

TECHNICAL REPORT
66-48-PR

**HUMAN FACTORS ASPECTS OF THE
QM-EQUIPPED SOLDIER IN JUNGLE OPERATIONS:
AN OPERATIONAL APPROACH**

by

Joseph T. Tambe

and

George E. Stembridge

May 1966

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760



PIONEERING RESEARCH DIVISION
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FOREWORD

This investigation is the first in a program of research which seeks to predict effects of tropical environments on human factors (mobility, visibility, communications, logistics) in combat operations. The ultimate aim is to relate experimental findings to techniques for insuring the soldier has appropriate clothing, equipment, and rations. This report serves to define the "work place" and the tasks of the man-equipment system and to identify relevant problem areas for future research.

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ABSTRACT

This study explores Human Factors problems associated with jungle operations by means of field observations made during tactical exercises conducted at the Jungle Warfare Training Center. The operational and physical environments, required soldier tasks and activities, and the equipment used are described. The major problems discussed concern combat load, heat, mobility, and certain features of rations.

HUMAN FACTORS ASPECTS OF THE QUARTERMASTER-EQUIPPED SOLDIER IN JUNGLE OPERATIONS: AN OPERATIONAL APPROACH

1. Introduction

Since World War II much has been written concerning the physical and operational hardships of the combat soldier operating in the tropics (4,5,8,15,17), and there has been extensive research on human performance under tropical conditions (1,3,11,12,13,16). Nevertheless, most previous work has not dealt with combat operations, nor has much been done in the operational context of the jungle. Similarly, the relationships among the soldier, his mission, and the equipment-environment complex have not been extensively treated.

There has, however, been some work on the identification of activities required of the combat soldier. A report by Dunlap and Associates (9) lists tasks judged to be most important in combat. A more comprehensive reference on the combat activities of soldiers is the research memorandum by the Human Resources Research Office (Hum RRO), "Critical Combat Skills, Knowledges and Performances Required of the 1962 Light-weapons Infantryman" (18). This work, based largely on testimonial evidence, is an expanded, general job description of the light-weapons infantryman (LWI). From the 41 performance categories enumerated, some activities of the combat soldier in a variety of environments can be inferred. Unfortunately, this report does not consider the soldier in special environments such as the jungle.

Similarly, little information is available on how the individual soldier makes use of his personal equipment and to what extent his equipment is suitable for the required tasks during actual operation in the jungle. Existing information, although useful, is non-specific and in many cases based solely on opinion. More detailed studies involving actual on-site investigations seem warranted.

During the campaigns of World War II extraordinary feats of endurance were performed in the tropics by trained men with high morale. In addition to training and motivation, human engineering improvements in personal equipment can increase performance to higher levels than usually found with troops in the field.

This investigation, based upon an empirical approach, represents an initial effort to investigate the human factors aspects of personal equipment in the jungle by using trained military observers to accompany small units in jungle operations. It represents an attempt to study man-equipment interactions in a realistic environment under operational conditions.

2. Objectives

The investigators believed that the major human factors problems were concerned with requirements for increase in mobility, relief from effects of heat, reduction of combat load, and acceptance of rations. The initial work in this program was viewed as an exploratory effort to examine these factors and to identify other major problems concerning the soldier and his equipment. Also, it was anticipated that this would lead to the delineation of man-equipment performance problems that would lend themselves to later experiments. Accordingly, this study was concerned primarily with describing jungle combat situations and determining the activities and tasks required by the man-equipment system.

The specific objectives were the following:

(1) Activity - To determine the tasks performed by the soldier in the execution of assigned missions.

(2) Clothing Equipment Rations - To determine use, suitability, compatibility and acceptance of individual clothing, equipment, and food under operational conditions.

3. Method

a. Site

The Fort Sherman Military Reservation in the Panama Canal Zone was selected for this study since it is representative of most of the world's wet tropical areas. At Fort Sherman, the home of the U. S. Army Jungle Warfare Training Center (JWTC), it was possible to collect information on U. S. Infantry units during actual tactical jungle operations. A geographic and climatic summary of Fort Sherman is attached as Appendix C.

b. Subjects

The subjects, infantry troops stationed at USARSO and assigned to the JWTC for training, were organized into squads which made up a student company. The squad which most closely approximated the TOE* rifle squad was selected for observational study. The selected squad

*TOE - Table of Organization and Equipment, the official table prescribing the composition of tactical units.

was composed of 11 men: three Privates (E-2s), five Privates First Class (E-3s), one Specialist Fourth Class (E-4), and two Sergeants (E-5s). It should be noted that on the raid operations (see below) three men were attached to the subject squad by the task force commander and were integrated into the squad. Hence, the squad numbered 14 men in this (raid) exercise.

c. Equipment

Individual clothing and equipment worn and used by the subject squad consisted primarily of non-standard items which were prescribed by JWTC because of their availability. (See Item List, Appendix H.)

d. Tactical Exercises

The Jungle Warfare Training Center conducts a 3-week course in small-unit infantry operations. Two major tactical exercises in the curriculum were selected as the best available representation of combat operations in the jungle.

(1) The first exercise was a company patrol base operation (approximately 45-1/4 hours) consisting of a reconnaissance patrol during the first day, followed by a combat patrol on the second day. The reconnaissance patrols were conducted by half-squad units (5 or 6 men), and the combat patrol was conducted by a platoon (approximately 40 men).

(2) The second exercise was a raid conducted by a company-size task force (approximately 100 men). The raid covered a period of approximately 55-1/2 hours.

A description of the exercises is contained in Appendix D.

e. Procedures for Recording Data

Types of data - Data were collected by controlled field observations which were made continuously during tactical exercises by observers accompanying the selected rifle squad. The information collected consisted of: activity data, meteorological and geographic data, data on use of and incompatibility of equipment items, and questionnaire responses. Observations were recorded narratively on portable, battery-operated wire recorders; the time of observation was recorded to the nearest minute.

Standard glossaries of terminology and checklists were carried by observers (see Appendix A for glossary). They did not restrict their terminology and descriptions to the checklist; however, the lists were used when possible.

Observer - Four observers accompanied the squad. The forward observer was located directly behind the "point man"*. This observer timed and recorded activities of the "point man" and also observed other subjects near the front of the squad. A rear observer, located directly forward of the last man in the squad, timed and recorded this subject's activities and observed other subjects near the rear of the squad. The primary tasks of these observers were to identify and time the activities of their sectors of the squad. To insure observation of the entire squad in bivouac, the observers were assigned to different elements of the squad.

Climatic measurements were made hourly by a meteorological observer located in the center of the squad. Because they were not always taken exactly on schedule, supplementary climatic data were obtained from a weather station a few miles from the actual sites (see Appendix F).

Use and incompatibility data on clothing, individual equipment, and rations were recorded by a fourth observer who randomly changed his position in the squad each hour while on the march.

The forward and rear observers also recorded equipment-use data and incompatibilities as a secondary duty. Photographs of each subject, taken before and after each exercise, were also used to provide data on wearing, carrying, and effects of use on clothing, equipment, and rations.

Questionnaire - An "open-end" questionnaire was administered to the subject squad following the completion of the patrol base and the raid exercises. The questionnaire provided related subjective information on salient aspects of the field observations.

4. Results

a. Operational Records

(1) Reconnaissance Patrol Base - The reconnaissance patrol data pertain to half a squad as obtained by one observer since the

*The "point man" is the leading man of the squad.

squad was divided into two patrols. Unfortunately, due to mechanical difficulties with the recording equipment, the other reconnaissance patrol data were lost.

Combat Patrol - The combat patrol data represent observations made by the rear observer accompanying the squad. Since he could observe about four men, it represents observations on about one-third of the subject squad. Observations by the forward observer were lost due to equipment malfunction.

The data identified as "patrol base" data represent a combination of existing reconnaissance and combat patrol time data plus qualitative data collected during bivouac. It should be noted that on the raid operation (see below) three men were attached to the subject squad by the task force commander and were integrated into the squad. Hence, the squad numbered 14 men in this raid exercise.

(2) Raid - The activity data for the raid consist of observations made by the two independent observers on the forward and rear thirds of the subject squad. Because of the restrictions described earlier, the data of each observer represent observations on about four men each.

b. Activity

Tables I-VI present qualitative descriptions of troop activity during the exercises as recorded by the observers. Each table indicates a major activity category, a listing of all the activities subsumed in that category, and the occurrence or non-occurrence of each sub-activity per tactical exercise. The data are presented in this manner because it became apparent that the observer was severely limited in scope of observation. Restrictions imposed on the observer precluded a detailed systematic quantification of activity data. Consequently, quantification was limited to the major categories, and the sub-activities were recorded secondarily as having occurred during the major activities.

c. Time

Table VII presents time distributions of the major activity categories for each exercise.

