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## Commentaries

### Operation FLYSWATTER: A War Within a War

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#### Preamble

Despite extensive experience with mosquito-borne diseases affecting combat capability of the Armed Forces during World War II and Korea, in 1965 the United States military was unprepared to deal with the *Anopheles* mosquito in the highlands of South Vietnam and the subsequent malarial casualties. Regardless of the weekly use of prophylactic measures, up to 50 percent of American soldiers initially involved in combat operations in the heavily forested regions of South Vietnam developed malaria. Not until nearly two years after the introduction of American ground troops into the Southeast Asian conflict did the Department of Defense authorize the extensive insecticide aerial spraying necessary to protect both Allied and indigenous forces. Even then, military leadership failed to take advantage of much of the knowledge and experience of an existing stateside unit specifically tasked in aerial spraying and mosquito control.

This commentary reviews the events and supporting historical information related to the fixed-wing aerial spraying of insecticides from October 1966 to December 1971 during the Vietnam War. The historical information was divided into two categories; the need for criti-

cal information assessing the spread and impact of malaria among military and civilian personnel, and the operational information essential for combating the mosquitoes that were the carriers of malaria. Using modified UC-123 transport planes to spray malathion insecticide, Operation FLYSWATTER was the eventual fixed-wing, large-area answer to the biting insect. Unlike the short time-on-target of the defoliation missions, the insecticide spray aircraft's treetop level flights lasted for as much as two very hazardous hours of flying. So successful were these missions in controlling mosquitoes that preventative medicine requests ultimately resulted in 14 major allied military bases and their adjoining Vietnamese cities being sprayed routinely every 9 days, weather permitting. The 'mosquito war' required over 1,300 individual missions and dispensed approximately 1.76 million liters of malathion concentrate. Operation FLYSWATTER was a significant part of the overall United States' preventative medicine program to reduce the number of man-days lost to ground forces due to malaria. Ironically, although the program was widely publicized through both military and civilian in-country channels, the memories of many veterans of the Vietnam War would later confuse exposure to the insecticide spray missions with the spraying of the Agent Orange defoliant in Vietnam.

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#### 1 Introduction

Malaria, spread by mosquitoes, has been influencing military campaigns in Southeast Asia since Kubula Khan [1]. During World War II Allied forces in the Pacific theater suffered more casualties from this disease than from enemy action, and solving this problem became a major objective of Allied commanders. Despite this historical experience, during the first two years of combat-force involvement in South Vietnam, more than 10,000 Americans were rendered casualties by this bothersome insect and the rediscovery of an operational solution was not implemented until 1967. To combat the impact of malaria among military personnel, the United States Military Assistance Command, Vietnam (MACV) ultimately authorized Operation FLYSWATTER, using 7<sup>th</sup> Air Force 'RANCH HAND' UC-123 defoliation aircraft modified to an insecticide configuration. Little has been published on the history of this Operation, and as a consequence there exists much confusion in the civilian and Vietnam veteran communities as to the use of RANCH HAND aircraft for this mission.

#### 2 Background

The Vietnamese phrase for malaria is *sat ret rung*, which literally means 'jungle fever'. The principal malarious region of South Vietnam was the central highlands where the malaria parasitic species encountered were *Plasmodium falciparum*, *P. vivax*, and some *P. malariae*. *P. vivax* predominated in the Coastal Plains and Delta Region. Unfortunately, the most serious malaria, *falciparum*, was also most prevalent, accounting for 50–75% of cases in the US Army in Vietnam. Although both *falciparum* malaria cases and the abundance of *Anopheles* mosquitoes increased with the summer monsoon season, neither disappeared in tropical Vietnam as they did in winter in the temperate zones. Furthermore transfers of parasite reservoirs from hyperendemic, independent malaria foci to all parts of Vietnam became increasingly obvious in 1966 as Montagnard and Vietnamese refugees and military personnel moved from one area to another [2,3].

