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TRAPPING OF AIR-BORNE INSECTS ON SHIPS IN THE PACIFIC, PART 8[1]

By J. E. Guilmette, Jr., E. P. Holzapfel and D. M. Tsuda[2]

Abstract: Six cruises were made aboard ships in the Pacific during 1967 and 1968 to continue studies of trans-oceanic dispersal of insects. Specimens obtained together with new and modified equipment and techniques used are discussed. Suggestions are included for further changes to improve the program.

The six cruises listed below were taken by J. E. Guilmette, Jr. and represent the entire trans-oceanic insect survey work done by the Museum between 1 July 1967 and 1 January 1969.

R/V T. Cromwell	Hawaiian Islands-Inter-island only	Aug.-Sept. 1967
R/V D. S. Jordan	San Diego-Eastern Tropical Pacific	Oct.-Nov. 1967
R/V D. S. Jordan	San Diego-Eastern Tropical Pacific	Dec. 1967 Jan. 1968
U. S. N. S. Silas Bent	Sasebo, Japan-Sea of Japan	Apr.-May 1968
U. S. N. S. Silas Bent	Sasebo, Japan-Sea of Okhotsk	May-June 1968
R/V D. S. Jordan	San Diego-Offshore California	Sept.-Oct. 1968

Specimens from the Cromwell (Inter-island Hawaii) are not included in this report due to their large number and the proximity to land of the ship at all times during collecting. A total of 835 specimens and several fragments resulted from the other 5 cruises with the largest numbers appearing in the orders Homoptera, Diptera and Hymenoptera.

Methods: During the 18-month period covered by this report, 4 types of samplers were used. The nylon organdy cone-shaped nets on 75 cm diameter rings suspended from ropes and/or cables (Yoshimoto & Gressitt 1960) screened the largest volume of air on all 6 cruises. The electric suction trap (Yoshimoto, Gressitt & Mitchell 1962) underwent further modifications and was used on both cruises aboard the *Silas Bent*. The new automatic device was completed by the Meteorology Research Institute, Inc. and was used for the first time on the *D. S. Jordan* in the fall of 1968. The spin-sect black light suction trap (Holzapfel & Perkins 1969) was used on all but the Hawaiian

1. Results of a project supported by a grant to Bishop Museum from the Oceanography Branch, Office of Naval Research.

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inter-island cruise in a continued effort to determine what role the ship plays in transporting insects found at great distances from land. A Kramer-Collins Spore Sampler supplied by Kansas State University was used on the California and Japan cruises in an effort to determine the dispersal of fungi over the ocean. It was operated from the front railing of the flying bridge of the *Silas Bent*. The impacted slides resulting from this survey were sent to Dr Charles L. Kramer of the Division of Biology at Kansas State for analysis.

Prior to each cruise stainless steel cables were attached to the mast yardarms located forward of the engine stack and secured to the deck of the ship. A new method for supporting the 75 cm nets and rings was developed allowing them to rotate freely and face into the wind at all times (fig. 1). On the Hawaiian inter-island cruise 4 nets were flown 15 meters aft of the bow with the lowest net suspended approximately 12 meters above the water line. On the Eastropac cruises aboard the *D. S. Jordan* 4 nets were flown on each side of the flying bridge ; the lowest being about 14 meters above the water line. On the cruises from Japan aboard the *Silas Bent* 6 nets were flown some 18 meters above the water line on the port yardarm of the signal mast. Off California, aboard the *D. S. Jordan* 5 nets were used above the flying bridge.

The electric suction trap was modified by removing the rotating intake (Holzapfel & Harrell 1968) and replacing it with a flat cover supported by baffels divided into 4 quadrants. A circular black light was added to attract flying insects and an anemometer was placed atop the cover to record relative wind speeds (fig. 3). This modified Johnston type sampler was designed to provide uniform collecting and is especially useful during periods of relative light airs and during periods when wind speeds are too great for the use of nets. It was operated from the starboard deck of the flying bridge aboard the *Silas Bent*. Its operation proved successful in areas of high insect density. Since the volume of air screened by the trap was not sufficient to produce adequate numbers of insects in areas of low density it would probably prove to be more practical on or near land.

The new automatic insect sampler (fig. 2 & 4) developed by Meteorology Research, Inc. of Altadena, California is a time resolution device which may be used when no technician is free for sea duty. The sampler is basically a moving gauze strip drawn between the trap intake and a screened suction fan. Insects are drawn into the intake by the fan and held on the moving gauze strip. As they are moved off the screen by the take-up reel they are sealed to the gauze by a layer of mylar plastic.

Once secured aboard a vessel and supplied with power, the sampler loaded with 9 meter rolls of gauze and mylar will collect continuously for two weeks without any further servicing. When the gauze has all passed the collecting area, power is automatically stopped. The exterior intake incorporates a black light unit and special yellow

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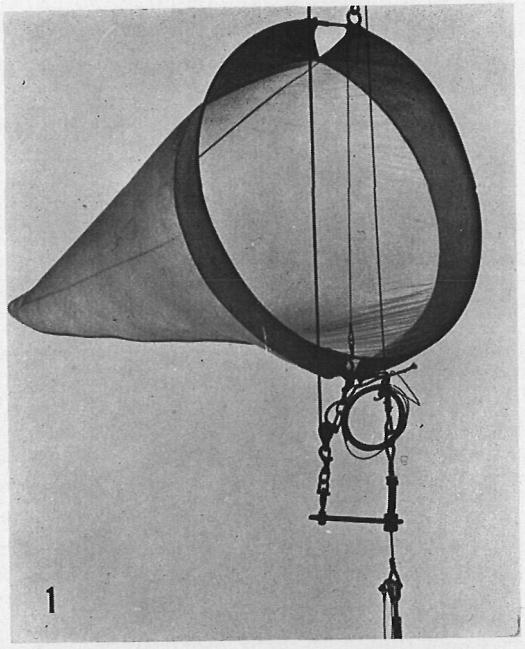
Fig. 1. Nylon net of 75 cm ring illustrating the new cable and cord rigging which permits free movement during shifts of relative winds.

Fig. 2. The automatic insect sampler developed by Meteorology Research Inc.

Fig. 3. The electric suction trap with its modified top section.

Fig. 4. Internal working parts of the automatic insect sampler. Roll of gauze at right is drawn across collecting area in center. Mylar from roll at upper left laminates insects to gauze before being stored on take up roll at lower left.



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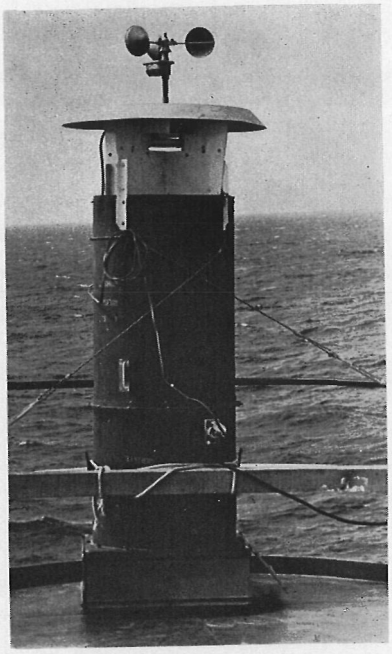

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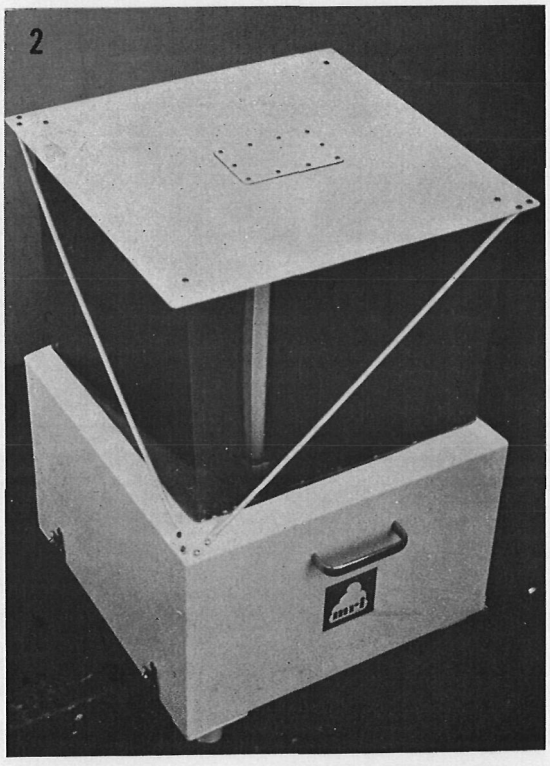

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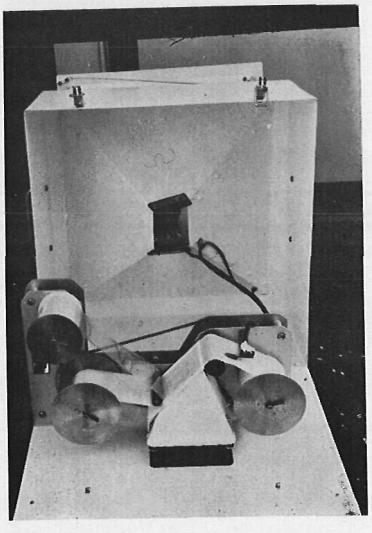


paint which serve as attractants. The device was tested aboard the *D. S. Jordan* off the California coast in the fall of 1968 and the mechanics performed as expected though it was noted that a larger suction motor would increase the volume of air screened and hold the larger and more active insects more firmly to the gauze.