TABLE I

FOOT MOVEMENT ACTIVITY

Activity	Exercise		
	<u>Recon.</u>	<u>Combat Patrol</u>	<u>Raid</u>
March	X	X	X
Climb	X	X	X
Descend	X	X	X
Descend with rope			X
Cross obstacles	X	X	X
Wade streams	X	X	X
Wade swamps			X
Move in bounds	X	X	X
Move into position for assault		X	X
Withdraw from objective area	X	X	X
Post security to clear danger areas		X	X
Advance to reconnoiter	X		
Visual and verbal communication	X	X	X
Search for trail	X		
Navigate by compass	X		
Take concealment	X	X	X
Take cover			X
Cut trail			X

TABLE II
HALTS ENROUTE - ACTIVITY

Activity	Exercise		
	<u>Recon.</u>	<u>Combat Patrol</u>	<u>Raid</u>
Rest	X	X	X
Eat and drink	X	X	X
Reconnoiter	X		
Rendezvous--rally point	X	X	X
Security--rally point	X	X	X
Reorganize		X	X
Halt in bounds	X	X	X
Disperse	X	X	X
Wait to cross stream			X
Security--of danger area			X
Halt while leaders confer			X
Wait to descend, after descend			X
Prepare to move out			X
Wait to maintain contact (column catch up)	X		X
Wait for air strike			X
Check position	X		
Visual and verbal communication	X	X	X
Assemble	X		
Fill canteens in stream	X		X
Search for trail	X		
Test fire automatic weapons		X	
Cover withdrawal		X	
Wait for coord. with guerrillas			X
Take concealment	X	X	X
Cut trail	X		

TABLE III
WATER TRANSPORT - ACTIVITY

Activity	Exercise		
	<u>Recon.</u>	<u>Combat Patrol</u>	<u>Raid</u>
Embark and debark, LCM*			X
Embark and debark, boats			X
Rowing			X
Visual and verbal communication			X
Resting on LCM enroute to hostile shore			X
Take cover			X

*LCM - Landing Craft Medium

TABLE IV
TEMPORARY ENCAMPMENT - ACTIVITY

Activity	Exercise		
	<u>Recon.</u>	<u>Combat Patrol</u>	<u>Raid</u>
Rest			X
Eat and drink			X
Maintain weapons			X
Post security			X
Receive rations, ammunition, and water			X
Visual and verbal communication			X
Prepare to move out			X
Pack and unpack			X
Await nightfall for boat departure			X
Wash (personal hygiene)			X
Take concealment			X
Wash clothing			X

TABLE V
BIVOUAC - ACTIVITY

Activity	Exercise	
	<u>Patrol Base</u>	<u>Raid</u>
Pack and unpack	X	X
Rest	X	X
Sleep in shelter	X	X
Sleep on ground		X
Post security	X	X
Prepare and take down shelters	X	X
Prepare tactical fires	X	
Prepare and eat rations (hot and cold)	X	X
Drink	X	X
Briefing, debriefing, receiving orders	X	
Receiving supply of rations and water	X	X
Receiving supply of ammunition		X
Dig latrines and sumps	X	
Personal hygiene	X	X
Maintain weapons	X	X
Inspection and preparation for mission	X	
Clearing vegetation	X	
Prepare to move out--form to move out	X	X
Visual and verbal communication	X	X
Take concealment	X	X
Disperse	X	X

TABLE VI
ENEMY CONTACT - ACTIVITY

Activity	Exercise		
	<u>Recon.</u>	<u>Combat Patrol</u>	<u>Raid</u>
Support assault w/MG* fire		X	
Shift supporting fire		X	
Amphibious assault--clear enemy resistance			X
Assault objective		X	X
Counter-ambush		X	
Receive enemy fire	X	X	X
Surveillance	X		
Visual and verbal communication	X	X	X
Take cover	X		
Take concealment	X		

*MG - Machine Gun

TABLE VII
PERCENT OF TOTAL MISSION TIME

Activity	Exercise				
	<u>Patrol Base</u>		<u>Total Including Bivouac</u>	<u>Raid</u>	
	<u>Recon. Patrol</u>	<u>Combat Patrol</u>		<u>Observer 1</u>	<u>Observer 2</u>
Foot movement	67	61	18	20	24
Water transport	--	--	--	9	9
Halt enroute	31	36	9	22	18
Temp. encamp.	--	--	--	11	11
Bivouac	--	--	72	38	38
Enemy contact	2	3	1	1	1
Total mission time					
	7hrs. 25min.	5hr. 7min.	45hr. 15min.	55hrs. 27min.	

d. Mobility

Table VIII presents an estimate of mobility rate for each exercise. These rates were calculated on two basic considerations.

$$(1) \text{ Average speed enroute } = \frac{\text{total distance}}{\text{total time (water transport-temporary encampment-bivouac)}}$$

$$(2) \text{ Average speed during movement } = \frac{\text{total distance}}{\text{total time in foot movement}}$$

The map distance of the route followed was used in each case as an estimate of the actual distance traversed.

TABLE VIII
MOBILITY RATES FOR THE EXERCISES

Exercise	Map Distance (Meters)	Avg. Speed Enroute (Meters per Hour)	Avg. Speed in Foot Mvmt. (Meters per Hour)
Patrol Recon. Patrol	4,550	613	915
Base Combat Patrol	4,900	957	1,570
Raid Observer 1	14,525	624	1,310
Observer 2		624	1,091

e. Climatology and Geography

A summary of the climatic and geographic conditions during tactical troop movements is presented in Tables IX, X. Since some climatic field data were lost through occasional operational difficulties, supplementary weather station data were used as needed. Detailed geoclimatic profiles of the routes of the tactical moves are supplied in Appendix E.

f. Clothing, Equipment, and Rations

Table XI summarizes observations made on the use, deficiencies, and incompatibilities of clothing, equipment, and ration items. Most of the entries are based on observations and photographs of the subject squad; some of the data were obtained by observing other squads and individuals. Operations and environmental difficulties did not permit quantification of the data; however, many observations were substantiated by responses to questionnaires.

TABLE IX

SUMMARY OF CLIMATIC FACTORS OBSERVED DURING
THREE TACTICAL MISSIONS

Climatic Factor	Reconnaissance Patrol	Combat Patrol	Raid
<u>Temperature (°F)</u>			
Maximum	87	87	88*
Minimum	73	81	74*
Range	14	6	14
<u>Relative humidity (%)</u>			
Maximum	100	90	100
Minimum	74	69	75
Range	26	21	25
Avg. dry bulb temp. (°F)**	82.0	83.6	79.1
Avg. wet bulb temp. (°F)**	77.4	78.9	77.1
Avg. relative humidity (%)**	82.2	81.5	91.9
Total precipitation (in.)	.0	.0	1

*Weather station data - Fort Sherman Shelter Station.

**Calculated from all observed or station data during mission.

TABLE X

SUMMARY OF VEGETATION TYPES OBSERVED DURING THREE TACTICAL MISSIONS*

Vegetation Type	Tactical Exercise					
	Ia. Reconnaissance Patrol		Ib. Combat Patrol		II Raid	
	Map Distance (Meters)	Percent of Total Distance	Map Distance (Meters)	Percent of Total Distance	Map Distance (Meters)	Percent of Total Distance
Rain forest	4,250	94	2,400	48	7,975	55
Rain forest secondary growth	300	6	750	15	2,850	19
Tropical deciduous forest	---	--	950	19	1,825	13
Grass land	---	--	800	18	---	--
Cativo secondary growth	---	--	---	--	1,425	10
Coastal thicket	---	--	---	--	200	1
Cativo	---	--	---	--	250	2
TOTAL	4,550		4,900		14,525	

*These data were derived from vegetation maps of the routes traversed.

TABLE XI

OBSERVATIONS PERTAINING TO CLOTHING, EQUIPMENT, AND RATIONS

Item	Used or Carried During: *			Unusual Uses	Variations in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb.	Raid				
Ammunition bandoleers	X	X	X		Worn across chest and hips; tied around canteen; ammunition clips removed and attached to rifle sling		
Ammunition, cal. 30, belted		X			None; belted ammunition carried around the neck.		
41 Bayonet	X	X	X	In lieu of hunting knife	None; attached to pistol belt.		
Boot, combat,** tropic, direct- molded sole (DMS)	X	X	X			Did not provide enough traction. Lug recesses not deep enough and/or lugs spaced too closely together.	Mud became packed between lugs, causing loss of traction
Boot, combat, tropic w/buck- les and cuff	X	X	X				Better traction than direct molded sole boots.
Boots, combat, leather	X	X	X			Poor traction.	Not suited for use in the jungle.

*Reconnaissance Patrol (Recn), Combat patrol (Comb.), Raid.

**Tropic combat boots with cuffs and buckles and regular combat boots were worn by the subject squad. A few DMS boots were worn by others.

TABLE XI (cont'd)

Item	Used or Carried			Unusual Uses	Variations in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb.	Raid				
Canteen and cover	X	X	X		Attached to pistol belt at hips; attached to pistol belt at buttocks. Attached to pistol belt at the middle of the back.	Canteen attached at the hip interfered with arm movement. Canteen was difficult to remove from the cover when wet.	Each subject carried two canteens. Difficulty in removing canteen from cover probably influenced subjects to carry the canteen at the hips.
Canteen cup	X	X	X	Cooking utensil			
Cap, utility	X	X	X			The cotton field cap does not have air vents. Luminous tape did not adhere to cap.	A few wore the cotton field cap. Luminous tape was affixed to the caps to aid in movements at night.
Climbing rope, individual roll		X	X		On the pack; fastened to belt; across the shoulder.		
"Comfort kit"		X			None; taped to suspender at the front of the shoulder.		Comfort kits consisted of band aid tins and contents which were: tweezers, salt tablets, band aids, needle and thread, merthiolate, etc.

TABLE XI (cont'd)

Item	Used or Carried			Unusual Uses	Variations in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb.	Raid				
Fatigues, shirt and trousers, cotton sateen, 8.5 oz.	X	X	X			Required a long time to dry.	Some subjects buttoned their shirt collars as a protection against insects. Shirt and trouser pockets were used. Shirts were worn outside the belt to enhance air circulation to the body.
Fatigues, shirt and trousers, tropical poplin, 5.5 oz.*	X	X	X		Sleeves worn down and rolled up.	Snagging and tearing at the trouser legs by brush and thorns. Rolled up sleeves result in cuts and scratches from vegetation while moving.	Dried faster than cotton sateen fatigues.
First aid pouch	X	X	X	Used to carry tablets, water purification tablets, compass	None; attached to the front of the pistol belt.	Pouch shrank when wet.	
Flare containers			X	Used to carry maps, protractor	None; taped to front suspenders.		

*The 5.5 oz. cotton sateen fatigues were worn by the subject squad. A few poplin fatigues were worn by others.