The deployment of major US combat forces into South Vietnam found them unprepared for the disease-ridden conditions. Despite the weekly use of prophylactic choroquine-primaquine pills, 5 to 50% of American soldiers coming off early field actions in the heavily forested regions of South Vietnam would develop malaria [4]. By December 1965, the overall Army admission rate for hospitalization was 98.4 admissions per thousand per year, nearly rivaling some Pacific theater rates of World War II. Indeed, some units operating in the Ia Drang

Valley had rates as high as 600/thousand/year. Two of the first infantry battalions sent into the Central Highlands "were rendered ineffective" as a result of losses due to malaria [5].

Compounding the threat to Allied troops in South Vietnam was the discovery of chloroquine-resistant *Plasmodium falciparum* infections in 1965, when up to 80% of cases failed to be cured by standard chloroquine therapy [3,6]. A highly effective new regimen using quinine, pyrimethamine, and dapsone was adopted by the US Army, but at the risk of some complications and side effects. From 1965 to 1969, more than two of every three US Army hospital admissions in Vietnam were as a result of disease, mainly malaria. During the same period, battle injuries accounted for only one of six admissions. Equally important was the problem of introduction of malarial parasites into local *Anopheles* mosquitoes by veterans of the various Allied nations on their return from Vietnam. Unlike previous wars, the rapid repatriation home of veterans by air transport interfered with the requirement for the full eight weeks of chemoprophylaxis, especially for the long latency *P. vivax*. Malaria would be the greatest medical problem imported to the Continental United States by Vietnam veterans [3,6].

Ironically, the enemy in Vietnam was both a major contributor to and a target of the same malarial infections that plagued the Allied forces. Interrogations of prisoners and review of captured documents indicated that the most serious problem faced by infiltrating North Vietnamese soldiers was malaria [7]. Unit incident rates as high as 50% were reported, with the most serious cases left behind at rest stops along the way, or even returned north; however, most disease-stricken infiltrators were forced to stay with their group, albeit at the cost of lowered morale and delayed movement. Even groups fortunate enough to be accompanied by medical corpsmen frequently faced a shortage of medical supplies to treat the various diseases [8,9]. The resultant high infection rates among enemy personnel, in conjunction with rates of 50–75% among chronically infected indigenous personnel, provided a ready reservoir for the mosquito population to feed on [7]. Obviously combat contact in enemy-held areas exposed Allied forces to regions where little or no preventive medicine had taken place.

As a 1965 Preventive Medicine Orientation to Vietnam pamphlet stated, there was "a foolproof method of avoiding malaria in Vietnam: don't get bitten by *Anopheles* mosquitoes" [3]. As desirable as this solution was, it was equally unlikely. Obviously, in addition to identification and treatment of the disease came eradication of the parasite carrier. But enemy activity made use of traditional ground-based equipment and processes hazardous except in secure areas, while the publication of Rachel Carson's *Silent Spring* made the widespread use of dichlorodiphenyltrichloroethane (DDT) unacceptable. In 1966, both the Army and Navy were experimenting with low volume dispersal of malathion insecticide via helicopter. The Navy used a "Helicopter Insecticide Dispersal Apparatus, Liquid" (HIDAL) that had to be semi-permanently mounted on a Marine Corps UH-34 helicopter [10]. The Army trials involved a commercially designed system that could quickly be mounted on Bell UH-1D helicopters without modification of the aircraft [11,12].