The method for determining on-ship insect contamination with the use of interior black light traps (Harrell & Holzapfel 1966 & Holzapfel & Perkins1969) was continued. Nets were also placed over all exterior ventilator openings forward of the 75 cm nets.

Collections were made and data recorded every 6 hours starting at midnight. Complete weather information was obtained for the periods of collecting with emphasis placed on upper level wind information since research has shown that it is a major parameter of insect dispersal (Taylor 1960).

Results: Brief passage on the Cromwell provided a training period for the Naval Technician who had taken over the ship trapping survey work. Due to proximity of other Hawaiian Islands, danger of contamination from the ships and difficulty experienced in obtaining accurate ship positions, specimens from that vessel are not included in this report but may become a part of an inter-island Hawaii program presently being proposed. Specimens from the other 5 cruises are listed in tables 1–5. Of the 835 insects collected, 451 belonged to the Order Homoptera, 218 were Diptera and 54 were Hymenoptera. While inadequate records were kept of the collecting of insects from the interior of the ship, when the data from table 6 is compared with the corresponding cruise on tables 1–5, it can be seen that at no time was there a definite correlation between the numbers or types of insects collected in the atmosphere and those from the interior of the ship.

Graphs 1 through 4 present a picture of the distance from land at which the various specimens were collected, together with their numbers and the direction of the wind at the time of collection. These graphs cover the insects collected in tables 1 through 4 and should be studied together with charts 1 through 3 which present the generalized wind flow at the 850–700 MB level. Until further identification is made of the specimens, no attempt will be made to present trajectories to the probable source of the collected insects.

Discussion: The need to analyze collections made at sea from a quantitative standpoint has been recognized for several years (Holzapfel & Harrell 1968; Holzapfel & Perkins 1969). Analysis of the data obtained from the samples during 1967–68 tends to indicate that it will be necessary to collect in areas of higher insect density before statistics can be accurately applied to the results. The inconsistency of sample numbers versus distance from land on the 6 cruises taken will not permit the normal Poisson distribution approach. The analysis by other means was also impractical due to the relatively small numbers at distances greater than 160 km from land.

While total numbers prevent the data from being analyzed statistically, weather conditions probably produce the greatest variable. Rain squalls, fog and storm conditions all tend to clump insects into atmospheric pressure gradients and thus confuse their dispersal patterns. Such conditions also reduce sampling efficiency by increasing the wind resistance of the nets and by making it difficult to remove specimens from them. Using previous collecting information to choose the best area in which to continue the program, i.e. highest numbers at greatest distances from land, the study will

