Pacific Insects 3 (4): 549-555 October 25, 1961

A HIGH SPEED AIRPLANE TRAP FOR AIR-BORNE ORGANISMS[1]

By J. L. Gressitt, J. Sedlacek, K. A. J. Wise and C. M. Yoshimoto

BISHOP MUSEUM, HONOLULU, HAWAII

Abstract: An insect trap for operation in a Super-Constellation airplane was developed in 1960 by Bishop Museum. To date the trap has been operated for 186,970 km (116,684 statute miles) and has trapped 23 arthropods. Groups represented are Diptera, Hymenoptera, Heteroptera, Homoptera, Psocoptera, Isoptera, Lepidoptera, Coleoptera and Acarina. The highest insect taken was a termit ♀ at 5,790 m (19,000 ft.). Vegetable and mineral material has also been trapped and is partly tabulated.

Introduction: As a phase of the program "Zoogeography and evolution of Pacific insects" Bishop Museum is engaged in the study of dispersal of insects across ocean. This forms a part of studies directed towards an understanding of the origins, development and relationships of the insect fauna of the oceanic Pacific islands. Since 1957 the museum has been doing trapping from ships at sea in the tropical Pacific (Gressitt & Nakata, 1958; Yoshimoto & Gressitt, 1959, 1960, 1961). Commencing in 1959, work has been carried on in Antarctic areas on land, at sea and from Otter airplanes (Gressitt, Leech & O'Brien, 1960; Gressitt, 1961; Gressitt, Leech, Leech, Sedlacek & Wise, 1961). In 1960–61 trapping was done on the "Monsoon Expedition" of the Scripps Institute of Oceanography in the South Pacific and the Indian Ocean (Gressitt, Coatsworth & Yoshimoto, in press). In addition to the surface work it was considered highly desirable to trap insects higher in the air over the ocean. This is necessary for the determination of the levels, and air currents, involved in the dissemination of arthropods to the islands.

With the financial backing of the National Science Foundation (both the U. S. Antarctic Research Program and the Program for Systematic Biology), and the cooperation of Air Development Squadron Six, U. S. Navy, and the Lockheed Aircraft Corp., a trap was produced in September 1960 for use in a Super-Constellation airplane. The trap was installed at Christchurch, New Zealand in a Super-Constellation of Air Development Squadron Six (VX-6) in November 1960.

Description: The trap (figs. 1–3) consists of an intake tube pointing forward on the starboard side of the plane's fuselage forward of the wing and propellers, enlarging in diameter to decrease air speed, and entering the forward port-hole in a smooth "S-curve" and further increasing in diameter inside the cabin of the plane. The diameter of the in-

1. Partial results of the project "Studies of air-borne organisms in the Antarctic area" supported by the U. S. Antarctic Research Program, National Science Foundation, and "Study of organisms in the atmosphere" and "Zoogeography and Evolution of Pacific Insects" supported in part by grants from the Program for Systematic Biology, National Science Foundation.