The principal drawbacks to both the Army and Navy programs were the helicopter's high vulnerability to ground fire at the altitude from which the chemical had to be applied, and the limited amount of chemical that could be carried. The Standard Agricultural Aviation System for UH-1 helicopters had a 760-liter herbicide supply tank and a 14-meter spray boom, but the UH-1 could only lift off with a maximum of 570 liters in the tank, resulting in limited short flights. Furthermore, the 15-meter flight altitude to achieve an effective spray swath of 45 meters was almost suicidal over enemy-controlled areas [13]. Both services had asked for the use of a larger conventional aircraft, such as the C-123B 'Provider,' to conduct spray tests; although Preventive Medicine personnel were generally skeptical of the transport's potential for useful results. This concern was contrary to the experience that the United States Air Force (USAF) had accrued through the Special Aerial Spray Flight (SASF) at Tactical Air Command Headquarters, Langley Air Force Base (AFB), Virginia [14]. This unit represented the culmination of airborne pest spray knowledge dating from the events of World War II's Pacific theater, the Korean War, and numerous national emergency situations in the interwar periods. SASF also was experienced in spraying stateside military bases and maneuver areas [15]. By 1965, SASF had three C-123's modified for liquid spray dispersal, but these aircraft were not deployed to Vietnam. Instead these aircraft were available worldwide for pest control projects. In Vietnam the difficulty was that the demands for combat operations for the limited numbers of C-123s apparently took precedence over "slapping mosquitoes" in the minds of military leadership [16].

### 3 RANCH HAND Gets an Added Mission

It was not until October 1966 that USAF Headquarters, at the insistence of the Commander of US Forces in Vietnam, decided it could spare one of the RANCH HAND UC-123 defoliation aircraft to be reconfigured to spray the insecticide malathion as part of a test program to reduce mosquitoes in South Vietnam. The test program, however, required 'bite' and 'count' tests by individuals located on the ground at night with flashlights in the sprayed areas, not a desirable assignment in wartime South Vietnam, so the trials were relocated to a test area in Thailand [17]. On 14 October 1966, a RANCH HAND aircraft, thoroughly cleaned of herbicide residues and equipped with the finer orifice nozzles needed for insecticide dispersal, left Saigon for Bangkok, Thailand.

Unfortunately, when the test aircraft arrived in Bangkok, it was discovered that an unusually dry season in the test area had reduced the mosquito breeding areas to the point that the population was too low for meaningful evaluation. After several days in Thailand, the evaluation team returned to South Vietnam to conduct limited tests. Although reduction of the mosquito population would benefit the Viet Cong as well as Allied forces, the test aircraft would occasionally encounter ground fire. During one flight over a wide river valley the aircraft received ground fire and a 'hit' in the insecticide supply tank. The crew elected to 'emergency dump' the entire remaining load of insecticide and return to base [15,18]. In all fairness to the crew, they obviously felt 'naked' without the multiple spray aircraft and the Forward Air Controller (FAC) and fighter escorts that normally accompanied the planes on herbicide targets.

Despite continuing high casualty rates due to malaria, the test eradication program was terminated and nothing more occurred until early 1967. RANCH HAND, now a full-sized separate USAF squadron, the 12<sup>th</sup> Air Commando Squadron (12<sup>th</sup> ACS), again was tasked to clean and prepare one of their UC-123 aircraft for in-country tests. As before, the 'decision makers' were ignoring and duplicating nearly 20 years of experience in spray operations and mosquito control programs already accumulated by the Special Aerial Spray Flight in the United States. After the initial development stages of the herbicide spray concept, SASF's only role in the Vietnam program had been to provide hands-on spray training at Langley to aircrews selected for RANCH HAND assignment. The "reinvention-of-the-wheel" syndrome had once more become the delaying force behind a needed program [16]. Again because of the obvious danger to observers spending the night in Vietnamese jungles counting mosquitoes, the new trials were conducted over Con Son Island, a secure island off the Mekong delta.

Following successful Con Son trials, the 12<sup>th</sup> Air Commando Squadron was ordered to modify and permanently assign one of its eighteen UC-123s to fulltime pesticide duty under the control of the MACV Surgeon General's Office [19]. Code-named Operation FLYSWATTER, the UC-123 aircraft was the ideal vehicle for wide-area pesticide spraying. Insect control had become an added task for the herbicide spray squadron. Malathion storage and servicing were made available at three locations in Vietnam: Bien Hoa Air Base, Cam Ranh Bay Air Base, and Da Nang Air Base. Responsible units were the Army's 20<sup>th</sup> Preventive Medicine Unit, the Army's 105<sup>th</sup> Medical Detachment, and the Navy's Preventive Medicine Unit, respectively. The Navy unit was later replaced by the Army's 172<sup>nd</sup> Preventive Medicine Unit. Overall control by the MACV Surgeon General was exercised thru the Army's 67<sup>th</sup> Medical Group and 44<sup>th</sup> Medical Brigade [3].