TABLE XI (cont'd)

Item	Used or Carried		Unusual Uses	Variations in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb. Raid				
Foot powder		X	X	Used as absorbent in underarm and groin areas		
Gloves, shell, leather	X	X	X		Black dye discolored the hand. No air ventilation to the hand.	Gloves worn as protection against thorns, etc.
Heating tablets		X	X			
Hunting knife	X	X	X	None.		Carried only by one subject.
Insect repellent		X	X	Used as lighter fluid to start fires. Applied to skin to warm the body	Sweating reduced its effectiveness.	Used frequently.
Insoles, boot, nylon	X	X	X		Caused irritation particularly on toes.	
Intrenching tool			X	On back of pack; on hip.	Hip-carry potential source of injury to ribs in case of a fall.	Issued but not carried by subject squad; however, a spade was used on patrol base bivouac.
Life preserver			X	None; around the waist.		

TABLE XI (cont'd)

Item	Used or Carried			Unusual Uses	Variations in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb.	Raid				
Machine gun, cal. 30 (LMG)		X			Carried by hand; suspended from two front suspender straps.		Subjects alternated in carrying the machine gun.
Machete and sheath	X	X	X		Attached to pistol belt at the hip; on the pack.	Blade loses sharp edge quickly; when worn at the hip the machete and sheath interfered with movement when stepping over obstacles. Hip-carry is a potential source of injury to ribs in case of fall.	The machete was rarely used during tactical moves.
Mosquito bar		X	X	Used as blanket	None; in pack.		
Pack		X	X		High, on shoulders, low, on back.	Requires frequent shifts of the load. Interferes with skin evaporation of perspiration. Causes blocking of evaporation.	
Pistol belt	X	X	X		None; fastened around the waist.		
Plastic bags	X	X	X	Used to protect cigarettes, maps, etc., from getting wet			

TABLE XI (cont'd)

Item	Used or Carried			Unusual Uses	Variations in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb.	Raid				
Poncho		X	X	Shelter; ground sheet; used in constructing brush rafts	Fastened to top of pack; fastened to back of pack; inside the pack.		Not used as rain garment during troop movement due to lack of ventilation.
Rations (meal, combat, individual)*	X	X	X	Accessory packet in package used as drinking cup. Empty cans were vented at the bottom and used with heating tablets as "cookers."	Inside the shirt; in pockets; tied to front suspender straps; in the pack; inside socks which were tied to suspenders .	Cylindrical cans difficult to carry. Rations are too heavy.	
Rifle, M1	X	X	X	Used to assist in maintaining footing on slippery surface	Slung on shoulder, carried in hand.		
Socks, wool, OD and black	X	X	X	Used to carry rations		Black socks discolored the feet.	
Suspenders		X	X	Front straps fastened to machine gun to assist in carrying	Front straps fastened to pistol belt; front straps unfastened.		Some subjects pulled forward on front straps to shift the load.

*See Appendix I for a brief description of the components.

TABLE XI (cont'd)

Item	Used or Carried			Unusual Uses	Variation in Method of Wearing or Carrying	Observed Deficiencies and Incompatibilities	Comments
	Recn.	Comb.	Raid				
Underwear	X	X	X			White T-shirts provide no camouflage.	Many subjects did not wear T-shirts. Some wore underwear as outer garment for sleeping.
Water purification tablets	X	X	X				Water discipline not in effect. Iodine tablets used freely, water consumption apparently not reduced.

5. Discussion

a. Limitations of Data - It should be noted that the data as presented here have many limitations.

(1) They do not, of course, represent the full range of activities that did or could have occurred in jungle operations. One reason for this is that activities such as evacuations, CBR measures, helicopter movements, supply by air, to name a few, were not part of the training situation.

(2) In addition, only a few missions were studied, and these are not necessarily representative of jungle operations.

(3) Also, the observers themselves were limited in the scope of their observations. Had they been able to observe more squads they probably would have recorded more activities.

(4) Another difficulty is the problem of validity stemming from the use of a small sample. Other units and other men could conceivably do different things.

(5) Finally, it must be recognized that psychologically the conditions were not those of actual combat. Although conditions were well simulated, true combat stress was lacking.

b. Activity Data - The activity data show that many of the activities listed under the major categories are not peculiar to infantry operations in the jungle. Specifically, there is some correspondence between 19 of the 41 performance categories in the job description of the light weapons infantryman (LWI) and the activities recorded in these exercises (see Appendix B for a listing of the categories). The chief differences were in the use of weapons, communications, transportation, individual combat performance, and squad tactics as discussed below:

Weapons. The observed rifle squad used only the rifle and machine gun. The description of the LWI lists the use of 15 weapons, some of which may be considered in the relatively heavy class.

Communications. The rifle squad used individual-to-individual methods such as visual, auditory, and pyrotechnic signals.

Transportation. Movement was restricted primarily to foot marches. The use of vehicles was limited to assault boats and assault craft during the raid.

(Individual Combat Performance - The observed squad was engaged in 12 of the 16 listed performances. These were: personal hygiene and

field sanitation; maintenance of clothing and equipment; land navigation (including orientation, maps, and compass); emplacement of shelters; observation; combat intelligence and reporting; cover; concealment, and camouflage; combat feeding, and performance of basic physical skills.

Squad Tactics - The squad was observed in three or four performances listed in Appendix B, i. e.: (a) formations, battle drills, elementary fire and maneuver; (b) techniques of fire; (c) and supporting fire.

A review of these differences suggests close agreement between the observed squad and the LWI in individual combat performance and squad tactics. Such agreement probably was found because the rifle squad itself was the focus of this study. Also, artifacts of the training situation as prescribed and, perhaps, to some degree, the peculiarities of the missions, may have furthered this tendency.

The differences between the soldier in non-tropic environments and the jungle soldier, with respect to common activities, appear to result largely from differences in the techniques applied. For example, land navigation by compass, in both temperate and tropical environments, requires that steering points be used to maintain an azimuth. Nevertheless, because of the dense vegetation and reduced visibility in the jungle, steering points are selected more frequently and closer to each other than in a temperate environment. The frequency of moving by irregular bounds (i.e., frequent starting and stopping) is conditioned in the jungle, not only by the terrain and vegetation but also by the increased need for continuous vigilance and security measures to prevent surprise by the enemy.

c. Time and Mobility Data

(1) Disparity between Observers - It is interesting to note that on the raid two observers with the same squad agreed on the time distribution of activity categories except foot movement and "halt enroute" (Table VII). The differences are opposite in direction, with the forward observer recording more time at halt and the rear observer recording more time in movement. It might appear that such disparity is excessive. Apart from observer differences, the lack of agreement is probably due to slight variations in ground pattern actually traversed by the forward and rear elements of the squad, in addition to actual differences in activities. Examples of differences in activity would be: incongruous arrivals and departures, and differences in waiting by forward elements for rear elements as a result of the alternate elongation and contraction of the column. This latter effect is indicated by the greater amount of time spent by the rear elements (observer 2) in foot movement and less in halt enroute. This points to

"catching up" movement by rear elements while the forward elements appear to have been waiting. Considering these factors, it is not surprising to find this disparity between observers.

(2) Time Differences Among the Tactical Missions - Tables VII and VIII summarize the time involved in the tactical moves during the three exercises. The data indicate that the troops spent much time moving to or away from enemy contact. Encounters with the enemy were infrequent and short in duration. When an enemy contact did occur it was consummated in a very short period.

During the reconnaissance patrol about two-thirds of the time was spent in foot movement and less than one-third of the time was spent at a halt. Nevertheless, the average speed during movement was quite slow (approximately 915 meters per hour). The net result was a low overall speed during the tactical move.

The combat patrol spent slightly less time in foot movement and slightly more time at a halt, but the average speed during movement was relatively rapid (approximately 1,570 meters per hour). The net result was a comparatively high overall speed for the combat patrol.

The raid exercise shows that time was divided more evenly between foot movement and halt enroute than in the other exercises. Average speed enroute was comparable to that of the reconnaissance patrol, but when actually moving, the average speed was relatively high.

(3) Mobility Rates - The mobility rates were influenced by numerous factors; the most easily identifiable were: load, tactics, motivation, size of the unit, trafficability, physical condition of the troops, time allotted to accomplish mission, decisions of the commanders, temperature, terrain, and vegetation. These are discussed below.

Load - The missions differed with respect to the load carried. During the reconnaissance patrol the subject squad carried a minimum of equipment, whereas in the combat patrol and in the raid full combat loads were carried. Although the actual weights of loads carried on the latter two missions are not known, it is likely that the load carried during the raid was heavier. Added to the individual load on the combat patrol was the net increase in weight of the machine guns and ammunition carried by some members of the squad instead of rifles as in the reconnaissance patrol.

Tactics - The combat patrol and the raid were similar in that their mission was to fight. However, it was necessary for both

to avoid detection until the action on the objective. The reconnaissance patrol, on the other hand, with a surveillance mission, moved independently of the parent unit and spent more effort in avoiding enemy encounters since it had little fighting capability.

Motivation - There are no indications that differences in motivation between the reconnaissance patrol and the raid were significant. During the combat patrol motivation may have been influenced by the fact that the troops were to return to administrative barracks immediately following this exercise. This incentive was not present in the other two exercises.

Unit Size - The size of the unit was also a variable. The reconnaissance patrol was half a squad, the combat patrol was a platoon, and the raid was a company-size task force. During the raid the subject squad was increased by three men (attached by the task force commander). Hence, there were differences between exercises in the make-up of the squad. Also, in all three operations, movement was in column-of-files formation. Consequently, the mobility rate of the observed squad was dependent on the preceding elements. The length of the column also affected the mobility of the entire unit. In this respect the reconnaissance patrol had a mobility advantage, but actually was slowest.

Trafficability - A considerable amount of rain fell during the raid but not during the reconnaissance and combat patrols. There was rain before each mission, but much more rain fell before the raid than before the other operations. During the foot movement on soft rain-soaked ground, there were many instances where troops were observed slipping, sliding, and falling. On numerous occasions troops helped each other and used vegetation to maintain their footing. As a result, the mobility rate in the raid was probably influenced more by reduced traction resulting from the rain, than were the other exercises.

Physical condition - The physical condition of the troops before each exercise was probably constant. Nevertheless, if the length of the mission affected physical condition by progressive deterioration, the mobility rate of the raid would have been affected most. This, however, is not evident in the resulting movement rates.