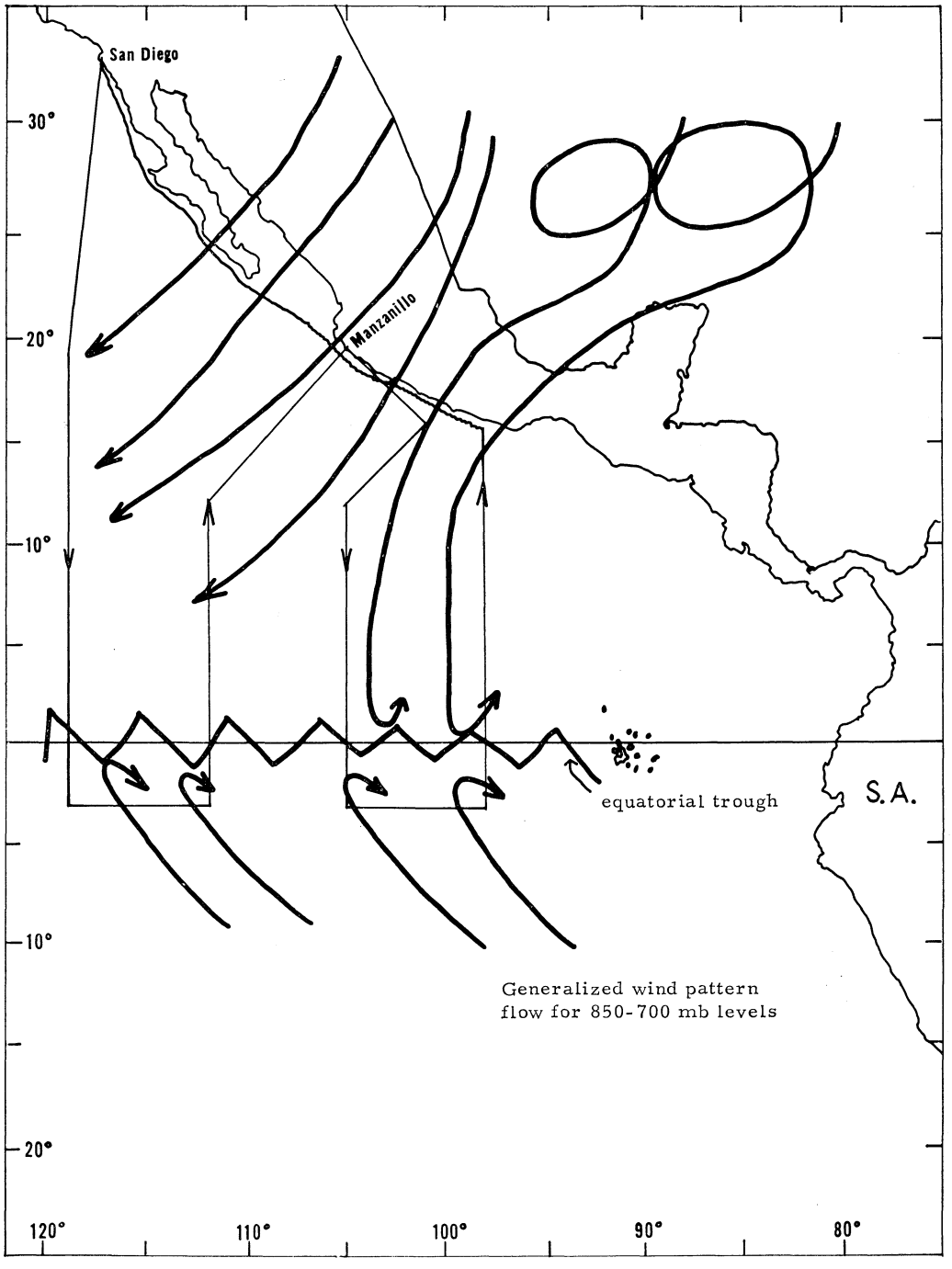
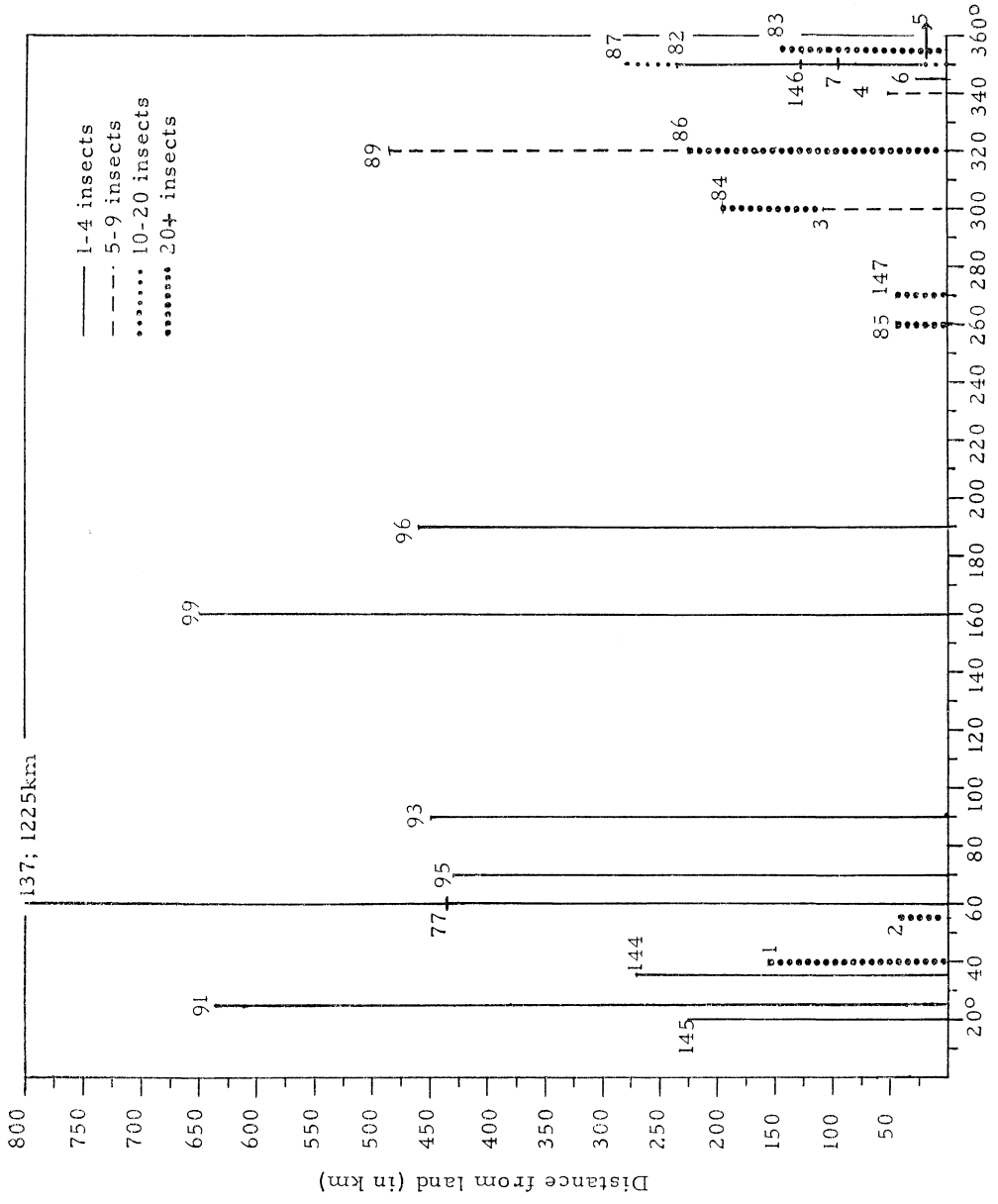
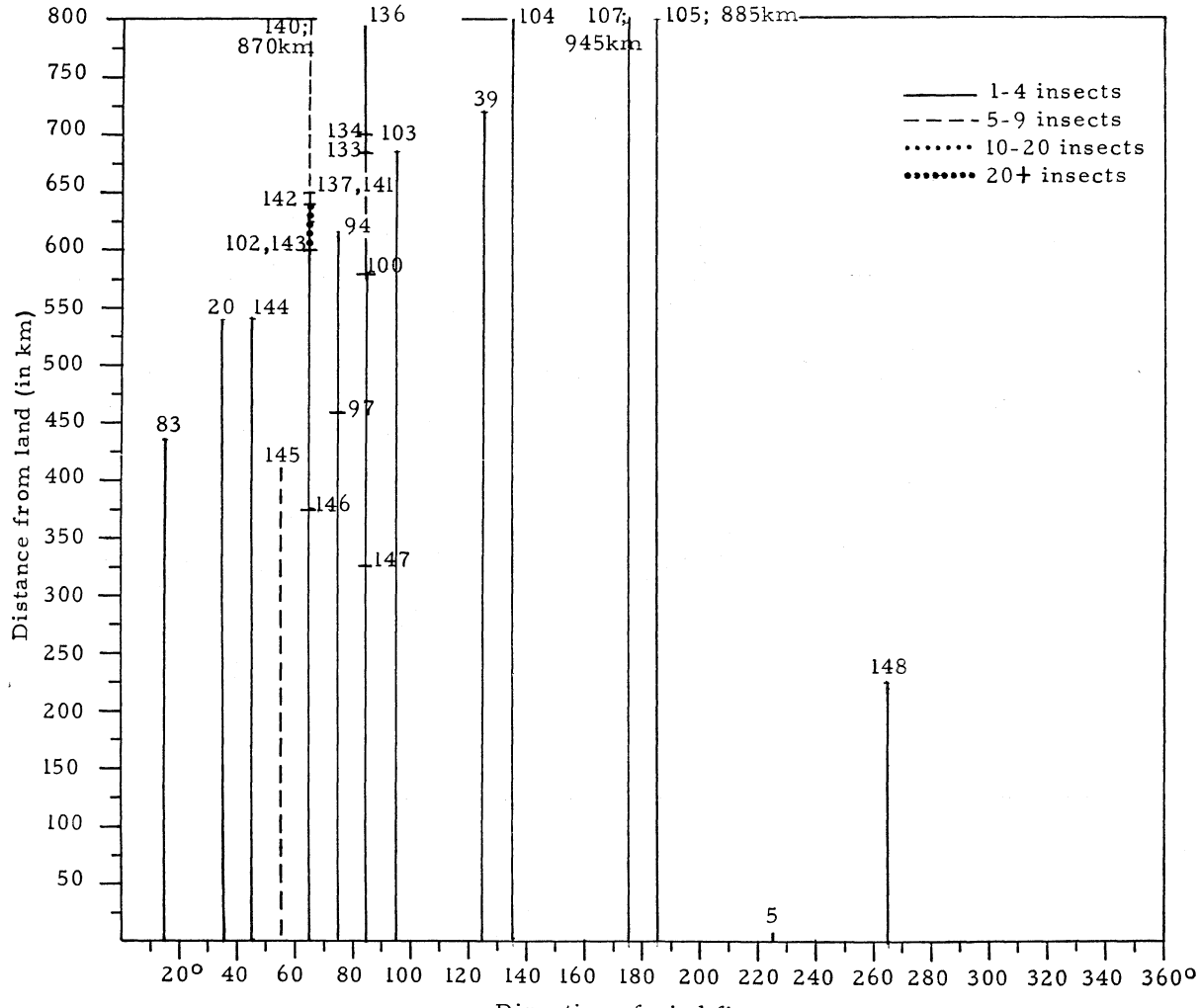


Chart 1. EASTROPAC # 50 and # 60 ; *R/V David Starr Jordan.*

Numbers indicated in graphs 1–4 correlate with sample numbers in corresponding tables 1–4.