#### 4 Modification of the UC-123

To distinguish what became popularly known as the 'Bug Bird' from the herbicide-spraying aircraft of the squadron, the selected UC-123 was stripped of its camouflage paint and coated with an alodine compound to guard against the insecticide's corrosive effects (Fig. 1) [20]. It was hoped that enemy troops would recognize the benefits provided by the



**Fig. 1:** RANCH HAND UC-123 'Silver Bug Bird' of Operation FLYSWATTER at Bien Hoa Air Base, Vietnam, 1968

aluminum-colored UC-123's anti-mosquito mission and therefore not attempt to shoot down the unarmed and unarmored obsolete transport, as they did the camouflaged planes spraying herbicides. Other modifications included opening the ram air scoop and venting the chemical tank to the heater exhaust to aid in the removal of the strong malathion fumes from the interior of the aircraft; removing the unneeded tail spray boom; and installing an electric motor-driven pump to flush the windshield and thus remove the spray which accumulated on the windshield during repeated spray runs. An additional benefit of the tail boom removal was that the 10-cm tail boom supply line could now serve as an alternate method of dumping the chemical in an emergency. The spray booms that were mounted under each wing were fitted with 32 Teejet<sup>®</sup> nozzles that produced a median spray droplet of less than 50 microns [21,22].

The first Bug Bird was 'Little Devil' (serial number 56-4396). 'Little Devil' was soon replaced by 'Patches' (serial number 56-4362). 'Patches' was one of the first three aircraft that originally entered South Vietnam in 1961 and got its name from the numerous hits received from ground fire and the many metal patches subsequently applied over the damaged skin areas. By 1967 the plane had taken well over 500 'hits' during herbicide missions. It had also become the first and only C-123 to fly completely around the world when, in 1962, it returned to the United States by way of Afghanistan and Iran where it assisted in their fight against a plague of locusts. When once again assigned to Vietnam, the aircraft became a sentimental (and perhaps superstitious) favorite of the unit and the airmen hoped to avoid losing the venerable 'Old Lady' by assigning her to the safer Bug Bird duty [16].

#### 5 Control with the Insecticide Malathion

Malathion initially was scheduled to be dispensed over nine different major US bases and their adjoining cities in South Vietnam on a regular basis of every 11–14 days [23]. Ideal time for spraying was the 1½ hr immediately after dawn and the 1½ hr just before sunset, when the mosquitoes were most active. The insecticide was most effective against the insects when in flight, rather than as larvae. Malathion was applied at the rate of 0.59 liters/hectare of a 57% concentrate, and spray restrictions were the same as for herbicide application, i.e., maximum winds of 10 knots, maximum temperature of 30° C, and no rainfall during or for one hour after spraying [11]. Spraying was conducted at a maximum of 45 meters above the terrain and at an air speed of 130 knots. The low rate of application enabled one insecticide sortie to cover about 6,000 hectares [20].

The first operational malathion mission was flown on 6 March 1967. The mosquito suppression task represented a radical change for the RANCH HAND aircrews. Herbicide missions had to be flown with multiple spray planes (two to twelve) accompanied by a Forward Air Controller (FAC) and fighter escorts. To protect the herbicide aircraft, MACV directives required target areas to be completely free of all friendly ground forces and to be authorized as 'free fire' areas for the accompanying fighter escorts [23]. Unlike the herbicide missions, the single insecticide aircraft was not supported by either FAC or by fighter escort during the low-level flights that lasted for as much as two hours (low-level exposure during herbicide mis-

sions seldom totaled more than 10 min). Mosquito missions were usually preceded by psywar leaflet drops several days ahead of time describing the benefits of the mission to the communities, and asking the people not to fire at the silver aircraft. On the day of the mission a U-10 Helio-Courier 'speaker' aircraft from the 5<sup>th</sup> or 9<sup>th</sup> Air Commando Squadrons often accompanied the insecticide aircraft, circling overhead and broadcasting that the malathion was for their own good and that it posed no threat to people, animals, or crops [24,25].