Time allocation - The rates of mobility were probably affected also by the decisions of the commander in each operation. Different commanders directed each operation, and each leader decided

the speed of movement according to the requirements of the mission. No clear advantage in any operation can be deduced, but any differences in the manner in which the units were pressed by the commanders certainly would have affected mobility rates.

Climate and terrain - The climatic conditions during all three exercises were fairly uniform. Maximum temperatures were almost the same for each exercise. On the average, the two daylight missions were very similar; however, the raid included day and night for almost three days and the climatic conditions were more variable. There was a difference in rainfall and, as previously stated, the raid was probably influenced by this factor.

The geographic data reflect the differences in terrain and vegetation for these missions. The combat patrol had fewer obstacles, fewer topographic direction changes, terrain that was more consistently downhill, and what may have been more passable vegetation.

d. Geographic and Climatic Data

(1) Vegetation - While the descriptions in Appendix G indicate the principal differences between vegetation types encountered during the tactical activities (Table X), it should not be assumed that the vegetation took the precise forms described nor that there was uniformity within a vegetation type.

The raid mission involved several vegetation types, whereas the reconnaissance patrol was associated with only two. The combat patrol has been characterized as having more passable vegetation because the rain forest secondary growth was mature, and therefore easily traversed. Also, the grassland was easily traveled after the lead elements of a column had made the initial penetration.

(2) Climatic data - The climatic data, Table IX, appear to be representative of typical rainy season conditions for the Panama area. Unfortunately, not enough data were collected to permit a true measure of heat stress during the study. Although globe thermometer readings were not taken, an estimated wet bulb globe temperature (WBGT) index was calculated for the hottest midday conditions for each exercise by taking .7 of the aspirated wet bulb temperature plus .3 of the dry bulb temperature. From this formula the highest estimated WBGT was 82.1 for the reconnaissance patrol, 83.5 for the combat patrol, and 83.8 and 82.1 for the second and third days respectively of the raid. These may be compared to the usual heat stress criterion WBGT index of 85 (6, 14, 19).

Effective temperatures (ET) were also calculated to indicate heat stress during these exercises. Windspeeds were not measured at the field sites. However, since windspeed in this area typically does not exceed 3 miles per hour under the jungle canopy (2) ET for "still air" (velocity 30 feet per minute) and 3 miles per hour (velocity 26 1/4 feet per minute) were determined. Assuming that winds varied from 30 feet/minute to 26 1/4 feet per minute, the ET for the hottest conditions on the reconnaissance patrol varied from 77-82 and from 79-84 on the combat patrol. During the raid, hot conditions occurred only on the second and third days, and highest ET probably varied from 80-84 and from 78-82 respectively. A suggested effective temperature criterion for heat stress is about 80 (7, 10, 20).

Thus it appears that climatic conditions approached critical heat stress limits during a few hours of the hottest part of the day. These conditions were similar for the reconnaissance and combat patrols and for the second and third days of the raid. In general, heat stress was not a major critical problem during these exercises.

Details of temperature, rainfall, terrain, vegetation, and topography, for the subject exercises are reported by Chambers (2).

e. Clothing Equipment, and Rations

Missions - The entries in Table XI indicate that the majority of the items used or carried in the combat patrol were also used or carried in the raid. Very little equipment was used on the reconnaissance patrol, which conforms to the practice of carrying only items necessary to accomplish the mission. The subject squad elected to leave even their suspenders behind on this mission.

Unusual uses - The entries in the column on unusual uses, particularly those pertaining to foot powder, insect repellent, mosquito bar, and the poncho, may be indicative of other specific needs of jungle soldiers. They also serve as excellent examples of items that can be used for multiple purposes, some of which are quite different from the purpose originally intended. In the case of the use of suspenders for machine gun carry, extended use in this manner would probably cause the failure of the metal hooks. Had it been available, the universal carrying sling would have been more suitable. However, it is apparent that this improvisation was a better method than the hand-carry of the machine guns.

The poncho proved to be a very versatile and useful item. The table shows that contrary to its common function as a protective overgarment the poncho was used primarily as a ground sheet and shelter.

It was not used as a rain garment by marching troops who expressed opinions that it greatly increases perspiration and hinders the movement of arms and legs.

Variations in method of wearing or carrying - As might be expected, the table shows numerous variations in wearing and carrying items. The fatigue shirt is of particular interest. As prescribed by JWTC, it was worn outside the trousers to increase ventilation. Some subjects opened the shirt by unbuttoning the first few buttons. On the other hand, a few subjects were observed with buttoned collars. This may have been an attempt to gain protection against stinging and biting insects at the expense of ventilation.

Ventilation can also be improved by opening the pistol belt, but this creates other problems in load-carrying such as instability and imbalance of the load.

Improvised items such as "comfort kit", map case (flare case), sock for carrying rations, and a "cooker" may indicate needs for which there is no provision. On the other hand, the table indicates that some items such as sleeping accessories, entrenching tool, underwear, and helmets were omitted or used little. It is noteworthy that none of the last three items was prescribed by JWTC (Appendix H) during these exercises.

In the case of the sleeping accessories, tropical sleeping gear was not in the supply system. At nightfall the troops usually slept on the ground. On some occasions semi-permanent or "hasty" shelters ("bohios") were constructed with saplings and vegetation, and the soldiers were able to sleep with some shelter (Fig. 1). The tactical situation often restricts noise-making, thus hampering shelter construction. Furthermore, because of the wet ground and the presence of mites, ticks, and chiggers, the soldier should not sleep on the jungle floor. Perhaps a hammock (such as the lightweight hammock currently under test), an air mattress, or a unitized tent would be useful. In some areas a hammock cannot be used because there are too few trees. Whatever form sleeping gear takes, it is apparent that it should be adaptable to easy and noiseless preparation without benefit of illumination, and it should be adaptable for on- and off-ground use.

The entrenching tools were not carried by the subject squad during the exercises. However, other troops were observed carrying and using the item. Furthermore, a spade was observed in use in the bivouac area of the patrol base. This may be an indication of reluctance to carry an essential but infrequently used item.

As the table indicates, many soldiers did not wear underwear. The elimination of underwear may relieve heat effects since one layer



Figure 1. A hasty shelter.

of insulating material is removed. Furthermore, irritation and chafing may be reduced.

The steel helmet does not appear in Table XI. While this seems to be typical of jungle operations, it must be realized that no live firing was involved. Aside from the additional weight, the principal objection to wearing the helmet is the noise produced when moving through brush.

d. Deficiencies and Incompatibility

Table XI also shows deficiencies and incompatibilities observed during these exercises.

The data on boots is of particular interest since three types were observed. The ordinary combat boot was clearly unsuited for jungle use because there was poor traction and no provision for drainage. The tropic boot with direct-molded sole (DMS) did not provide enough traction despite a lug pattern with a recess of 1/4 inch. The lugs were not deep enough or were too closely spaced resulting in a buildup of mud under the boot and around the edge of the outer sole which caused much slipping. In contrast, the non-standard tropic boot (with buckles and cuff) provided better traction than the direct molded sole boots. A new boot now under development which provides deeper and wider lugs may correct this deficiency.

The M1945 pack exerted excessive pressure on the shoulders and back. Troops were frequently observed shifting the pack load higher in order to relieve shoulder pressure and back discomfort.

The pack and suspenders also interfere with the evaporation of perspiration from the skin. The suspenders and pack press the shirt fabric against the shoulders and back of the wearer, impeding evaporation and resulting in less efficient cooling.

The current standard M56 load-carrying system may have corrected these deficiencies, since the load is concentrated in the lumbar area, the pressure on the back and shoulders is relieved. Less body surface may be blocked by this configuration with less restriction of evaporative cooling.

Of the two types of fatigues observed, in general the standard 8.5-ounce cotton sateen type seemed hotter than the 5.5-ounce poplin. They also take longer to dry and prolong the discomfort of the wearer.

e. Need to Reduce Heat Load

Figure 2 is suggestive of the need to reduce the heat load in the jungle. Before the combat patrol mission began, the



Figure 2. Evidence of perspiration soaking during the combat patrol.

troops in the pictures were dry. After the mission, all of the subjects were perspiration-soaked in the upper torso; a few were also soaked in the trousers.

In addition to their extra weight, heavy fabrics such as the 8.5-ounce cotton sateen may tend to aggravate heat effects because of their failure to dry out quickly. Not only do heavy fabrics increase heat load during the day, such clothing may also increase chill at night. Unlike a hot-dry environment in which sweat can be evaporated, the typical wet tropical environment does not permit efficient use of all the sweat produced. Accordingly, in the evening the body micro-environment is saturated, and the soldiers experience cold due to the unevaporated liquid held in the clothing from both sweat and rain. Furthermore, this prolonged wetting probably contributes to the high incidence of skin infections and irritations in the jungle. Hence, the recently adopted tropic fatigue uniform (not available in sufficient quantity during this study) made from the poplin fabric should represent an improvement over the sateen uniform because of its light weight and its ability to dry out quickly. On the negative side, however, it should be noted that some snagging and tearing by brush and thorns were observed in the trouser legs of the poplin fatigues.

Rations - The chief objection to the current ration appears to be its weight (see Appendix I for a description of the Meal, Combat, Individual). One ration, exclusive of its shipping case, weighs about 5 pounds; thus a 3-day ration weighs almost 15 pounds. This addition to the load is excessive, particularly in the jungle where an increase in heat production is less tolerable than in temperate or dry climates. A new ration currently under development, the Meal, Ready-to-Eat, Individual, with a planned weight of 1 pound will be improvement.

A new design for ration containers is needed since the cylindrical ration cans are awkward to carry. To overcome this, some troops used a sock to carry ration cans in order to make them readily available and to avoid their protruding under the shirt or in the pockets. A flat ration container would be more suitable, since such containers could be more easily carried in the pockets or pack as desired.