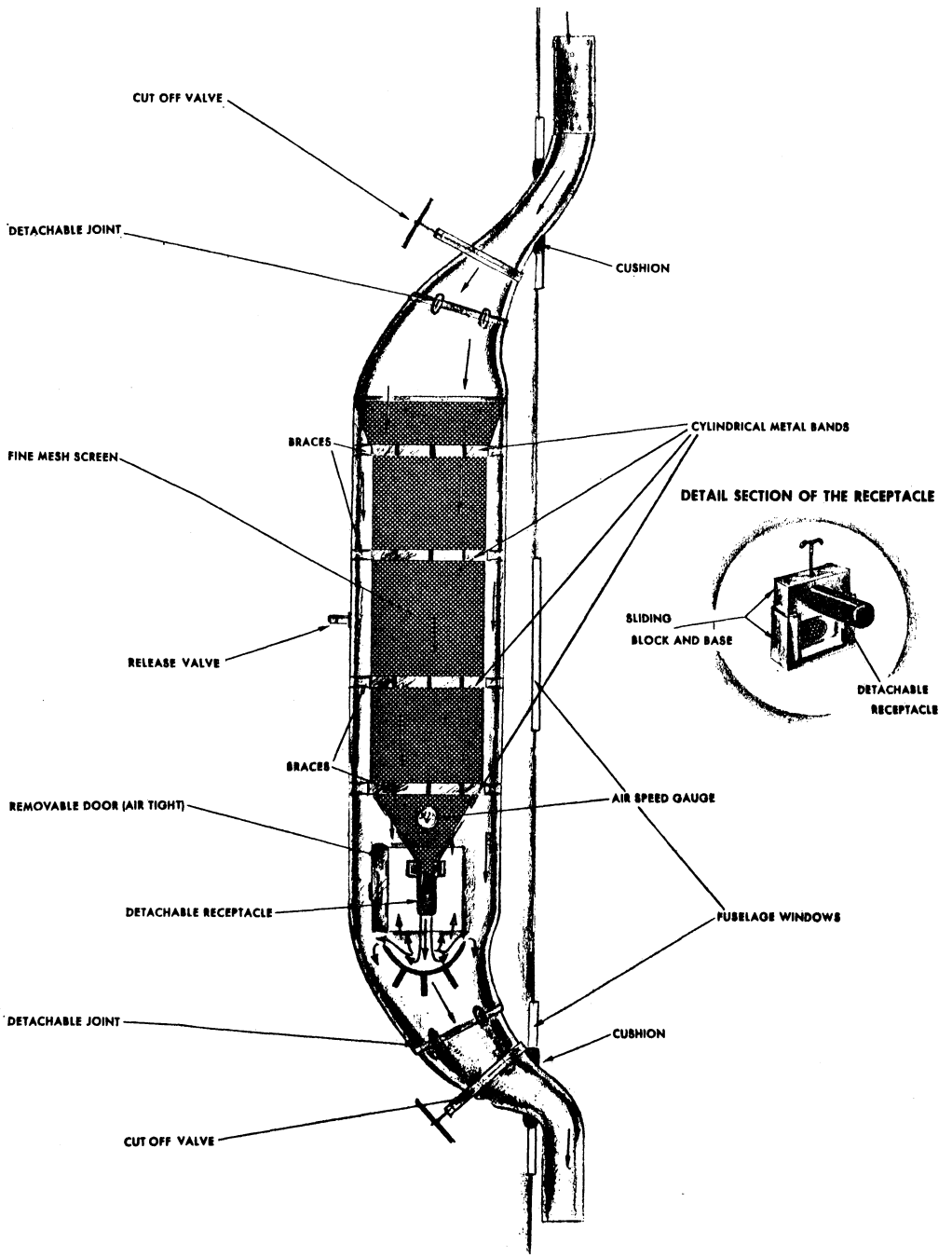

Fig. 1. Preliminary diagram of internal airplane trap. The actual trap produced varies in several aspects.

