bardeen had previously shared the 1956 Nobel Prize in physics with two other U.S. physicists for the invention of the transistor. He is the only person to have twice won a Nobel Prize in physics. He remarked that "while one and one are two, 1/3 plus 1/3 is only 2/3."

While the banquet was in progress in the Gold Hall, in the adjoining Blue Hall some 600 Swedish students were dining and preparing for post-banquet festivities. The laureates and guests proceeded out of the Gold Hall on to a high balcony overlooking the Blue Hall. Then they descended a marble staircase while students marched around below waving large banners, and a student choir sung several spirited songs. This was followed by dancing until the early hours of the morning.

## New Liquid Laser Mixer

John F. Giuliani, an optical scientist at the Naval Research Laboratory (NRL) has developed a versatile electro-optical parametric liquid mixing device which permits collinear mixing of multi-wavelength laser sources over optical pathlengths larger than any reported to date.

The NRL mixer is a highly transparent commercial fluoroalcohol which possesses a nearly flat refractive index over the visible and near-infrared spectral regions. Giuliani has made use of this unique optical dispersion for the production of parametric light amplification in the red spectral region, by the simultaneous mixing of a low power CW helium-neon laser with high power pulsed ruby laser source.

The greater power-handling capability of the liquid, as compared to a crystal, should allow the same fractional gain to be achieved with higher input powers than usual optical parametric amplifiers. Moreover, it may be possible to incorporate this liquid into the cavity of a red-emitting dye laser to extend its tunability into the near-infrared.

Future possible application using the NRL liquid device with mode-locked pulsed laser sources include a simple method for measuring ultrashort pulse times and shape information. Another, involves a new means of obtaining a broad frequency band of intense light over the entire visible spectrum, using a single mode-locked ruby laser. The NRL investigator cites this last application of the liquid as a potentially simple and inexpensive intense broadband light generator.

## Fertilizer that Reduces Oil Slicks Developed by Navy Research

A Navy research program on the biodegradation of oil-polluted waters has developed a special fertilizer formula for use on floating oil slicks that increases by ten-fold the natural biodegradation process.

The study, conducted by Dr. R. Bartha and Dr. R. M. Atlas of Rutgers University and sponsored by the Office of Naval Research, was presented at a workshop on "The Microbial Degradation of Oil Pollutants" held last December. The workshop, the first conference ever held on the subject, was jointly sponsored by ONR, the U.S. Coast Guard and the Environmental Protection Agency. The proceedings, which include 34 papers, have just been published and can be obtained from the Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana 70803, for $6.00.

The Rutgers team has been pursuing experiments using nutrients, particularly nitrogen and phosphorus salts, that improve the ability of the bacteria to digest or degrade oil, which also accelerates reproduction. The problem has been, however, that these nutrients dilute rapidly in the open sea and also tend to stimulate algal blooms, thereby creating another problem.

After several trials, the Rutgers group found that an oleophilic (oil-adhering) combination of octyl-phosphate and a slow-release paraffinized area fertilizer gave as good or better performance than nitrogen and phosphorus salts. The oleophilic formula, which has been evaluated on the surface of flow-through seawater tanks, not only greatly increases the biodegradation rate but also does not stimulate algal blooms. The cost of treatment using the fertilizer formulation is estimated to be reasonable.

The fertilizer is not designed to dissipate oil slicks by itself but rather supplement currently used methods for oil cleanup, such as skimmers. Used in conjunction with such techniques the fertilizer should help to speed up substantially

the abatement of oil pollution. Further tests with the fertilizer are to be conducted in oil-polluted New Jersey coastal waters.

Another study by the same two authors supported by ONR and also presented at the workshop reported on several microbial commercial products for degrading petroleum. The products are sold in a freeze-dried state for "seeding" the oil spill and contain a nutrient source for fertilization.

The authors found that none of the products tested stimulated oil biodegradation, and one of them, in fact, resulted in the oil degrading at a much slower rate than natural seawater. The authors have theorized that in coastal waters at least, microbial seeding is likely to be more successful if active rather than freeze-dried material is used so as to minimize the lag period prior to the onset of oil biodegradation.

## Guide for Cleaning and Salvaging Electronic Equipment

The Naval Research Laboratory (NRL) has published a procedural instruction entitled, "Guide to NRL Cleaning and Salvaging Techniques for Reclaiming Equipment Contaminated with Seawater, Oil, and Smoke Deposits," by H. R. Baker and R. N. Bolster. It is listed as NRL Report 7563.

The manual includes chemical cleaning techniques developed at NRL for salvaging contaminated electrical and electronic equipment, as well as the personnel and equipment needed to establish a shore-based cleaning facility.

In addition, methods of salvage that satisfy the majority of cleaning problems encountered in the field are listed.

Copies of this manual may be purchased directly by writing to the National Technical Information Service, Department of Commerce, Springfield, Va. 22151.

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*Snail shedding cercariae.* *See page 1.*

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