Graph 1. EASTROPAC #50; *R/V David Starr Jordan.*



Graph 2. EASTROPAC #60; *R/V David Starr Jordan.*

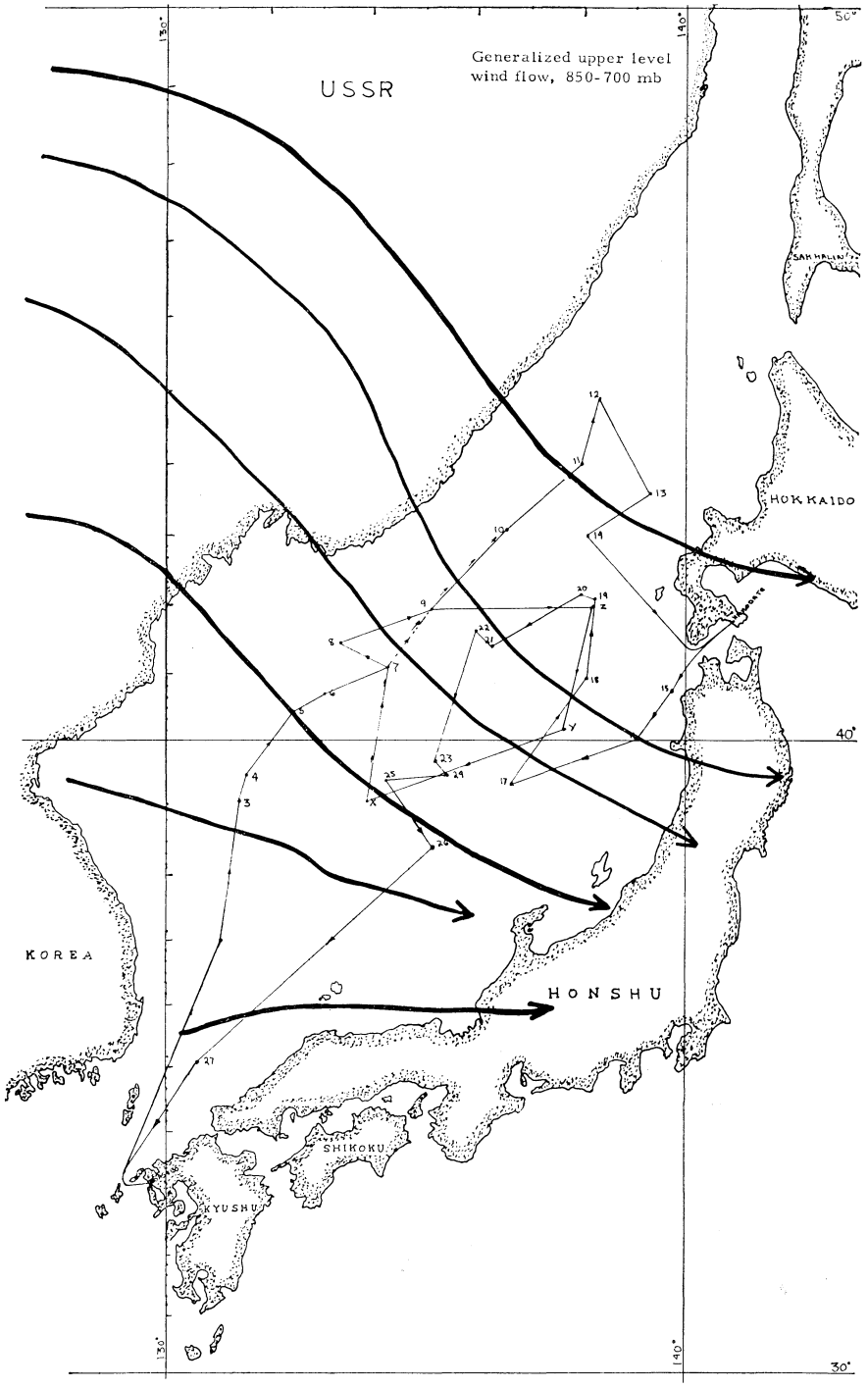


Chart 2. Sea of Japan; *USNS Silas Bent.* (Connected line indicates the cruise pattern and the numbers along the line represent oceanographic stations).

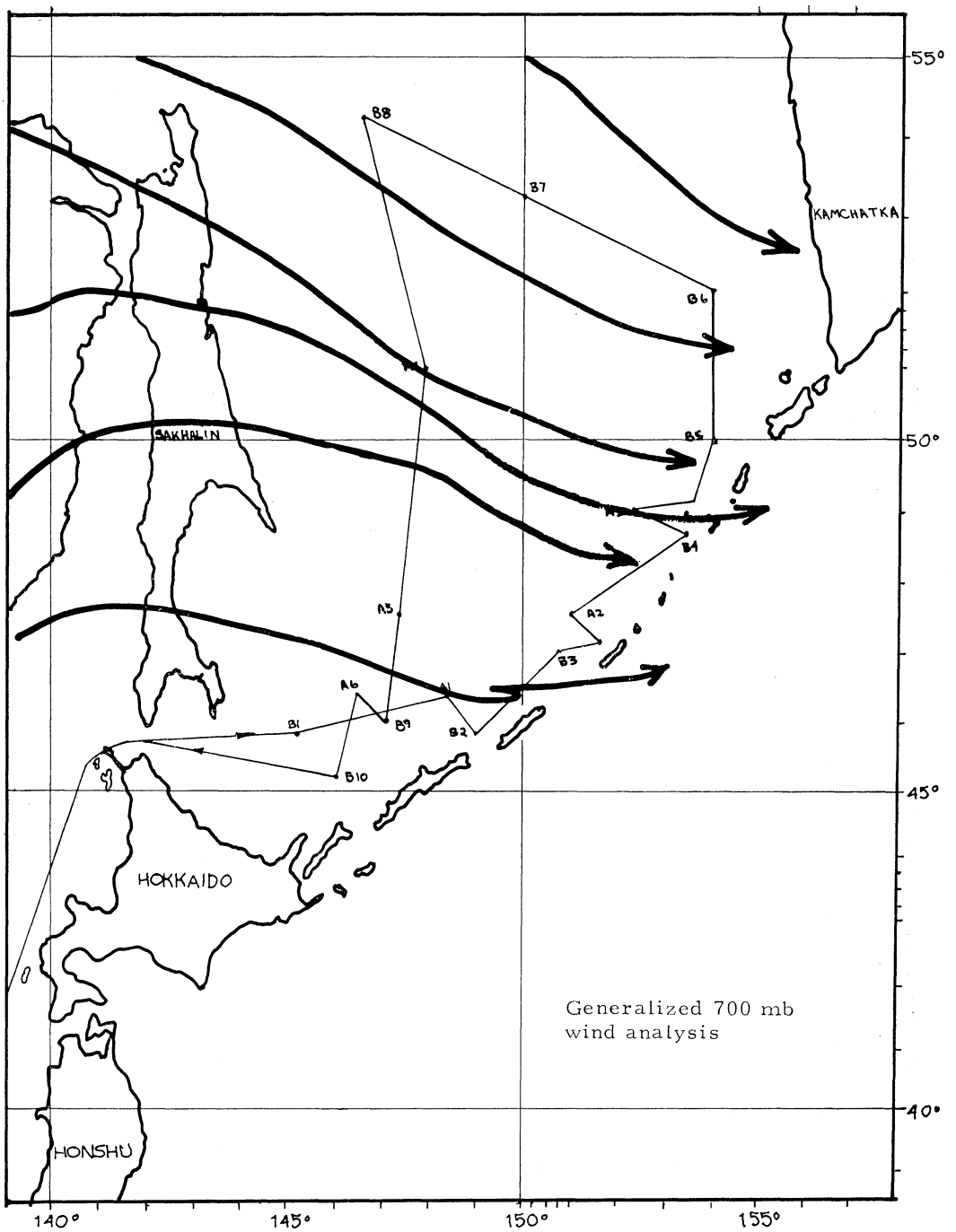
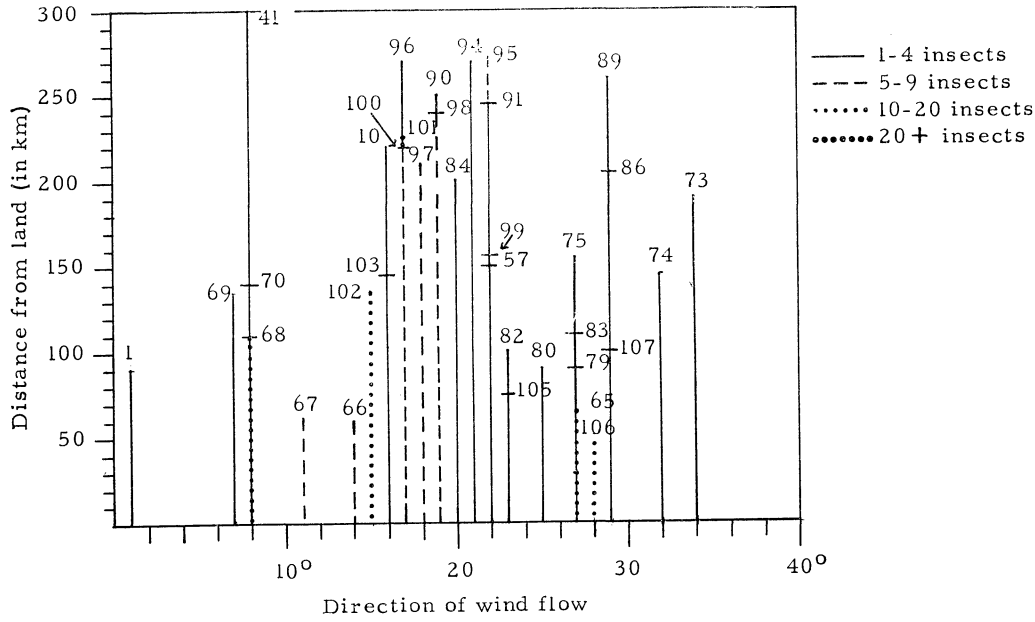
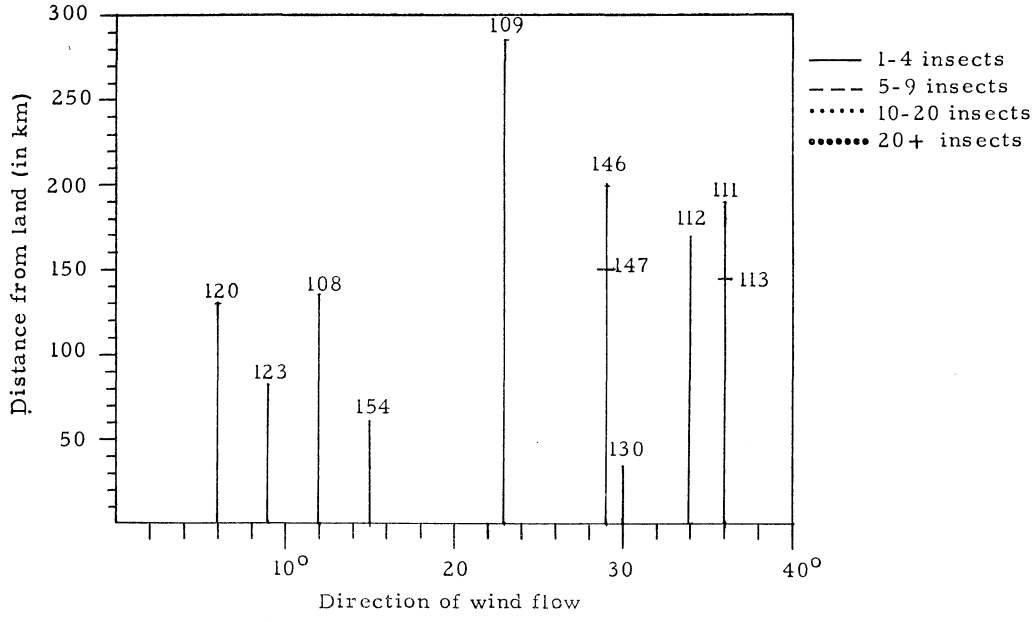