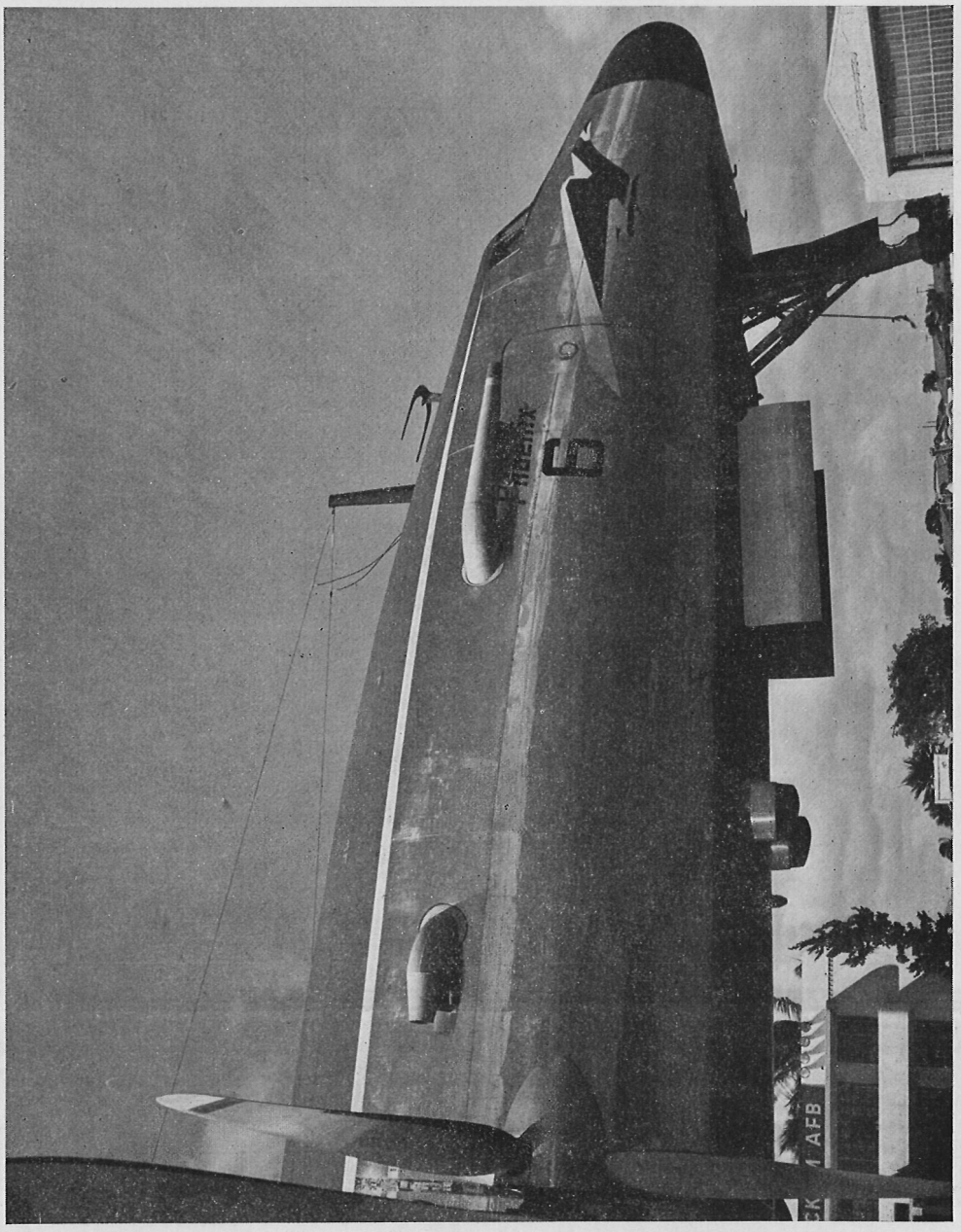

Fig. 2. View of forward part of Super-Constellation, showing trap inlet and outlet (Official U. S. Navy photograph).