Ration Acceptance - There were no specific patterns in discarding, hoarding, and exchanging of foods. A few ration items such as canned fruit (peaches and apricots), pound cake, and pecan loaf appeared to be popular. The meat components did not appear to be highly prized, although there seemed to be some liking for the meatballs with beans and frankfurters with beans.

In some instances men were observed throwing away or giving away components. On the reconnaissance patrol one subject did not

carry rations; this may be an indication of preference for a light load over food. On the other hand, at least one subject carried commercially canned sardines as a supplement to his issued rations.

There were some general patterns in preparing and eating rations. In bivouac they were usually prepared and eaten by men in small groups, whereas on the march, eating usually took place during an announced halt for that purpose. During the halt men usually ate individually, not in groups. Some small items such as cheese component, biscuits, and jam components were consumed during the march.

Limitations of data: clothing, equipment and rations - As with the activity data, there are limitations on the data concerned with use of clothing, equipment, and rations. In particular, the absence of true combat conditions probably affects not only tactical behavior but also use of some equipment and rations. Under conditions of actual combat, items used or carried may be different from those presented in this report.

6. Comments on Difficulties in Methodology

As indicated earlier, supplementary climatic data were used, and some qualitative data necessarily had to be presented instead of quantified data. These compromises developed from practical difficulties which fell into three categories: mechanical difficulties with equipment, environmental difficulties, and observer involvement as discussed below:

a. Mechanical Difficulties with Equipment

Despite efforts to protect and test equipment before use, there were breakdowns in the recorders. In anticipation of this, microphones and recorders had been "tropicalized", and extra accessories and extra recorders were made available. Every effort was made to keep all apparatus in a state of good repair. Nevertheless, equipment breakdowns occurred in the field, and they were detected too late to be remedied.

b. Environmental Difficulties

Environmental difficulties were due mostly to extremely reduced visibility in the dense vegetation. Rugged and precarious terrain and occasional weather difficulties such as sudden torrential rain prevented concurrent recording and traverse.

c. Observer Involvement

The requirement that the observer perform the same basic activities as the troops led to complete involvement of the observer. At a halt, observers had to build their own shelters, prepare and consume food, rest,

sleep, and protect equipment. Such demands no doubt reduced observer efficiency.

It is clear that collecting data in an actual operation has advantages over the laboratory situation, but of course there are many disadvantages also. Such disadvantages and the effects on the resulting data must be given proper consideration in studies of this type.

7. Conclusions

a. Activity

(1) The activities reported herein are a sample of activities which may occur in similar jungle operations under the same conditions.

(2) To the extent that these activities, particularly individual combat performance and squad tactics, agree with testimonial evidence on the LWI (in all environments), they constitute empirical support for such testimony.

(3) The activities reported indicate that under the conditions described in this report many basic infantry activities are expected to occur in the jungle as well as in other environments.

(4) When common activities do exist between the soldiers in jungle and soldiers in other environments, the main differences appear to be in the requirement for more time in accomplishing some tasks and in different techniques used.

b. Clothing, Equipment, and Rations

The human factors problems believed to be important were borne out by the results; no new significant problems were identified. Important areas continue to be:

- (1) Traction surfaces in footwear.
- (2) Reduction of the heat load.
- (3) Reduction in the number and weight of individual items.
- (4) Increase in items with multiple purposes.
- (5) Increased ventilation in clothing.
- (6) Use of quick-drying and non-absorbing fabrics.
- (7) Reduction in size and weight of ration components.
- (8) Packaging and containers for ration components.

c. Methodology

The techniques used resulted in some empirical data that are more specific than data previously available. However, much data are

still qualitative and general because of the preponderance of uncontrolled variables, the difficulty of the investigator's task, and the relative insensitivity of the methods. Proper consideration must be given to these factors in studies of this type.

d. Application

The results of this study provide a descriptive sample of some of the important elements of the human factors aspects of infantry operations in the jungle.

8. Recommendations

a. The multiple uses, variations, and improvisations observed are suggestive of potential changes and improvements that might be made in existing and future systems. These factors, and the deficiencies and incompatibilities reported, should be further investigated to determine their generality for corrective action which may be indicated.

b. Experiments to follow should be simplified and reduced in scope and initial emphasis should be on the optimization of subsystems rather than the total complex of man, equipment, and environment. Optimal subsystems should then be considered in the ultimate total system. Experiments should be based on the tests of simulated performance, over wide ranges of trade-offs in such variables as durability, weight, heat load, bulk, stability, austerity, protection, acceptance, and vulnerability.

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A P P E N D I C E S

APPENDIX A

Glossary of Terms

March - any tactical foot movement in the general category of walking.

Foot movement - any tactical march by foot; excludes enemy contact.

Climb - ascending foot movement over terrain with gradual or steep grade.

Descend - downward foot movement over terrain with gradual or steep grade.

Move in bounds - foot movement characterized by frequent irregular starting and stopping.

Halt enroute - any temporary halt during movement to a specific destination; does not include bivouac, temporary encampment, and enemy contact.

Halt in bounds - frequent and irregular halting as part of movement in bounds.

Water transport - water surface movement in surface craft; includes embarking and debarking.

Temporary encampment - a long halt enroute for a specified purpose but not for an overnight bivouac.

Bivouac - an overnight encampment usually involving the construction of temporary or "hasty" shelters.

Enemy contact - offensive or defensive actions against the enemy; includes reconnaissance.

Deadfall - fallen trees that impede or delay foot movement.

Obstacles - streams, rivers, gullies, large deadfall areas, cliffs.

APPENDIX B

Summary of Performances Categories in Critical Combat Skills, Knowledges, and Performances Required of the 1962 Light Weapons Infantryman (MOS 111.0)

a. Weapons Usage

1. Maintain, use for protection and warning, and engage targets with hand grenades.
2. Maintain and engage targets with pistol, automatic, cal. 45.
3. Maintain and employ bayonet against enemy personnel.
4. Maintain and engage targets with rifles, M14 and M1.
5. Engage enemy targets with rifle grenades.
6. Maintain and engage enemy targets with rifles, M14AR and BAR.
7. Maintain and engage enemy targets with machine gun, M60.
8. Maintain and engage enemy targets with 3.5-inch rocket launcher.
9. Maintain and engage enemy targets with portable flame throwers.
10. Maintain and engage enemy targets with and maintain recoilless rifle, 90MM (medium assault weapon).
11. Maintain and engage enemy targets with antitank weapon, light (rocket, grenade, 66MM, XM-72).
12. Install, salvage and fire weapon, antipersonnel M18 (Claymore).
13. Install, salvage and fires mines, antitank and antipersonnel and warning and illuminating devices.
14. Check and use demolitions and boobytraps on targets.
15. Maintain and engage targets with grenade launcher, 40MM, M79.

b. Communications

1. Maintain, receive, and transmit by radio.
2. Maintain, check, install, receive and transmit by wire communications.

3. Act as messenger.

4. Respond to, relay, or initiate individual-to-individual communications by visual, auditory, touch and pyrotechnic signals.

c. Transportation

1. Prepare, adjust and arrange combat load and march by foot.

2. Drive vehicles, mount and dismount surface and air transport, load air transport, launch and paddle assault boat.

d. Individual Combat Performances

1. Administer first aid.

2. Practice personal hygiene and field sanitation.

3. Maintain his clothing and equipment.

4. Observe and practice the code of conduct, evasion and escape.

5. Maintain orientation and direction, measure distance in land navigation.

6. Associate ground with map.

7. Measure direction with compass in land navigation.

8. Construct emplacements, shelters, obstacles, fields of fire and fighting positions, and remove obstacles.

9. Observe and detect or associate hostile targets and report military information (combat intelligence).

10. Report and prevent security violations (counter-intelligence).

11. Use cover.

12. Use camouflage and other techniques for concealment.

13. Take protective measures against CBR and nuclear explosives.

14. Take protective measures against mines, boobytraps, warning and illuminating devices.

15. Prepare for and engage in combat feeding.

16. Perform basic physical skills as necessary to carry out mission.

e. Squad Tactics

1. Apply specific drills and coordinated effective fire and maneuver against an enemy.
2. Adjust and shift, apply the techniques of fire.
3. Coordinate movements with supporting fire.
4. Coordinate movements with tanks.

APPENDIX C

Climatic and Geographic Summary of Fort Sherman

From a climatic and geographic viewpoint Fort Sherman encompasses many major climatic, terrain, vegetation, and soil types.

The climate is predominantly tropical marine with no large variations in temperature. The average annual precipitation is about 130 inches most of which falls during the rainy season from May through December. The mean relative humidity is high, usually about 80 percent. The northeast trade winds blow steadily during much of the year. However, little wind penetrates the canopy of the rain forest.

The vegetation offers a variety of tropical types such as red, black and white mangrove swamps, manicara swamp, raffia palm swamp, coastal thicket, cativo, rain forest, secondary growth, tropical deciduous forest and savanna areas. Since there is little elevation, there are no cloud forests. Cultivated rice paddies, sugar cane fields and bamboo groves, are also absent.

The five major soil types (sand, silt, clay, peat, and rock) are found at Fort Sherman.

Fort Sherman is very rich in many forms of wildlife, including a variety of amphibians, reptiles, mammals, mosquitoes, fleas, ticks, bugs, and flies. The reptiles include poisonous snakes such as the Bushmaster, the fer-de-lance and the coral snake. The mammals include the puma, the ocelot, the jagarundi, and many types of monkeys. The mosquitoes include the anopheles (the mosquito that can carry the Malaria parasite and transmit the disease).