Chart 3. Sea of Okhotsk ; *USNS Silas Bent.* (Connected line indicates the cruis pattern and the numbers along the line represent oceanographic stations).



Graph 3. Sea of Japan ; *USNS Silas Bent.*



Graph 4. Sea of Okhotsk; *USNS Silas Bent.*

Table 1. EASTROPAC # 50; *R/V David Starr Jordan* (Guilmette)*.

No.	Date 1967	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
01	17. X	40°	10kn	031°12′N	117°24′W	030°19′N	117°38′W	155km Baja Calif.	2	Thysanoptera	
									1	Hemiptera	Lygaeidae
									8	Homoptera	Aphididae
									2	〃	Cicadellidae
									1	〃	Delphacidae
									1	〃	Psyllidae
									1	Diptera	Agromyzidae
									1	〃	Canaceidae
									1	〃	Chironomidae
									1	〃	Drosophilidae
									1	〃	Ephydridae
									1	〃	damaged
									1	Coleoptera	Staphylinidae
									1	Hymenoptera	Aphelinidae
									1	〃	Mymaridae
									2	〃	Trichogrammatidae
02	18.X	55°	04	030°19′N	117°38′W	29°06′N	117°48′W	43km Guadalupe I.	3	Mallophaga	
									4	Homoptera	Aphididae
									7	〃	Cicadellidae
									1	〃	Psyllidae
									2	Lepidoptera	Microlep.
									2	Diptera	Ephydridae
									1	Hymenoptera	Agaontidae
03	18.X	300°	08	029°06′N	117°48′W	027°54′N	117°58′W	108km Guadalupe I.	1	Hemiptera	Lygaeidae
									3	Homoptera	Aphididae
									2	〃	Cicadellidae
									1	Lepidoptera	Microlep.
04	18.X	340°	09	027°54′N	117°58′W	029°13′N	117°44′W	54km Guadalupe I.	1	Homoptera	Aphididae
									3	〃	Cicadellidae
									1	Lepidoptera	Geometridae
									2	〃	Gelechiidae
									2	Diptera	Drosophilidae
05	18.X	350°	04	029°13′N	117°44′W	029°16′N	118°09′W	18km Guadalupe I.	5	Mallophaga	
									1	Hemiptera	Lygaeidae
									2	Homoptera	Cicadellidae
									2	Lepidoptera	Microlep.

* Numbers appearing in the first column in tables 1–5 represent sample numbers. It should be noted that not all samples contained insect specimens.

Table 1 (continuation).

No.	Date	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
06	19.X	345°	08kn	029°16′N	118°09′W	028°36′N	118°14′W	27km Guadalupe I.	1	Thysanoptera	
									1	Lepidoptera	Microlep.
07	19.X	350°	04	028°36′N	118°14′W	027°26′N	118°22′W	95km Guadalupe I.	1	Homoptera	Cicadellidae
									1	〃	Psyllidae
									1	Lepidoptera	Microlep.
77	6.XI	60°	09	014°24′N	109°36′W	014°56′N	108°57′W	435km Socorro I., Mexico	1	Homoptera	Cicadellidae
82	7.XI	350°	15	017°11′N	107°16′W	017°32′N	106°20′W	235km Coast of Mexico	1	Hemiptera	Nabidae
									1	Homoptera	Aphididae
83	7.XI	355°	06	017°32′N	106°20′W	018°11′N	105°39′W	145km Coast of Maxico	2	Hemiptera	Miridae
									1	〃	Lygaeidae
									157	Homoptera	Aphididae(winged)
									24	〃	〃 (nymphs)
									1	〃	Aleyrodidae
									8	〃	Cicadellidae
									11	〃	Delphacidae
									1	Hemiptera	Lygaeidae
									2	〃	Miridae
									2	Lepidoptera	Microlep.
									7	Diptera	Ceratopogonidae
									3	〃	Chironomidae
									1	〃	Chloropidae
									1	〃	Dolichopodidae
									8	〃	Ephydridae
									2	〃	Tipulidae
									2	Coleoptera	Staphylinidae
									1	Hymenoptera	Encyrtidae
84	8.XI	300°	01	018°11′N	105°39′W	018°30′N	105°11′W	195km Coast of Mexico	29	Homoptera	Aphididae(winged)
									4	〃	〃 (nymphs)
									1	〃	Psyllidae
									1	Diptera	Cecidomyidae
									1	Diptera	Ceratopogonidae
									2	〃	Tipulidae
									1	〃	damaged
85	12.XI	260°	06	016°42′N	099°58′W	016°16′N	100°29′W	45km Coast of Mexico	10	Homoptera	Aphididae
									4	〃	Aleyrodidae
									1	〃	Cicadellidae
									1	〃	Delphacidae
									1	〃	Psyllidae

									5	Diptera	Ceratopogonidae
									1	〃	Chironomidae
									2	〃	Ephydridae
									1	〃	Tipulidae
									1	Coleoptera	
									8	Hymenoptera	Agaontidae
									1	〃	Braconidae
									4	〃	Cynipidae
									4	〃	Encyrtidae
									1	〃	Scelionidae
86	12.XI	320°	04kn	016°16′N	100°29′W	015°36′N	101°13′W	225km Coast of Mexico	1	Hemiptera	Miridae
									1	〃	Veliidae
									1	Homoptera	Aleyrodidae
									3	〃	Aphididae
									2	〃	Delphacidae
									1	Thysanoptera	
									1	Coleoptera	Staphylinidae
									1	Diptera	Ceratopogonidae
									1	〃	Ephydridae
									1	Hymenoptera	Ceraphronidae
									3	〃	Cynipidae
									1	〃	Dryinidae
									2	〃	Encyrtidae
									2	〃	Scelionidae
87	12.XI	350°	06	015°36′N	101°13′W	015°08′N	101°40′W	280km Coast of Mexico	1	Homoptera	Aleyrodidae
									1	〃	Aphididae(winged)
									5	〃	〃 (nymphs)
									1	〃	Cicadellidae
									1	Thysanoptera	
									1	Hymenoptera	Agaontidae
									1	〃	Encyrtidae
									1	〃	Mymaridae
									1	Araneida	
89	13.XI	320°	06	014°25′N	102°26′W	013°57′N	102°59′W	485km Coast of Mexico	2	Homoptera	Aleyrodidae
									1	〃	Delphacidae
									1	Thysanoptera	
									2	Araneida	
91	13.XI	25°	12	013°18′N	103°42′W	012°47′N	104°17′W	635km Coast of Mexico	1	Homoptera	Aleyrodidae
									1	Araneida	
93	14.XI	90°	06	012°10′N	104°58′W	011°30′N	105°05′W	450km Clipperton I.	1	Psocoptera	
95	14.XI	70°	20	009°54′N	105°23′W	008°59′N	105°26′W	430km Clipperton I.	1	Lepidoptera	damaged
96	15.XI	190°	13	008°59′N	105°26′W	008°22′N	105°13′W	460km Clipperton I.	1	Homoptera	Delphacidae

Table 1 (continuation).