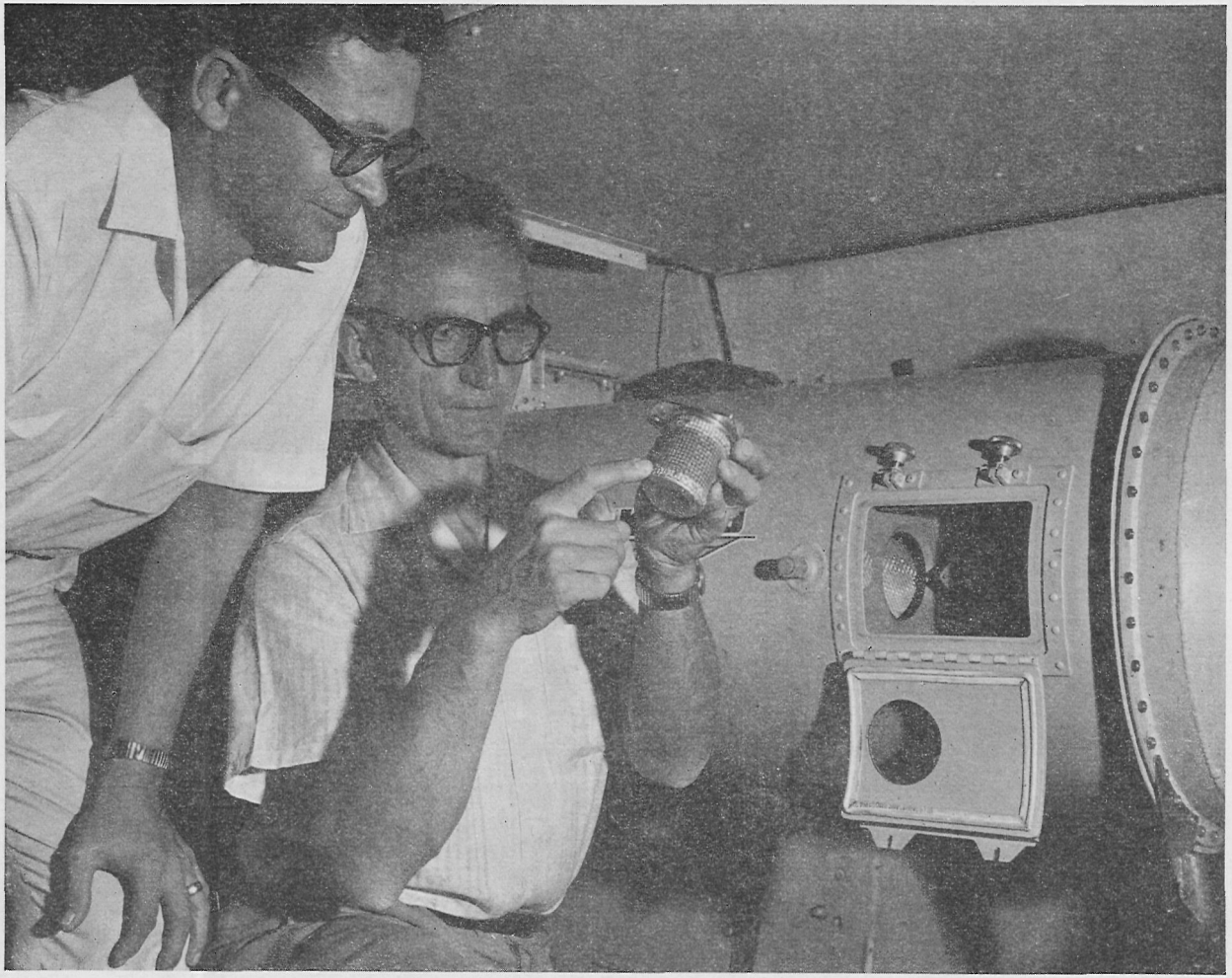

Fig. 3. View of trap at receptacle opening, with J. Sedlacek showing receptacle to L. W. Quate (Official U. S. Navy photograph).

take opening is 10 cm, at the port-hole is 25 cm, and that of the main body of the trap inside the plane is 45 cm. A baffle behind the receptacle further slows the air speed in the trap. The outside air speed of 200–245 knots is reduced to less than 20 knots. Length of trap from intake to receptacle is 365 cm and total length is 595 cm.

The inside anterior one-half of the cylinder is lined with fine-meshed stainless steel screen. Posteriorly this forms into a funnel. The specimens are thus concentrated and pass through the apex of the funnel into the receptacle. The receptacle can be quickly removed and emptied in flight by closing the intake and outlet valves, de-pressurizing the cylinder, and opening the air-tight door to the receptacle. The air outlet curves out through the next port-hole and is larger in diameter than the intake opening. The trap is equipped with a de-icing mechanism and an internal air-speed indicator. (The diagram, fig. 1, gives only an approximate idea of the trap's construction, as it is an early draft of the plan, before subsequent modifications in the planning).

The trap was originally planned by Yoshimoto and Gressitt with advice from A. C. Snodgrass, maintenance official at Hickam Air Force Base. Further advice was supplied by officers of Air Development Squadron Six at Quonset Point Naval Air Station, by naval aviation architects and a representative of the Lockheed Aircraft Corp. The final planning, and construction, was done by Lockheed Aircraft Corp.

Operation: The trap was operated during the Antarctic season, from November 1960 to March 1961—by Sedlacek early in the season and by Wise later in the season. After the first few flights and some tests, some modifications were made which improved function and catches. In April the trap was dismantled in Christchurch and transported to Honolulu, where it was installed in a Super-Constellation plane of the Airborne Early Warning Barrier Squadron Pacific on Oahu. During May and June, Yoshimoto operated the trap

Table 1. Insects taken in high speed trap on Antarctic Program (Sedlacek: S; Wise: W.).

