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Underwater Noise and the Distribution of Snapping Shrimp with Special Reference to the Asiatic and the Southwest and Central Pacific Areas

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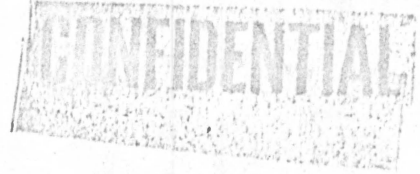
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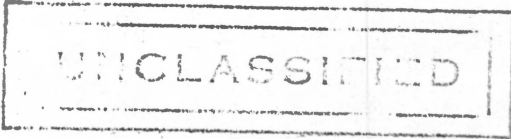
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UNDERWATER NOISE AND THE DISTRIBUTION OF SNAPPING SHRIMP WITH SPECIAL REFERENCE TO THE ASIATIC AND THE SOUTHWEST AND CENTRAL PACIFIC AREAS

by

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January 15, 1944

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References: (a) BUSHIPS ltr Serial No. C-0352(940Dd) of 23 May 1946 to UCDWR and other addressees.
(b) BUSHIPS ltr Section 940, Security--4 Serial No. C-5619(940Dd) to CNO dated 11 March 1946.
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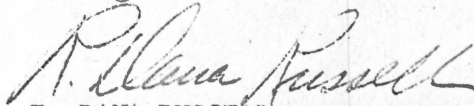
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UNDERWATER NOISE AND THE DISTRIBUTION OF SNAPPING SHRIMP WITH SPECIAL REFERENCE TO THE ASIATIC AND THE SOUTHWEST AND CENTRAL PACIFIC AREAS

Two genera of snapping shrimp, i.e., Crangon (Alpheus) and Synalpheus, have been found to produce a characteristic crackling underwater noise of sufficient intensity to constitute a serious problem in the use of Sonar equipment in harbor defense and other anti-submarine activities. The acoustic energy of the crackling noise produced by these small crustaceans is characterized by a strong contribution between 3 and 20 kc, and there is but little diurnal fluctuation in intensity at any given locality. The animals mentioned live abundantly in tropical and subtropical regions. They occur mainly in coastal waters of about 30 fathoms or less and live only on bottoms composed of coral, rock, shell or other types of material providing ready concealment. Sound surveys along the east and west coasts of the United States and in the Bahamas have shown a positive correlation between the known distribution of these noise producers and the presence of the above type of background noise. Single specimens produce a sharp "crack" when disturbed. The continuous crackling sound results from the simultaneous activity of a whole colony. More complete discussions of shrimp crackle as an underwater sound phenomenon will be found elsewhere, especially in Refs. 1 to 7.

From results of the surveys in accessible areas and from a study of the habits of Crangon and Synalpheus, it is permissible to assume that the correlation between underwater noise and the geographic distribution of these animals will obtain in other areas. Recent reports from a survey vessel operating in the central and southwestern Pacific verify this assumption (see below). Figures 1 and 2 have been prepared to show localities in which snapping shrimp are known to occur in the Pacific and adjacent areas. For comparison, Fig. 3 gives the distribution along the American coast where the most sound surveys have been conducted. The data presented on these charts are compiled from all available biological publications. The arrows denote specific localities where either or both Crangon and Synalpheus species have been reported.

The locality records where specimens have been found are significant not only in indicating that shrimp crackle can be expected to occur in the specific locality indicated but more generally in revealing the widespread distribution of the animals in the warmer waters of the Pacific. The records suggest that the animals probably occur everywhere in the tropical Pacific where water depths and character of bottom are favorable. The gaps in warm water island areas do not signify the absence of the shrimps from these areas but show rather that no shrimp collections have been reported from these places. That the Marshall, Caroline and the Mariana Islands are inhabited by snapping shrimp is certain in view of the fact that they occur near various islands of the Hawaiian group, at Wake and Kusaie Islands and at certain of the Nanpo Shoto group. All of these island chains lie within the influence of warm water currents and are similar in general environmental conditions.