No.	Date	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long	Lat.	Long.				
99	15.XI	160°	04kn	006°49′N	105°10′W	005°51′N	105°10′W	650km Clipperton I.	1	Lepidoptera	Pyralidae
137	25.XI	60°	06	008°50′N	098°10′W	009°38′N	098°05′W	1225km Clipperton I.	1	Homoptera	Delphacidae
144	27.XI	35°	06	012°50′N	098°11′W	013°28′N	098°14′W	270km Coast of Mexico	1	Homoptera	Aphididae
145	27.XI	20°	05	013°28′N	098°14′W	014°05′N	098°12′W	225km Coast of Mexico	2	Homoptera	Aphididae
146	27.XI	350°	12	014°05′N	098°12′W	014°48′N	098°10′W	126km Coast of Mexico	1	Homoptera	Aphididae
147	27.XI	270°	06	014°48′N	098°10′W	015°42′N	098°07′W	45km Coast of Mexico	3	Homoptera	Aleyrodidae
									5	〃	Aphididae
									2	〃	Delphacidae
									6	Thysanoptera	
									1	Lepidoptera	Microlep.
									2	Coleoptera	Staphylinidae
									5	Hymenoptera	Agaontidae
									1	〃	Braconidae
									1	〃	Cynipidae
									3	〃	Encyrtidae
									1	Hymenoptera	Eulophidae
									1	〃	Mymaridae
									2	〃	Trichogrammatidae
									1	Diptera	Cecidomyiidae
									1	〃	Chironomidae
									2	〃	Sciaridae

Table 2. EASTROPAC # 60 ; *R/V David Starr Jordan* (Guilmette).

No.	Date	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
5	1967 20.XII	25°	15kn	028°36′N	115°18′W	028°06′N	115°11′W	7km Cedro I.	1	Homoptera	Psyllidae
									1	Homoptera frag.	
20	23.XII	35°	12	015°41′N	118°42′W	015°14′N	118°50′W	540km Clarion I.	1	Homoptera	Cicadellidae

39	28.XII 1968	125°	12	004°29′N	118°30′W	003°43′N	118°45′W	720km Culpepper I.	1	wing frag.	
83	8.I	15°	11	015°06′N	108°46′W	015°55′N	107°41′W	435km Socorro I.	2	Homoptera	Aphididae
94	16.I	75°	06	012°58′N	104°42′W	012°32′N	104°08′W	615km off Mexico	1	Homoptera	Psyllidae
97	16.I	75°	13	010°28′N	104°45′W	009°54′N	104°40′W	460km Clipperton I.	1	Homoptera	Cicadellidae
100	17.I	85°	15	008°46′N	104°45′W	007°25′N	104°45′W	580km Clipperton I.	1	Homoptera	Cicadellidae
102	18.I	65°	14	017°10′N	104°45′W	006°24′N	104°47′W	600km Clipperton I.	3	Homoptera	Delphacidae
103	18.I	95°	04	006°24′N	104°47′W	005°33′N	104°47′W	685km Clipperton I.	1	Homoptera	Cixiidae
									1	〃	Delphacidae
104	18.I	135°	06	005°33′N	104°47′W	004°30′N	104°41′W	800km Clipperton I.	1	Araneida	
105	18.I	185°	07	004°30′N	104°41′W	003°48′N	104°25′W	885km Clipperton I.	1	Homoptera	Cicadellidae
									1	〃	Delphacidae
107	19.I	175°	10	003°28′N	104°30′W	002°55′N	104°38′W	945km Clipperton I.	1	Araneida	
133	25.I	85°	08	004°05′N	097°49′W	004°34′N	097°45′W	685km Culpepper I.	1	Homoptera	Delphacidae
134	26.I	85°	04	004°34′N	097°45′W	004°56′N	097°45′W	700km Clipperton I.	1	Homoptera	Cicadellidae
136	26.I	85°	11	005°38′N	097°45′W	006°12′N	097°45′W	800km Clipperton I.	1	Homoptera	Cicadellidae
									1	〃	Delphacidae
137	26.I	65°	14	006°12′N	097°45′W	006°54′N	097°45′W	650km off Mexico	1	Hemiptera	Nabidae
140	27.I	65°	12	007°23′N	097°45′W	007°52′N	097°45′W	870km off Mexico	4	Homoptera	Cicadellidae
									3	〃	Delphacidae
									1	Neuroptera	Chrysopidae
141	27.I	65°	14	007°52′N	097°45′W	009°20′N	097°54′W	650km off Mexico	1	Hemiptera	Miridae
									1	Homoptera	Cicadellidae
									4	〃	Delphacidae
142	27.I	65°	14	009°20′N	097°54′W	009°59′N	097°46′W	640km off Mexico	1	Hemiptera	Reduviidae
									5	Homoptera	Cicadellidae
									21	〃	Delphacidae
									1	Neuroptera	Chrysopidae
143	28.I	65°	12	009°59′N	097°46′W	010°21′N	097°47′W	600km off Mexico	4	Homoptera	Delphacidae
144	28.I	45°	08	010°21′N	097°47′W	011°11′N	097°45′W	540km off Mexico	1	Homoptera	Cicadellidae
									3	〃	Delphacidae
145	28.I	55°	12	011°11′N	097°45′W	012°07′N	097°49′W	410km off Mexico	3	Homoptera	Aphididae
									1	〃	Cicadellidae
									1	〃	Delphacidae
146	28.I	65°	10	012°07′N	097°49′W	012°34′N	097°45′W	375km off Mexico	2	Homoptera	Aphididae
									2	〃	Delphacidae

Table 2 (continuation).

No.	Date	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long	Lat.	Long.				
147	1968 29.I	85°	05kn	012°34′N	097°45′W	012°55′N	097°50′W	325km off Mexico	1	wing fragment	
148	29.I	265°	04	012°55′N	097°50′W	013°45′N	097°53′W	225km off Mexico	1	Homoptera	Cicadellidae
									1	〃	Delphacidae

Table 3. Sea of Japan ; *USNS Silas Bent* (Guilmette).

No.	Date 1968	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
1	12.IVi	01°	18kn	036°32′N	130°53′E	036°42′N	131°02′E	90km Take I.	1	Homoptera	Aphididae (frag.)
									1	Diptera	Chironomidae (frag.)
									1	Hymenoptera	Formicidae(frag.)
10	14.IV	16°	09	038°04′N	131°24′E	039°22′N	131°26′E	220km Korea	1	Diptera	Ephydridae
41	19.IV	08°	03	039°11′N	134°11′E	039°19′N	134°13′E	300km Honshu	1	Hymenoptera	Braconidae
									2	insect frag.	
57	26.IV	22°	16	045°04′N	138°26′E	044°43′N	138°50′E	150km Siberia	1	Araneida	
									3	insect frag.	
65	2.V	27°	03	041°18′N	140°06′E	040°51′N	138°48′E	65km Kyuroku I.	1	Diptera	Agromyzidae*
									6	〃	Calliphoridae*
									3	〃	Syrphidae*
66	2.V	14°	08	040°51′N	138°48′E	040°45′N	138°51′E	60km Kyuroku I.	1	Diptera	Agromyzidae*
									3	〃	Calliphoridae*
									1	〃	Syrphidae*
67	3.V	11°	03	040°45′N	138°51′E	040°45′N	138°50′E	62km Kyuroku I.	7	Diptera	Agromyzidae*
									2	〃 frag.	*
68	3.V	08°	10	040°45′N	138°50′E	040°09′°N	138°16′E	110km Kyuroku I.	5	Diptera	Agromyzidae
									4	〃	Agromyzidae*
									1	〃	Culicidae*
									1	〃	Ephydridae
69	3.V	07°	06	040°09′N	138°16′E	040°03′N	138°05′E	135km Honshu	2	Diptera	Agromyzidae
70	3.V	08°	06	040°03′N	138°05′E	040°08′N	138°01′E	140km Honshu	2	Diptera	Agromyzidae
									1	Araneida	
73	4.V	34°	10	039°20′N	137°38′E	040°21′N	137°27′E	190km Honshu	1	Diptera	Ephydridae
74	4.V	32°	08	040°21′N	137°27′E	040°16′N	137°59′E	145km Honshu	1	Diptera	Agromyzidae
									1	〃	Ephydridae
									1	〃 frag.	