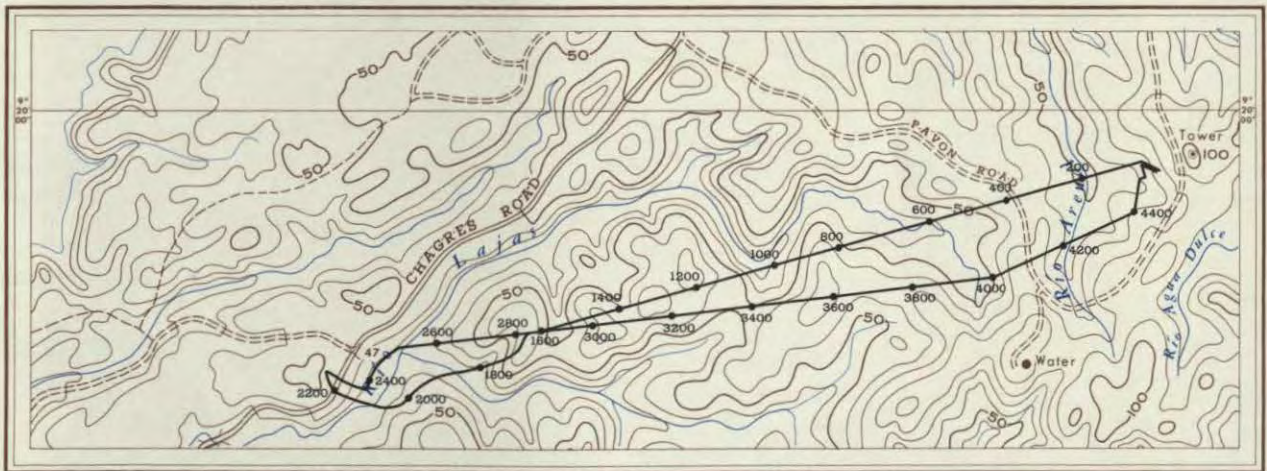
APPENDIX D

Description of the Tactical Exercises

1. Patrol Base

The first exercise observed, the company patrol base began shortly before dusk in the vicinity of the tower (Fig. 3). Security was established, and hasty shelters constructed before nightfall. The next morning the subject squad was given the mission of performing reconnaissance patrols and returning by 1700 hours. The mission began at 0750 and terminated at 1515 hours. Figure 3 depicts the approach and return routes traversed by alpha patrol of the subject squad. The only encounter with the enemy was on the objective when the patrol received some small arms fire, but the fire was not returned.

RECONNAISSANCE PATROL EXERCISE



15 AUGUST 1962

Figure 3

The following morning the operation consisted of an evacuation of the patrol base and the link-up with friendly forces. It was planned that the company depart the patrol base and each platoon destroy an objective enroute to a link-up point with friendly forces. The subject squad, now designated as the weapons squad, was armed with two light machine guns. The platoon mission was to evacuate the patrol base, destroy enemy observation "towers" and bunkers (Fig. 4), infiltrate hostile territory, and contact friendly forces. The platoon leader issued his order and at 0944 hours the platoon moved in column to the objective. Shortly before noon the objective was destroyed, and the assault elements closed on a rally point which had been secured during the attack. Following a tactical feeding at the rally point, the platoon moved toward friendly lines as shown in Figure 4. Enroute, the platoon was subjected to an ambush. The platoon (and the subject squad) took immediate counterambush action forcing the enemy to withdraw. Following reorganization, the platoon continued its march toward friendly units. Link-up was made at 1451 hours.

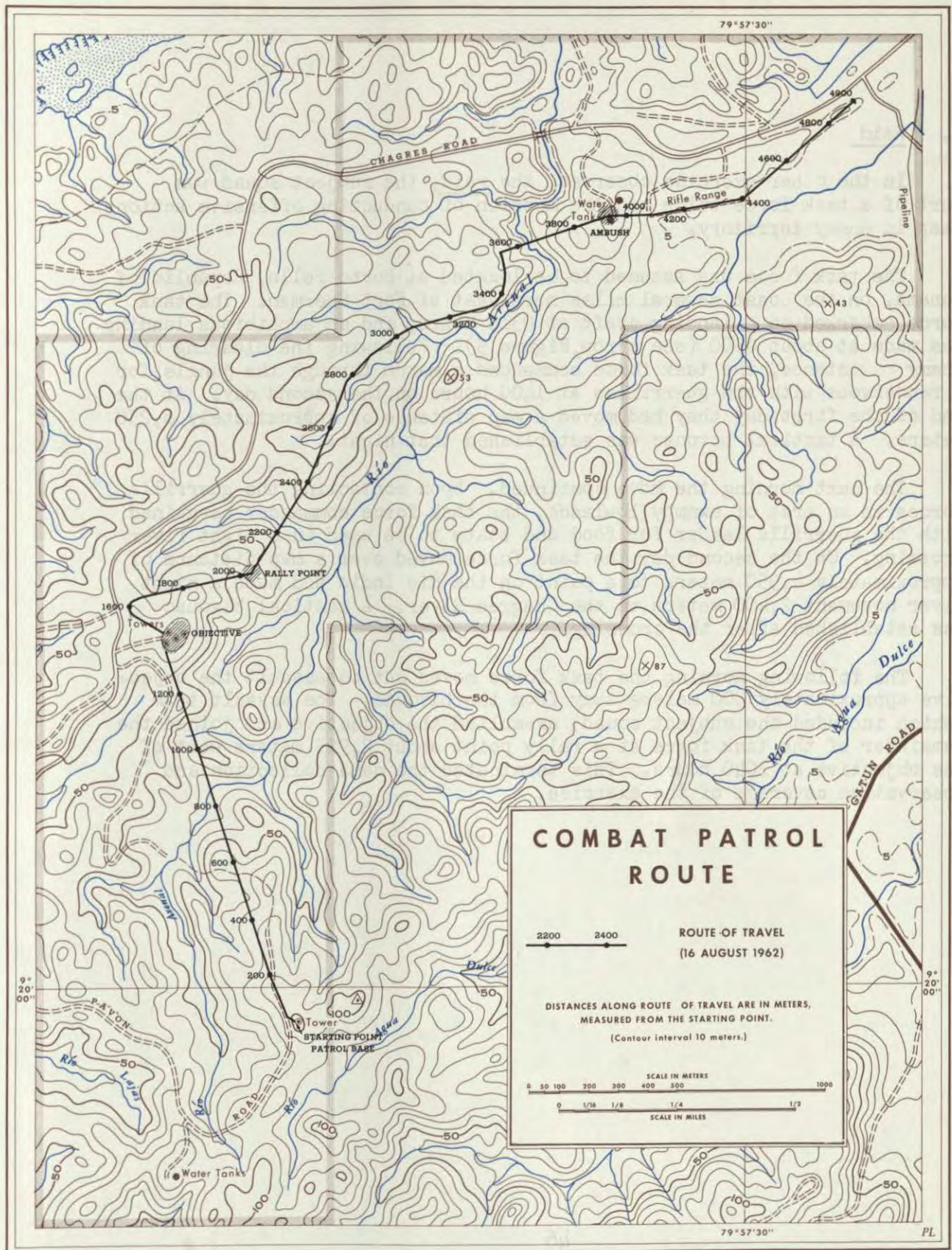


Figure 4

2. Raid

In the other exercise observed, the raid, the subject squad was part of a task force which had the mission of conducting offensive actions deep in enemy territory.

The task force was assumed to be located at Porto Bello, Republic of Panama, on the coast several miles northeast of Fort Sherman. The task force embarked on a landing craft at 0313 hours, and an amphibious landing was made at about 0500 (see arrow, Figure 5). Following the clearing of enemy resistance, the task force commenced a march through the jungle for a rendezvous with the guerrillas at 1400 hours on the second day. At the end of the first day they had moved a map distance of approximately 6,250 meters. A tactical bivouac was established that night.

The next morning the move continued. Upon contacting the guerrilla forces in an area of swampy lowlands, the task force commander bargained with the guerrilla leader for food and boats to be used in a night river crossing. On the second day the task force moved over a map distance of approximately 4,350 meters to a point on the Rio Indio and made a night river movement 2,400 meters up the Chagres River. A tactical bivouac was established after the crossing.

The following morning the task force moved out to assault the objective approximately 800 meters away from the bivouac. The assault team (which included the subject squad) assaulted the objective and joined the remainder of the task force at a rally point about 2,925 meters west of the objective at 1040 hours. This terminated the data collection and observation coverage of the exercise.