ABSTRACT

A relationship has been established between crackling ambient noise and the habits and distribution of snapping shrimp* in American waters, and unusually high noise levels at the higher frequencies can be expected in the areas where these animals are known to live. Therefore, it is considered important to know their geographic distribution in the inaccessible areas of the Pacific in order that the general sound conditions in coastal waters and areas of shoal water can be anticipated as an aid in the use of Sonar equipment.

These animals live under rocks and shells on the bottom, or in coral. Even when bottom conditions are favorable, they do not often live at depths greater than 30 fathoms. The report covers a survey of all biological literature dealing with the distribution of the noise-producing genera Crangon (Alpheus) and Synalpheus of the Pacific Ocean, the east and west coasts of North America and some contiguous areas. Three charts are presented giving the geographic distribution. These indicate that the animals occur virtually throughout the whole tropical and subtropical areas of the Pacific with the northern and southern margins delimited approximately by the 52°F surface winter isotherm. In examining the charts, it must be remembered that the absence of a positive indication may mean only that no observation has been made. The noise-producing animals undoubtedly have a wide distribution within the limits indicated. Within this area, their distribution is probably limited only by unfavorable water depths and bottom characters. Reference is made to recent survey work which verifies that serious shrimp crackle does occur in the central and southwest Pacific areas.

* The snapping shrimp is not the common edible shrimp.

On the other hand, crustacean collections that have been made north of Tokyo on Honshu have not yielded Crangon or Synalpheus except in the Mutsu Kaiwan vicinity where Crangon Japonicus is said to occur. On the west side of Honshu the population appears also to be restricted, not having been reported north of Kanazawa. In the south Pacific, the animals spread southward at least to the northern tip of South Island, New Zealand, where cold waters of the West Wind Drift merge with warmer waters from the north. It is evident that the geographic distribution of these two genera of Crustacea is governed by water temperature, but precisely how this operates is not yet clear. In general the 52°F winter surface isotherm marks the approximate northern and southern limits of distribution. The relationship, however, is a complex one and is not dependent simply upon attainment of this low temperature but rather upon the duration at or below this level. It appears that certain critical periods of life such as spawning or larval growth require a considerable period of temperatures near or about 60°F for the summer.

It should be noted that an abundance of records from any one area does not necessarily signify a heavy population in the area but merely that numerous collectors have made reports on the fauna from there due to its accessibility. The numerous records from the East Indies result mainly from the detailed work of the Siboga Expedition. There is no data providing information useful in judging the relative concentration of individuals in the different areas that have been studied. Several investigators have reported snapping shrimp from the Tokyo Bay area, some stating that they are common there, but since the area is situated near the northern limit of distribution where limiting factors are beginning to be felt, the population may be small especially outside the bay. That a diminution of high frequency ambient noise occurs near the northern margin of shrimp distribution on the open coast is shown by sound measurements taken on both the east and west coasts of the United States (Refs. 3 - 6).

Since the locality records shown in Figs. 1 and 2 were plotted, the U. S. Navy has conducted certain sound investigations in which Mr. W. E. Loomis of the Naval Ordnance Laboratory has obtained sound measurements at four widely separate areas in the central and southwest Pacific. The high level ambient noise characteristic of shrimp crackle was encountered at several points in each of these areas. This was true in localities designated specifically in the present report as harboring snapping shrimp and also in localities from which biological reports are not available but which lie within the designated geographic and oceanographic range of the animals.

The problem as to whether or not a specific locality will be characterized by shrimp crackle can only be decided when the depth and character of the bottom are taken into account as well as the geographic distribution of the noise-producing shrimps. Navigational charts will supply some information on bottom character, and greater detail for certain areas of the western Pacific can be obtained from special Bottom Sediment Charts published by the Hydrographic Office.