75	5.V	27°	16	040°16′N	137°59′E	040°13′N	137°45′E	155km Honshu	1	Diptera	Agromyzidae
79	6.V	27°	04	041°18′N	138°11′E	042°02′N	138°17′E	90km Okushiri I.	2	Diptera	Agromyzidae
									1	〃	Sphaeroceridae
80	6.V	25°	10	042°02′N	138°17′E	042°03′N	138°17′E	90km Okushiri I.	1	Diptera	Ephydridae
									1	〃	Tipulidae*
82	6.V	23°	04	042°08′N	138°03′E	042°06′N	138°11′E	100km Okushiri I.	1	Diptera	Agromyzidae
83	7.V	27°	04	042°06′N	138°11′E	042°02′N	138°01′E	110km Okushiri I.	1	Diptera	Agromyzidae
84	7.V	20°	04	042°02′N	138°01′E	041°34′N	136°49′E	200km Ō I.	3	Diptera frag.	
86	7.V	29°	10	041°21′N	136°18′E	041°39′N	136°02′E	205km Siberia	1	Diptera	Agromyzidae (frag.)
89	8.V	29°	18	041°31′N	136°05′E	040°55′N	135°46′E	260km Korea	3	Acarina(exuviae)	
									1	insect frag.	
90	8.V	19°	06	040°55′N	135°46′E	039°47′N	135°10′E	250km Hekura I.	2	insect frag.	
91	9.V	22°	12	039°47′N	135°10′E	039°40′N	135°13′E	245km Hekura I.	1	insect frag.	
94	9.V	21°	13	039°35′N	135°30′E	039°30′N	134°26′E	270km Hekura I.	1	Diptera	Agromyzidae
95	10.V	22°	10	039°30′N	134°26′E	039°31′N	134°23′E	272km Hekura I.	6	insect frag.	
96	10.V	17°	08	039°31′N	134°23′E	039°34′N	134°31′E	270km Hekura I.	1	Homoptera	Aphididae
97	10.V	18°	14	039°34′N	134°31′E	038°55′N	134°54′E	210km Hekura I.	3	Homoptera	Aphididae
									1	Diptera	Lonchaeidae
									1	〃	Syrphidae (frag.)
98	10.V	19°	20	038°55′N	134°54′E	038°29′N	134°14′E	240km Take I.	1	Homoptera	Aphididae
									2	Diptera	Agromyzidae
									3	〃	Ephydridae
99	11.V	22°	14	038°29′N	134°14′E	038°32′N	135°22′E	155km Hekura I.	2	Homoptera	Aphididae
100	11.V	17°	11	038°32′N	135°22′E	038°28′N	134°53′E	220km Honshu	3	Homoptera	Aphididae
									1	Diptera	Dolichopodidae
									1	〃	Sepsidae
101	11.V	17°	12	038°28′N	134°53′E	038°24′N	133°45′E	225km Take I.	4	Homoptera	Aphididae
									9	Diptera	Agromyzidae
									4	〃	Ephydridae
102	11.V	15°	14	038°24′N	133°45′E	038°18′N	132°52′E	135km Take I.	4	Homoptera	Aphididae
									2	Diptera frag.	
									2	Diptera	Agromyzidae
									2	Diptera	Ephydridae
103	12.V	16°	20	038°18′N	132°52′E	038°23′N	132°52′E	145km Take I.	1	Diptera	Ephydridae
									1	〃 frag.	
105	12.V	23°	30	037°48′N	133°08′E	036°59′N	133°29′E	75km Nakano I.	1	Hemiptera	Miridae
									1	Lepidoptera	(micro)
									1	Diptera	Muscidae
106	12.V	28°	26	036°59′N	133°29′E	036°26′N	132°41′E	45km Nakano I.	1	Homoptera	Aphididae
									4	Diptera	Agromyzidae*
									2	〃	Agromyzidae
									1	〃	Chironomidae
									3	〃	Drosophilidae
									2	〃	Ephydridae
									4	〃 frag.	
107	13.V	29°	25	036°26′N	132°41′E	036°00′N	131°58′E	100km Nakano I.	1	Diptera frag.	

* Insects caught in power suction trap, as compared to aerial nets.

Table 4. Sea of Okhotsk; *USNS Silas Bent* (Guilmette).

No.	Date 1968	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
128	23.V	12°	08kn	037°02′N	131°11′E	038°04′N	133°08′E	135km Take I.	2	Homoptera	Psyllidae
									1	Diptera	Ephydridae
									1	Diptera frag.	
109	23.V	23°	06	038°04′N	133°08′E	039°14′N	134°10′E	285km Take I.	1	Homoptera	Aphididae
									2	〃	Psyllidae
111	24.V	36°	12	040°46′N	135°42′E	041°34′N	135°29′E	190km Siberia	1	Diptera	Agromyzidae
									1	〃	Dolichopodidae
112	24.V	34°	12	041°34′N	135°29′E	042°04′N	137°20′E	170km Okushiri I.	1	Diptera	Agromyzidae
113	24.V	36°	12	042°04′N	137°20′E	042°23′N	137°27′E	145km Okushiri I.	1	Diptera frag.	
120	29.V	06°	06	045°01′N	140°49′E	045°51′N	145°08′E	130km Sakhalin	1	Diptera	Coelopidae
									1	Hymenoptera	Vespidae
123	30.V	09°	07	045°14′N	147°55′E	046°15′N	148°15′E	82km Ostrov Iterup	1	Orthoptera	Tettigoniidae
130	1.V	03°	04	048°00′N	152°03′E	048°41′N	153°23′E	33km Chirinkotan I.	1	Diptera	Coelopidae
146	7.VI	29°	15	047°31′N	147°21′E	047°27′N	147°32′E	200km Ostrov Iterup	3	insect frag.	
147	8.VI	29°	08	047°27′N	147°32′E	046°46′N	147°14′E	150km Ostrov Iterup	2	Homoptera	Aphididae
154	10.VI	15°	07	045°17′N	145°54′E	045°32′N	143°37′E	60km Sakhalin	1	Homoptera	Aphididae
									1	Diptera	Mycetopailidae

Table 5. Offshore California ; *R/V David Starr Jordan* (Guilmette).

No.	Date 1968	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
1	1.X	99°	Calm	032°43′N	117°24′W	032°52′N	117°45′W	43km La Jolla, Calif.	1	Coleoptera	Carabidae
									1	〃	Elateridae
									1	insect wing frag.	
									2	Diptera	Calliphoridae*
3	1.X	25°	01kn	033°18′N	118°12′W	033°32′N	118°33′W	2km Catalina I.	1	Lepidoptera	Noctuidae
									2	〃	Noctuidae*
									2	Diptera	Ephydridae*