The effectiveness of these precautions was reflected in the very low number of hits taken by the bug birds. Only rarely during the four years of operation did the insecticide crews receive ground fire, and then usually when spraying long-held enemy base-camp areas before major Allied ground assaults. Vietnamese farmers and plantation owners frequently took advantage of a government compensation program for accidental herbicide damage to crops by claiming that drought- or insect-caused injury was the result of spraying by "the big silver plane" [26]. Years later, when the Agent Orange controversy arose, numerous veterans of the Vietnam conflict also would mistakenly credit the insecticide aircraft as having sprayed them with "Agent Orange" [23].

During the remaining months of 1967 the 'bug bird' averaged 18.3 sorties per month. Total malathion dispensed in 1967 was 451,872 liters, with an average of 2,470 liters per sortie [25]. Manning the aircraft were volunteers from among the herbicide crews; insecticide duty broke the normal RANCH HAND routine since the crews landed at various bases with frequent overnight stays throughout South Vietnam. Volunteers had to be experienced and fully qualified in all phases of low-level operations since the insecticide missions could last as long as 2 hr of hazardous tree-top flying [16].

In addition to routine scheduled malathion applications to the approved base/city list, other insecticide targets originated at the local level where a malaria problem was present. Requests were sent to the Office of the MACV Surgeon General for approval. Approved targets went to the Tactical Air Control Center (TACC) for their coordination and returned to the MACV Surgeon General's office. MACV then forwarded the request to the 12<sup>th</sup> Air Commando Squadron where the Insecticide Flight Commander and sortie navigator planned and scheduled the target. A 'Priority One' target could be sprayed within 24 hours after the squadron was notified. Normally a target was sprayed within one week after the request was first submitted. Insecticide targets were 'group frugged' by the TACC since they didn't require the target areas to be clear of friendly forces like the herbicide missions did [18,24]. This was another reason for veterans in the future to believe they had been sprayed with dioxin-contaminated Agent Orange during combat field operations [23].

Insecticide sorties increased in 1968 from 180 to 230, as the insecticide project proved to be a successful part of the overall preventive medicine program in Vietnam. Although the total number of exposed US Army personnel increased, the number of man-days lost from duty due to malaria fell by 10%. In 1969 a second unpainted UC-123 was added to the insecticide mission and a total of 14 bases and adjacent cities were sprayed every nine days, weather permitting [23]. The insecticide unit was now a separate flight of the 12<sup>th</sup>

squadron under command of a major. Many of the replacements to RANCH HAND were newly graduated or inexperienced lieutenants with less than 400 hours flying time and no previous experience in other than high altitude jet aircraft. To give these pilots additional conventional and low-level navigation experience under at least semi-safe conditions RANCH HAND assigned them to copilot duties on the 'Bug Birds.' Experienced theater-qualified pilots were assigned for 30-day tours as the aircraft commanders. The 'good weather' quarter of April-June 1969 saw an insecticide record of 135 sorties spraying 165,000 liters of malathion. However the year-end totals were only 295 sorties and 378,860 liters.

While the herbicide mission prepared for phase out in early 1970 due to adverse publicity and international protest, the insecticide flight was busier than ever. From 80 sorties spraying 94,075 liters of malathion in the first quarter, requirements jumped to 110 sorties and 123,920 liters in the April-June quarter. The 'Bug Birds' were also tasked with something new in May 1970. Using both aircraft, 7<sup>th</sup> Air Force decided to try insecticide spraying a 'high threat' area of active combat at Landing Zone Baldy and Fire Base Ross in I Corps approximately 32 km south of Da Nang. The spray planes would be supported by Army helicopter gunships and 1<sup>st</sup> Marine Air Wing fighters. Psywar activities would be used to notify the enemy that the target was mosquitoes, a benefit to both sides. After arriving in Da Nang on 20 May to make final preparations, one of the 'Bug Birds' flew an unopposed survey flight over Landing Zone Baldy on the morning of 21 May. Unfortunately, the following morning, the aircraft encountered intense ground fire and were forced to abort the mission. At 7<sup>th</sup> Air Force's direction the two UC-123s attempted to spray Fire Support Base Ross on 29 May. Again heavy ground fire drove the mission off target. Although the eleven hits on the spray planes had caused no major structural damage or personnel casualties, further attempts to spray high threat areas were abandoned and the 'Bug Birds' returned to their more routine duties.