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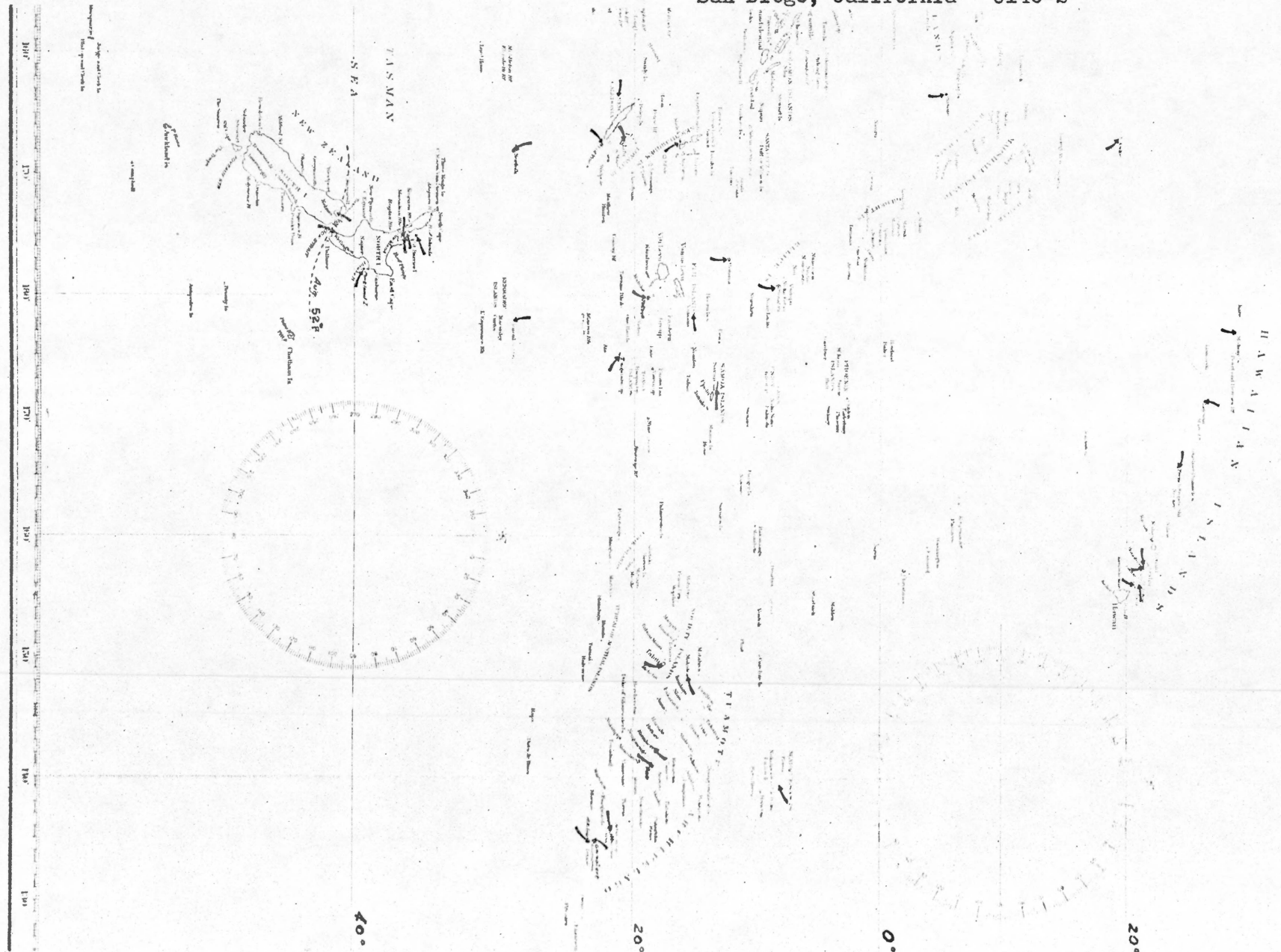
C O N F I D E N T I A L

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3. PRELIMINARY SURVEY OF CERTAIN BIOLOGICAL UNDERWATER SOUNDS ON THE EAST COAST OF NORTH AMERICA, Martin W. Johnson (UCDWR No. U63, May 25, 1943).
4. A SURVEY OF BIOLOGICAL UNDERWATER NOISES OFF THE COAST OF CALIFORNIA AND IN UPPER PUGET SOUND, Martin W. Johnson (UCDWR No. U100, September 10, 1943).
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The arrows denote locations where noise-producing species of snapping shrimp (*Crangon* and *Squalpheus*) are known to occur.

FIG. 2

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The arrows denote locations where noise-producing species of snapping shrimp (*Crangon* and *Synalpheus*) are known to occur.