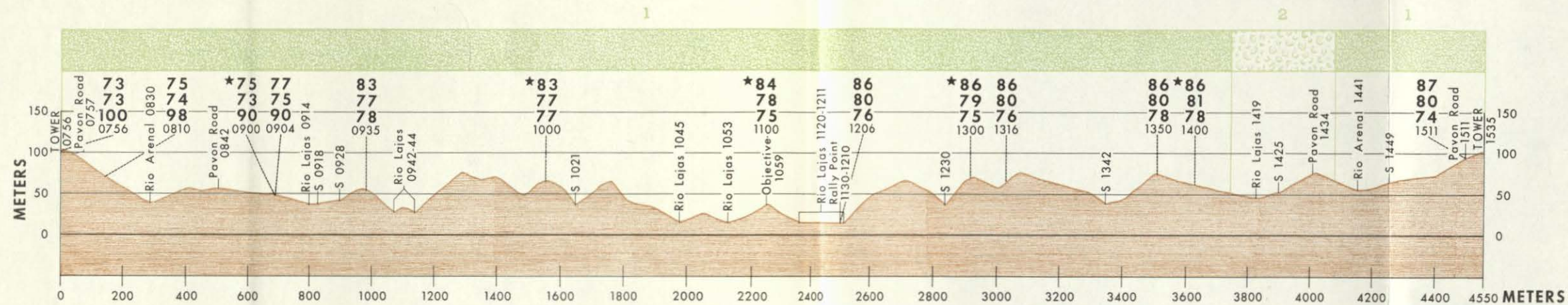
APPENDIX E

GEOCLIMATIC PROFILES FOR THE THREE EXERCISES

Reconnaissance patrol	Figure 6a
Combat patrol	Figure 6b
Raid	Figure 6c

RECONNAISSANCE PATROL

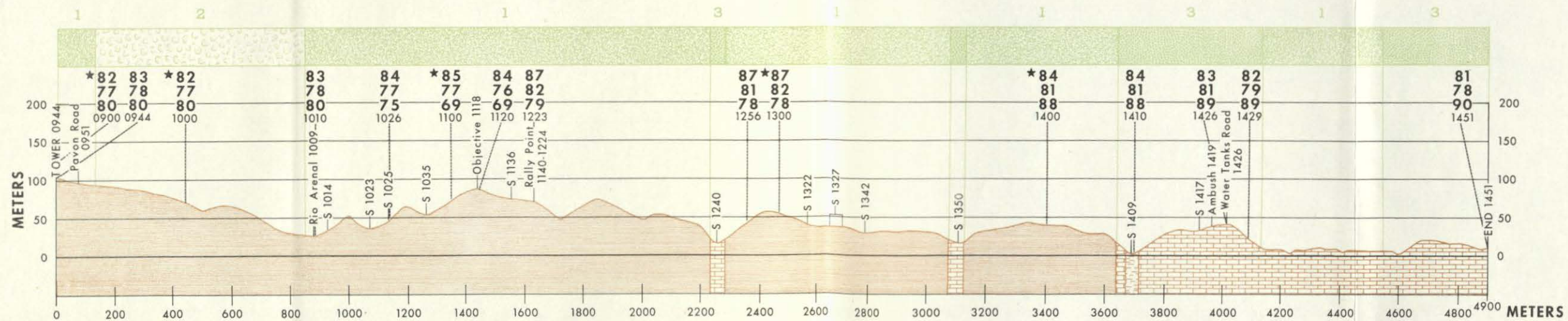
ROUTE PROFILE WITH SURFACE GEOLOGY AND VEGETATION TYPES



15 AUGUST 1962

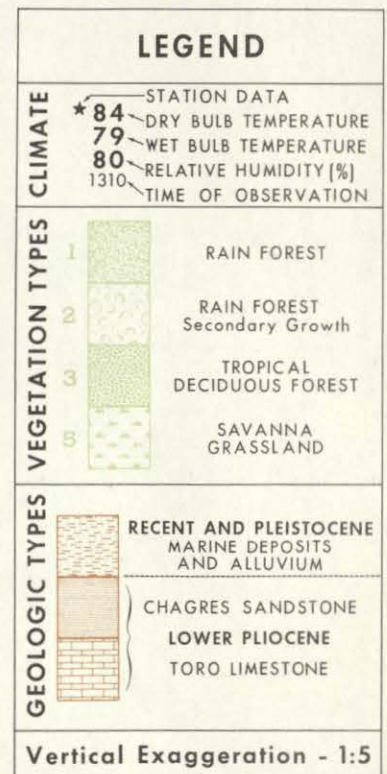
Figure 6a

COMBAT PATROL



16 AUGUST 1962

Figure 6b



Vertical Exaggeration - 1:5

NOTE: S = STREAM
LH = LUNCH HALT

RAID EXERCISE - 20-22 AUGUST 1962 ROUTE PROFILE WITH SURFACE GEOLOGY AND VEGETATION TYPES

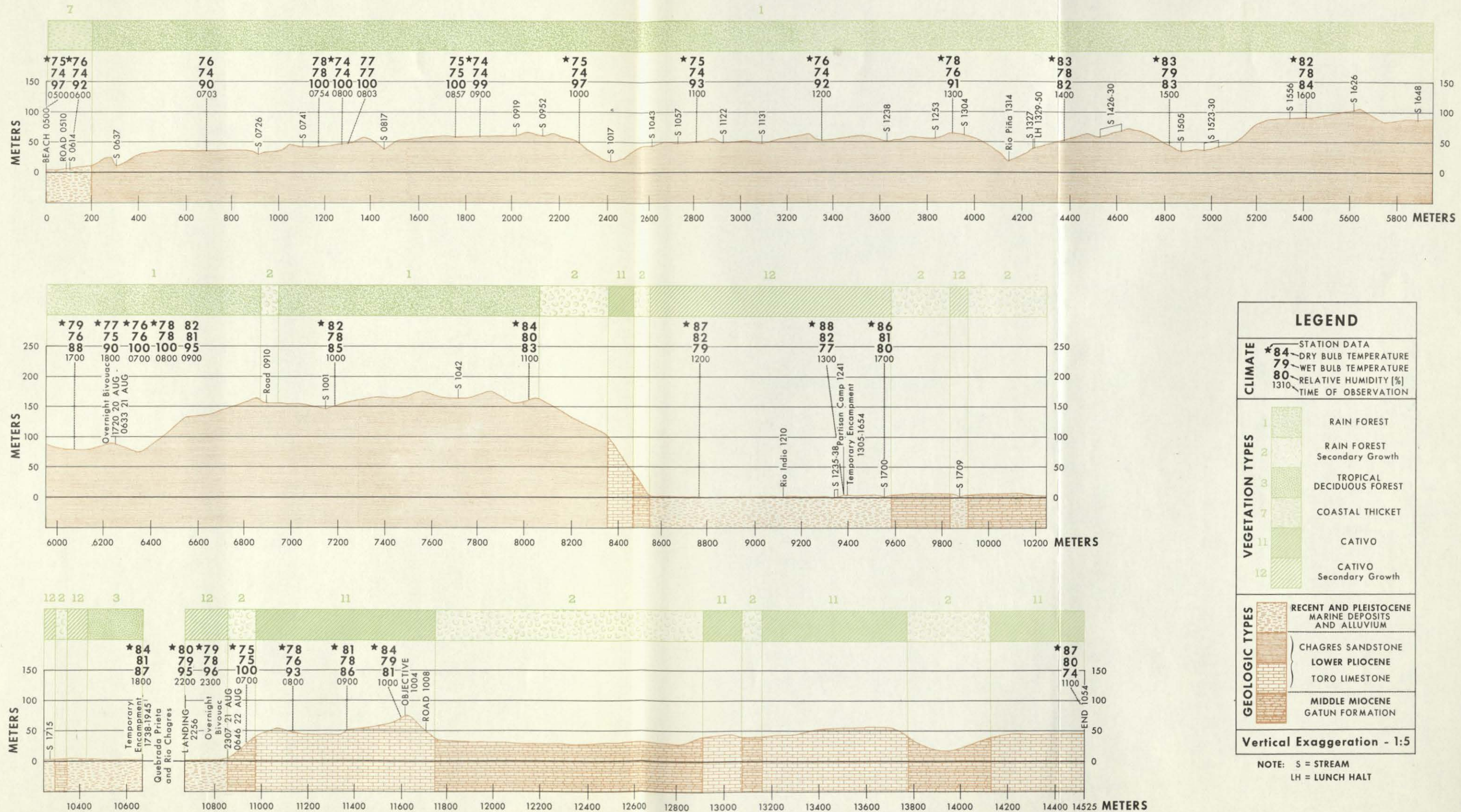


Figure 6c

APPENDIX F

Climatic Summary

a. Reconnaissance Patrol*

Time:	0700	0800	0900	1000	1100	1200	1300	1400	1500
Temp. °F:	73	75	78	83	84	86	86	87	87
R. H. %:	100	97	88	77	75	76	78	79	77
Precip.** (in.)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Precipitation totals refer to accumulation during hour ending as shown.

*Fort Sherman shelter station

**0.86 inch on previous day 0100-2400; 0.01 inch at 0500 hours prior to mission.

b. Combat Patrol*

Time:	0900	1000	1100	1200	1300	1400	1500
Temp. °F:	77	82	85	86	86	84	81
R. H. %:	93	80	70	80	79	88	91
Precip.** (in.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*Fort Sherman shelter station

**0.22 inch previous day 1600-2400; 0.01 inch at 0800 hours prior to mission.

APPENDIX F.

Climatic Summary (cont'd)

c. Raid*

	0100					0600					1200					1800					2400				
<u>Date</u>	<u>Temperature (°F-Dry Bulb)</u>																								
20				75	75	75	76	76	74	74	75	75	76	78	83	83	82	79	77	76	76	76	77	77	77
21	76	76	77	76	76	76	76	76	78	82	82	84	87	88	88	88	85	86	84	80	80	80	80	79	79
22	79	78	77	77	77	76	75	78	81	84	87														
	<u>Relative Humidity (%)</u>																								
20				95	99	94	92	93	100	99	97	93	92	91	82	83	84	88	88	85	88	92	93	96	95
21	96	95	96	98	99	100	100	100	95	85	83	79	77	77	76	80	80	87	95	96	95	95	95	96	98
22	98	98	99	100	100	100	100	93	86	81	75														
	<u>Precipitation (Inches)</u>																								
20				0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<u>Total Precipitation (Inches)</u>																								
20**				0300 - 2400			0.20																		
21				0100 - 2400			0.02																		
22				0100 - 1100			0.00																		

* Fort Sherman Shelter Station

**2.93 inches previous day 0100 - 2400; 0.02 inch at 0100 prior to mission.

APPENDIX G

Description of Vegetation Types

1. Rain Forest

Rain forest is the most luxuriant complex vegetative type in the world. It is best developed in those areas with minimum temperatures of 68° F. or above, where the annual rainfall is 75 inches or more and where there is an average of more than 1 inch of rain per month during a maximum 3-month dry season.

No particular part of the rain forest is representative of the whole. It is not homogeneous in composition, structure, or age. Pure stands of a single type of tree do not occur, since no particular species predominates. Hence, any description of such a forest must be in very general terms.

Rain forest is a mixed forest in which the crowns of the larger trees unite to form a dense forest-canopy, usually over 80 feet high. The canopy, although most commonly possessing a relatively level top, may here and there be penetrated by the protrudent crowns of individual giant trees. These trees frequently reach heights of 125 feet or more and may project completely above the prevailing level of the canopy. These emergent trees are never numerous over a large area and are never sufficiently plentiful to have their crowns merge to form an even higher level canopy.