## 6 Termination of the Program

In July 1970 the RANCH HAND squadron was deactivated and the remaining spray planes became 'A' Flight of the 310<sup>th</sup> Tactical Airlift Squadron, based at Phan Rang Air Base. This presented problems for the insecticide planes because Phan Rang had no insecticide re-servicing capability, forcing the planes to fly extra sorties to load malathion from the stocks at Bien Hoa, Cam Ranh Bay, or Da Nang. Other changes took place in July when the Army's 172 Preventive Medicine Unit assumed responsibility for malathion operations at Da Nang and when the spray nozzles on the insecticide planes were changed to allow a finer spray of a 95% insecticide concentration to be dispensed in place of the original 57% solution. In spite of the changes and distractions, the 'Bug Birds' flew a record 146 productive sorties dispensing 85,085 liters of malathion during the quarter. For the year the totals were 486 sorties and 387,735 liters, respectively.

With the withdrawal of United States' combat forces from South Vietnam Operation FLYSWATTER was terminated in December 1971. The 'mosquito war' flew over 1,300 individual missions and dispensed more than 1.76 million liters of

malathion concentrate, about one-half the total insecticide dispensed by all forces during the conflict [23]. The mosquito control program had significantly contributed to the reduction of US Army man-days lost due to malaria from 228,000 in 1965 to 168,000 in 1970 despite the huge manpower increase during the same period [5]. Most of the aircraft and ground equipments assets were turned over to the South Vietnamese Air Force as part of the 'Vietnamization' program. 'Patches' returned to the United States and eventually was retired to the USAF Air Museum at Wright-Patterson AFB, Ohio. The venerable 'old Lady' of the spray squadron was forced to remain in 'outside' display for several years due to the reeking smell of malathion, despite a number of unsuccessful attempts to 'deodorize' the aircraft. Not until 2005 was the former Bug Bird finally moved to honorable retirement in an inside display scenario, a memorial to war against one of mankind's oldest and most persistent enemies, the mosquito.

**NOTE.** On 9 September 2005, three specially-equipped C-130 transports of the 910<sup>th</sup> Airlift Wing, Aerial Spray Flight, from Youngstown, Ohio, were deployed to help control mosquito infestations in the Gulf Coast disaster areas of Louisiana and Texas following Hurricanes Katrina and Rita. Flying low-level missions across the stricken areas, the men of the US Air Force once again had been called to assist in the continuing war with disease-carrying insects, renewing the traditional efforts of the Langley Special Aerial Spray Flight and Operation FLYSWATTER in Vietnam [27].

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Except as otherwise noted, the information for this commentary was obtained from the historical records of the Special Aerial Spray Flight (SASF), 309<sup>th</sup> Air Transport Squadron (later, Air Commando Squadron); 12<sup>th</sup> Air Commando Squadron (later, 12<sup>th</sup> Special Operations Squadron); and SASF, 310<sup>th</sup> Special Operations Squadron (later, 310<sup>th</sup> Tactical Airlift Squadron); October 1965 thru December 1971, in annexes to Department of the Air Force, History of the 315<sup>th</sup> Air Commando Wing (later, 315<sup>th</sup> Special Operations Wing and 315<sup>th</sup> Tactical Airlift Wing), K-WG-315-HI, Quarterly Reports, Air Force Historical Research Center, Maxwell Air Force Base, Alabama, USA.

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