4	1.X	33°	07	033°32′N	118°33′W	033°33′N	118°30′W	2.5km Catalina I.	1	Lepidoptera	antennal frag.
5	2.X	26°	06	033°33′N	118°30′W	033°30′N	118°29′W	3km Catalina I.	1	Lepidoptera	Tineidae
									1	Diptera	Ephydridae
6	2.X	35°	06	033°30′N	118°29′W	033°33′N	118°32′W	4km Catalina I.	1	Homoptera	Psyllidae*
									1	Diptera	Agromyzidae*
									1	〃	Ephydridae
7	2.X	21°	08	033°33′N	118°32′W	033°33′N	118°32′W	4km Catalina I.	2	Homoptera	Aphididae*
									1	Diptera	Muscidae
9	3.X	25°	08	033°32′N	118°35′W	033°30′N	118°30′W	5km Catalina I.	1	Diptera	Drosophilidae
									1	〃	Ephydridae
									2	〃	Muscidae*
									1	Pseudoscorpionida*	
11	3.X	22°	06kn	033°32′N	118°33′W	033°34′N	118°35′W	6km Catalina I.	3	Homoptera	Aphididae*
									1	Hemiptera	Lygaeidae*
									1	Lepidoptera	Noctuidae
									1	Diptera	Ephydridae*
12	3.X	24°	07	033°34′N	118°35′W	033°31′N	118°32′W	2.5km Catalina I.	1	Diptera	Ephydridae
13	4.X	26°	04	033°31′N	118°32′W	033°32′N	118°31′W	3km Catalina I.	1	Hemiptera	Lygaeidae
									1	Diptera	Ephydridae
14	4.X	25°	06	033°32′N	118°31′W	033°35′N	118°30′W	4km Catalina I.	1	Homoptera	Aphididae*
									1	Neuroptera	Chrysopidae*
									1	Diptera	Ephydridae*
15	4.X	99°	Calm	033°35′N	118°30′W	032°42′N	117°26′W	20km Pt. Loma	1	Diptera	Agromyzidae
									1	〃	Ephydridae*
									1	〃	Muscidae
									1	〃	Psychodidae
16	4.X	32°	06	032°42′N	117°26′W	032°42′N	117°21′W	9km Pt. Loma	2	Diptera	Ephydridae*
									1	〃	Muscidae*
17	8.X	99°	Calm	032°45′N	118°15′W	033°09′N	117°57′W	40km San Diego	1	Lepidoptera	Tineidae*
									2	Diptera	Agromyzidae
									2	〃	Ephydridae*
									2	〃	Ephydridae
18	8.X	14°	04kn	033°09′N	117°57′W	033°24′N	118°36′W	9km Catalina I.	1	Homoptera	Aphididae
									1	Diptera	Agromyzidae*
									1	〃	Ephydridae*
									1	〃	Ephydridae

Table 5 (continuation).

No.	Date	Wind		Starting		Ending		Approx. Dist. Nearest Land	No. Spec.	Order	Family
		Dir.	Veloc.	Lat.	Long.	Lat.	Long.				
19	8.X	99°	Calm	033°24′N	118°36′W	033°23′N	118°38′W	8km Catalina I.	1	Homoptera	Aphididae*
									1	〃	Aphididae
									2	Hemiptera	Lygaeidae
									1	Diptera	Agromyzidae
									1	〃	Drosophilidae*
									1	〃	Muscidae
20	8.X	99°	Calm	033°23′N	118°38′W	033°25′N	118°39′W	7km Catalina I.	1	Hemiptera	Lygaeidae
									1	Diptera	Ephydridae
21	9.X	33°	07	033°25′N	118°39′W	033°26′N	118°37′W	6km Catalina I.	1	Lepidoptera	Tineidae*
									1	Diptera	Drosophilidae*
									2	〃	Ephydridae*
22	9.X	34°	08	033°26′N	118°37′W	033°27′N	118°37′W	5.5km Catalina I.	1	Diptera	Ephydridae
									1	〃 frag.	
									1	Hymenoptera	Ichneumonidae
23	9.X	27°	07	033°27′N	118°37′W	033°23′N	118°32′W	3km Catalina I.	3	Homoptera	Aphididae*
									3	〃	Aphididae
									2	Hemiptera	Lygaeidae*
									3	〃	Lygaeidae
									1	Lepidoptera	Noctuidae*
									1	Diptera	Drosophilidae*
									1	〃	Drosophilidae
									2	〃	Ephydridae*
									1	Araneida	
24	9.X	34°	06	033°23′N	118°32′W	033°24′N	118°34′W	5km Catalina I.	1	Homoptera	Aphididae*
									1	〃	Aphididae
									1	Hemiptera	Lygaeidae*
									1	〃	Lygaeidae
									1	Diptera	Ephydridae
25	10.X	28°	06	033°24′N	118°34′W	033°21′N	118°38′W	10km Catalina I.	1	Hemiptera	Lygaeidae
									2	Diptera	Drosophilidae
									1	Araneida	
26	10.X	30°	06	033°21′N	118°38′W	033°25′N	118°38′W	8km Catalina I.	1	Hemiptera	Lygaeidae
									1	Diptera	Drosophilidae

27	10.X	33°	02	033°25′N	118°38′W	033°21′N	118°39′W	6km Catalina I.	1 1	Homoptera Diptera	Aphididae* Drosophilidae*
28	10.X	99°	Calm	033°21′N	118°39′W	033°22′N	118°36′W	5.5km Catalina I.	1 1 1	Homoptera 〃 Lepidoptera	Aphididae* Aphididae damaged microlep.
29	11.X	27°	04	033°22′N	118°36′W	033°23′N	118°38′W	6km Catalina I.	1	Diptera	Ephydridae*
31	11.X	26°	02	033°20′N	118°23′W	032°42′N	117°27′W	4km Pt. Loma	1 1	Homoptera Diptera	Aphididae* Calliphoridae
32	11.X	99°	02	032°42′N	117°27′W	032°38′N	117°18′W	3.5km Pt. Loma	1 1 1	Hemiptera 〃 Diptera	Lygaeidae* damaged nymph* Muscidae*

NOTE : * denotes specimens caught in large suction trap (other specimens caught in wind sock nets.)

Table 6. All insects caught from ship interior.

R/V David Starr Jordan; EASTROPAC #50

Specimens mentioned by Guilmette not available

I. *R/V David Starr Jordan*; EASTROPAC #60

19.XII.	Hand	caught	inside	ship	1	Dermaptera : Forficulidae
23.XII.	〃	〃	〃	〃	1	Diptera : Muscidae
1.I. 68	〃	〃	〃	〃	1	Diptera : Muscidae
					1	Hymenoptera : Formicidae
24.I. 68	〃	〃	〃	〃	1	Hemiptera : Coreidae
27.I. 68	〃	〃	〃	〃	1	Lepidoptera : Pyralidae
					1	〃 Tineidae
					1	Microlepidoptera : damaged
28.I.68	〃	〃	〃	〃		
Dates not recorded		〃	〃	〃	1	Hemiptera : Pentatomidae
					1	Orthoptera : Gryllidae
					1	Lepidoptera : Geometridae
					2	〃 Noctuidae
					1	〃 Notodontidae
					1	〃 Pyralidae

II. *USNS Silas Bent*; Sea of Japan

3.V.68	Hand	caught	inside	ship	1	Diptera : Drosophilidae
					3	〃 Calliphoridae
					4	〃 Syrphidae
11.V.68	〃	〃	〃	〃	3	Diptera : Calliphoridae
					2	〃 Syrphidae

Table 6 (continuation).

III. *USNS Silas Bent* ; Sea of Japan (continuation)			
	No Date	Black Light Trap	1 Diptera : Scatopsidae
			1 〃 Chironomidae
			1 〃 Bibionidae
			1 〃 Tephritidae
			3 〃 Coelopidae
			7 〃 Sphaeroceridae
			2 〃 Ephydridae
			1 〃 Agromyzidae
			1 〃 Tachinidae
IV. *USNS Silas Bent* ; Sea of Okhotsk			
	29.V.68	Hand caught inside ship	1 Diptera : Calliphoridae
			1 Lepidoptera : Xylorictidae
	10.VI.68	Black Light Trap	5 Homoptera : Aphididae
			1 〃 Cicadellidae
			1 Coleoptera : Dermestidae
			1 〃 Anobiidae
			1 〃 Staphylinidae
			3 Diptera : Calliphoridae
			13 〃 Cecidomyidae
			3 〃 Ceratopogonidae
			37 〃 Chironomidae
			2 〃 Chloropidae
			1 〃 Coelopidae
			2 〃
			4 〃 Ephydridae
			1 〃 Heleomyzidae
			3 〃 Muscidae
			1 〃 Mycetophilidae
			1 〃 Phoridae
			4 〃 Psychodidae
			1 〃 Sarcophagidae
			5 〃 Scatopsidae
			1 〃 Sciaridae
			1 〃 Sphaeroceridae
			1 〃 Tipulidae

become more meaningful if these preselected areas are surveyed under as many climatic conditions and seasonal changes as possible.

A resumé of desirable conditions for areas of concentrated study include high insect density, strong upper level wind flow, climatic compatibility to insect migration and sufficient logistic and meteorological support to provide comprehensive data.

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