Inside the rain forest it is very shady, and on a cloudy day it is very dark and gloomy. However, when the sun shines, from the ground within the forest it is usually possible to see patches of sky through the canopy. The understory trees in the shaded interior tend to intercept any light that might penetrate the canopy. The trees growing within the shaded interior of the forest are of two major types. The first are sun-loving trees found inside the forest. These consist of small individuals of those kinds of trees already present in the canopy. The second are shade-loving trees or shrubs. Most of these are encountered only inside the forest. These are usually low-growing, generally less than 15 feet in height. Nevertheless, many plants of this type grow reasonably well, and even attain good size in the forest shade, but will die when exposed to full sunlight.

Horizontal depth of vision is limited by the spacing of the intervening tree trunks rather than the foliage. On the average, a person is usually visible up to a distance of between 50 and 100 feet. Trunks, large bushes, spiny palms, and thorny clumps of wild pineapple are usually easily avoided by short diversions from a given compass course.

2. Rain Forest Secondary Growth

Rain forest secondary growth is very significant throughout the wet-tropics. Cecropia trees are the most conspicuous trees and the best indicator of secondary growth. These weed-trees are usually the first to take over and establish themselves after an area is cleared. They grow rapidly and are small to medium-sized as compared with the trees that made up the original forest. Soon they form a dense thicket 5 to 40 feet tall. The trunks are up to 8 inches thick and are either crowded and pole-like, or are loosely spaced and branched close to the ground. At this time the forest is composed of relatively small trees with interlocking branches and crowded trunks, and are overgrown and interlaced with an abundance of slender entangling vines. Later, as the canopy is established, the forest becomes rather dense and shady.

In the early stages of growth, visibility is frequently reduced to a yard or two, and progress through it is with great difficulty, and then only after continuous and vigorous use of the machete. Later, as the forest develops, the large trees increase in number and size. The canopy is slowly raised in elevation, gaining in thickness and density, greatly improving visibility and traversability. Thus, travel in secondary growth is alternately easy or difficult.

3. Tropical Deciduous Forest

Tropical deciduous forest is a lower and more open forest than the rain forest. It usually contains a large proportion of trees that shed their foliage and remain leafless for a period of time during the dry season. It is best developed in those areas with minimum temperatures of 68° F. or above where the annual rainfall is either less than 75 inches or where there is an average of less than 1 inch of rain per month during a minimum 3-month dry season. Tropical deciduous forests are frequently found on shallow soils or over limestone areas.

Like rain forests, tropical deciduous forests are not homogeneous in composition, structure, or age, so no particular part of the forest is representative of the whole. Most of the species of trees in this type forest are different from those present in the rain forest. Tropical deciduous forest is also a mixed forest in which the crowns of the larger trees unite to form a forest-canopy. This is usually less than 80 feet in height. Likewise, the canopy is penetrated by emergent type trees.

The interior of the tropical deciduous forest is less shady than a rain forest. Sunlight frequently reaches the ground and large patches of sky are seen through the canopy. Here, depth of vision is limited by both the spacing of the intervening tree trunks and foliage, for there is a larger proportion of shrubs and small trees growing as undergrowth than is found in the rain forest. As a result, visibility is not increased, but is about the same, usually between 50 and 100 feet. Spiny

palms and thorny clumps of wild pineapple are more prevalent than in the rain forest. The Cedro espinosa, Bombax quinatum, a large spreading tree, which has a trunk covered with coarse, sharp, conic thorns, is very common. Likewise, by contrast, Gumbolimbo, Bursera simaruba, a tree recognized by its smooth brown trunk, is frequently found in tropical deciduous forests.

4. Savanna Grassland

Savanna grassland is best characterized as an extensive area of tall coarse grass interrupted by a scattering of low trees and shrubs. It is best developed in those areas with minimum temperatures of 68° F. or above where the annual rainfall is either less than 60 inches or where there is an average of less than 1 inch of rain per month during a minimum 4-month dry season.

There is great variation in the appearance of savanna grassland areas. This variation occurs with the time of year, and the predominate types of grasses found from place to place. It varies in color between a dull green to yellow, or tan to brown. It is found as a dense stand, or in clumps, bunches, or tufts. It is anywhere from a few inches to 20 or more feet in height. Also, it is homogeneous in composition or a mixture of grasses and other plants.

As the savanna grassland and season varies so does the depth of vision and the hazards to movement. When the grass is high it acts and appears as a wall, limiting vision to a few feet at most, and restricting forward movement. Blades of grass are stiff and frequently have harsh cutting edges. During the dry season there is the danger of being entrapped by fire.

Savanna grassland is frequently composed of Guinea grass, Panicum maximum, and Para grass, Panicum purpurascens. Guinea grass sometimes forms pure stands commonly 7 to 9 feet high. Other times, it is found in low depressions that collect water. Usually, however, Para grass and Paspalum plicatulum dominate, forming a low pasture less than 3 feet tall. Two ferns are sometimes associated with these low grasses, Blechnum occidentale and Pteris altissima.

5. Cativo

Cativo is named for a specific type tree, Prioria copaifera, and dominates a very distinctive type of forest. It is best developed on nearly level areas subjected to shallow, temporary flooding by fresh water. The water table during most of the year is usually within a foot of the ground surface. This tree is very large, and very conspicuous. Its large size, commonly 100 to 125 feet tall or more, dominates the forest in which it occurs. The only other large tree with which it is associated is an occasional giant fig tree, which is readily distinguished by its very conspicuous buttressed trunk.

The giant cativo trunk is cylindrical in shape and 2 to 4 feet thick. These trees are generally spaced no closer than 20 to 50 feet. The canopy is lofty, frequently over 100 feet, and flat-topped. The individual crowns are not crowded closely together in the canopy. Viewed from the ground the canopy is not particularly dense, with as much as 50 percent of the sky showing. Because of the height of the canopy, the interior of the forest has only very soft diffused lighting. Most of the small trees are immature cativos, less than 30 feet tall. Shade-loving varieties of small trees 6 to 15 feet tall are also frequently found, such as the hazardous Black palm, Astrocaryum standleyanum.

The woody growth inside the forest is scanty to very abundant. Even when abundant, the foliage is so thin that it affects very little either the visibility or traversability within the forest. Depth of vision is limited only by the spacing of the intervening tree trunks rather than the foliage, since low herbaceous plants do not grow well on this wet poorly drained soil. On the average, a person is usually visible from a distance of 50 to 100 feet.

6. Cativo Secondary Growth

Similar to the mature cativo, most of the trees are small immature cativos mixed with fig trees and black palms. Low herbaceous plants are usually very scarce. Visibility is restricted only by the density of the tree trunks, with a person being visible from a distance of only 20 to 50 feet.

7. Coastal Thicket

Coastal thicket is the first vegetation encountered above tidal level just behind sandy coastal beaches. This high thicket type of low woods also develops on the margins of mangrove swamps. As the result, the seeds of most of the plants are normally disseminated by the ocean currents. Because of this, coastal thickets are similar wherever found throughout the tropics.

Inside the thicket it is relatively open and not all densely shaded. This thin canopy is only 10 to 30 feet high with frequent breaks. The two most common and easily identified plants are the coconut palm, Cocos nucifera, and mahoe, Hibiscus tiliaceus. The mahoe tree gives the thicket most of its structural characteristics. Its gray herbage predominates on the seaward side and in the canopy. It has practically no trunk, since the branches start from close to the ground. Present along the sunny margins is the sea grape, Coccoloba uvifera, while palms are scattered throughout the thicket. Small shrubs are few and generally scattered; however, where there is maximum light, the low shrub, Nedelia triloba, may form ground cover.

Depth of vision varies considerably with the density of the thicket; usually it varies between 10 and 50 feet. At times, movement can be slow and

difficult, as the low-spreading branches of mahoe and the low-hanging, very thorny stems of Nickernut, Caesalpinia bonduc, are hindrances to free movement. Nevertheless, with moderate diversions, a course between obstacles is readily found.

APPENDIX H

List of Clothing, Individual Equipment, and Rations Prescribed by the Jungle Warfare Training Center for the Tactical Exercises

Boots, men's, combat, tropical with buckles and cuff closure system, brown.

Boot, combat, men's leather, black with laces.

Shirt, man's cotton utility, 8.5-ounce sateen, OG107 (fatigue shirt).

Trousers, men's, cotton utility, 8.5-ounce sateen, OG107 (fatigue trousers).

Cap, Men's, cotton utility.

Sheath, machete, leather, tan.

Load-carrying equipment M-1945, with first aid kit and two canteens.

Socks, Men's wool, cushion sole, black.

Poncho, lightweight.

Insect bar, nylon netting, mildew resistant, treated.

Meal, combat, individual.

Machete, rigid, handle.

APPENDIX I

A Brief Description of the Meal, Combat, Individual

The Meal, Combat, Individual is similar to the Ration, Combat, Individual ("C" ration). Three meals constitute a ration, and twelve menus are included. Each menu contains one canned meat item, one canned fruit, bread or dessert item, one B unit, an accessory packet containing cigarettes, matches, chewing gum, toilet paper, coffee, cream, sugar and salt, and a spoon. Meat items can be taken hot or cold. Each meal furnished approximately 1200 calories.

The following are examples of typical menus:

Beefsteak	Beefsteak and Potatoes	Boned Chicken
Pears	w/gravy	Bread
B-1 Unit	Pecan Cake Roll	B-3 Unit
Crackers (7)	B-2 Unit	Cookies
Candy Disc	Crackers (4)	Cocoa Beverage Powder
Peanut Butter	Cheese Spread	Jam
Accessory Packet	Accessory Packet	Accessory Packet

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13. ABSTRACT This study explores Human Factors problems associated with jungle operations by means of field observations made during tactical exercises conducted at the Jungle Warfare Training Center. The operational and physical environments, required soldier tasks and activities, and the equipment used are described. The major problems discussed concern combat load, heat, mobility, and certain features of rations.		

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Human factors	8					
Jungles	9					
Armed Forces operations	9					
Tropical regions	9					
Wet	0					
Tropical tests			8			
Military equipment			9			
Clothing			9			
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14. **KEY WORDS:** Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.