Date	Wind Direction	Wind Veloc. (knots)	Plane speed (knots)	Latitude	Longitude	Altitude (meters)	Order	Family	Trapper
1960									
20. XII.	320°–290°	10–12	223	31° 35′–27° 42′S.	176° 30′–178° 00′E.	3,350	†Diptera	Sciaridae	S.
〃	〃	〃	〃	〃	〃	〃	† 〃	Chironomidae	S.
1961									
5. III.	340°	20	180	Christchurch to 42° 00′S.	172° 30′E.	10–2,130	†Diptera	Syrphidae	W.
6. III.	265°	20	255	29° 00′–32° 10′N.	146° 30′–138° 00′W.	5,790	†Isoptera	?	W.
7. III.	270°	20	245	38° 45′N. to Washington, D. C.	76° 55′W.	1,830–10	*Hymenoptera	Encyrtidae?	W.
7. III.	270°	20	245	Washington, D. C. to 38° 48′N.	76° 36′W.	10–2,740	* 〃	Scelionidae (alive)	W.
10. III.	270°	10	200	Alameda, Calif. to 37° 40′N.	122° 30′W.	5–1,520	†Diptera	?	W.
12. III.	250°	20	220	3° 44′–10° 20′S.	172° 05′–174° 21′W.	1,830	†(Arthropoda)	?	W.

* Taken over North American continent

† Incomplete specimen

Table 2. Insects taken in high speed trap between Hawaii and Midway Atoll (Yoshimoto).

Date	Wind Direction	Wind Veloc. (knots)	Plane speed (knots)	Latitude	Longitude	Altitude (meters)	Order	Family
1961								
5. V.	225°	28	240	Oahu to 21° 25'N.	158° 20'W.	1,830	Heteroptera	Lygaeidae: *Nysius*
5. V.	〃	〃	〃	〃	〃	〃	† 〃	〃
5. V.	〃	〃	〃	21° 52'– 22° 05'N.	159° 30'– 160° 07'W.	3,050	Acarina: Trombidiiformes	
5. V.	〃	〃	〃	25° 15'– 26° 28'N.	168° 40'– 171° 50'W.	〃	†Heteroptera †Diptera	Lygaeidae: *Nysius*?
5. V.	〃	〃	〃	26° 28'– 27° 40'N.	171° 50'– 175° 32'W.	1,980	†Lepidoptera Heteroptera	Lygaeidae: *Nysius*
5. V.	〃	〃	〃	27° 40'N.	175° 32'W.	〃	Heteroptera	Lygaeid nymph 1st instar
5. V.	210°	25	250	28° 10'N.	177° 20'W.	3,050	†Heteroptera	Lygaeidae: *Nysius*
5. V.	〃	〃	〃	22° 15'N.	160° 14'W.	3,350	†Coleoptera	(small beetle)
22. V.	290°	25	250	23° 45'– 23° 10'N.	164° 55'– 163° 05'W.	3,960–2,740	†Heteroptera	Lygaeidae
29. VI.	242°	15	210	Oahu to 21° 22'N.	158° 19'W.	1,800	†(Insect)	(Fore wing)
29. VI.	〃	〃	〃	21° 22'– 21° 00'N.	158° 19'– 159° 00'W.	2,440	Psocoptera	Pachytroctidae: *Psyllonera williamsii* Banks?
29. VI.	〃	〃	〃	21° 00'– 22° 05'N.	159°00'– 160° 00'W.	〃	†Psocoptera	
29. VI.	〃	〃	〃	22° 30'– 23° 14'N.	161° 00'– 163° 00'W.	2,590	Homoptera	exuviae of 1st instar nymph of Cicadellidae

on flights to the Island of Hawaii and to Midway Atoll.

The trap was operated for about 160,900 km (100,000 statute miles) on five return trips between Christchurch and Quonset Point, Rhode Island, via Honolulu, plus about 13,600 km (8,424 statute miles) on two return trips between Christchurch and McMurdo Sound. During the post-Antarctic season the trap was operated on one return flight Oahu—Hawaii and on three return flights Oahu—Midway Atoll, totalling about 13,300 km (8,260 statute miles). Thus the total distance the trap has been operated is 187,800 km (116,684 statute miles), and the volume of air screened to date is about 1,390,000 cubic meters (0.00139 km^3).

Results: Specimens were trapped at altitudes from sea level to 5,790 meters (19,000 feet). The insects trapped are enumerated in Tables 1–2. Obviously, many more might have been taken if the flights over North America had been made in summer instead of in winter. No insects were trapped between New Zealand and Antarctica. On the flights between Oahu and Midway Atoll insects were taken only when the plane flew on the north side of the island chain, while the wind was from the southwest (after curving around over the main Hawaiian Islands). Some of the vegetable and mineral material taken in the trap is presented in Table 3.

Acknowledgements: In connection with the production and operation of the trap we are indebted to the National Science Foundation (U. S. Antarctic Research Program and

Table 3. Vegetable and mineral material trapped (selected samples). (Sedlacek: S.; Wise: W.; Yoshimoto: Y.)

Date	Wind Direction	Wind Veloc. (knots)	Plane speed (knots)	Latitude	Longitude	Altitude (meters)	Material	Trapper
1960								
20. XI.	230°	28	180	73° 02′S.	172° 40′E	1,800	Mineral: granite 1.7×1.5×1 mm	S.
2. XII.	130°–210°	12	225	17° 30′–11° 30′N	159° 20′–162° 40′W	3,000	〃 limestone, etc.	S.
5. XII.	170°–250°	12–45	220	61° 55′–59° 20′S	167° 20′–168° 10′E	3,050	Mineral: granite .5×.7 mm	S.
14. XII.	125°	55	248–260	49° 45–45° 00′S	174° 30′–173° 30′E	1,800–3,000	Plant: Monocot leaf sheath	S.
1961								
27. I.	250°	13	190	37° 40′–36° 35′N	122° 47′–125° 05′W	1,200	Plant: fragments	S.
30. I.	250°	25	215	32° 10′–36° 30′S	176° 20′–174° 45′E	1,200–1,800	〃 〃	S.
21. II.	250°	25–38	244	59° 50′–55° 40′S	167° 30′–169° 45′E	3,050	Mineral: granite 5×4×2.5 mm	S.
6. III.	270°	12	253	32° 10′N	138° 00′W	5,790	Plant: spines, scales	W.
9. III.	270°	20	240	41° 33′N	73° 52′W	3,050	Mineral: sand–quartz & igneous?	W.
9. III.	270°	20	240	41° 43′N	79° 25′W	〃	Plant: algae?	W.
10. III.	290°	20	230	32° 47′N	134° 25′W	2,400	〃 stem	W.
25. III.	270°	10	216	41° 22′N	81° 43′W	〃	〃 fragments	W.
5. V.	240°	25	210	22° 05′–24° 40′N	160° 07′–166° 55′W	3,050	Mineral: sand	Y.
〃	〃	〃	〃	26° 28′–27° 40′N	171° 50′–175° 32′W	〃	〃 〃	Y.
6. V.	235°	30	210	28° 12′–28° 10′N	177° 23′–177° 20′W	2,400	Mineral: sand	Y.
29. VI.	242°	15	210	Oahu to 21° 22′N	158° 19′W	5–1,800	Plant: stem	Y.
〃	〃	〃	〃	21° 22′–21° 00′N	158° 19′–159° 00′W	2,400	〃 Eufilicales sporangium	Y.

Program for Systematic Biology), the U. S. Navy (Naval Support Force Antarctica: Task Force 43, Air Development Squadron Six, and Airborne Early Warning Barrier Squadron Pacific), the Lockheed Aircraft Corporation, and the U. S. Air Force (Military Air Transport Service and Hickam Air Force Base). We are especially indebted to T. O. Jones, G. R. Toney, D. D. Keck, Albert Meek, A. C. Snodgrass, Rear Admiral D. M. Tyree, Captain J. A. Eady, Captain W. H. Munson, Major J. H. Foster, Captain L. P. Prestler, Commanders A. L. Rasmussen, E. N. Beeby, C. V. Zalewski, A. H. Magie and J. C. Snodgrass, Lt. Commander D. Reckling, and Mr. E. E. Goodale.