Can *Halobates* dodge nets? I: By daylight?[1]

ABSTRACT

The frequency of occurrence of the ocean-strider (*Halobates* spp.), taken in surface plankton samples during the EASTROPAC project, is lower in daytime than at night. The analyses indicate that these insects can see and often avoid the mouth of an approaching net.

The genus *Halobates* comprises oceanic insects closely related to the pond-skaters of freshwater lakes and streams; they are the only insects known to live in the open ocean. Of the 39 described species, many are endemic to island groups, but five are common in the open oceans (Herring 1961). The distributions of the open-ocean species in the Pacific (Savilov 1967; Cheng 1971*a*), Indian (Cheng 1971*b*), and Atlantic (Scheltema 1968; Cheng 1972) Oceans have been discussed elsewhere, although details of the distribution pattern of some species are far from complete. In spite of the early discovery of their existence, little information on the biology of these curious insects has been added to the literature since the *Challenger* expedition of 100 years ago. A review of presently available information on *Halobates* (Cheng 1973) reveals that much remains to be learned.

The ocean-striders live entirely on the surface of the sea and do not fly, since they are wingless. They are small—about 5 mm in body length—with long powerful middle and hind legs and shorter front legs modified for grasping prey. They are capable of moving at speeds of 50–100 cm sec^{-1}. Their freshwater relatives (e.g. *Gerris* spp.) are quick, agile, and often difficult to collect with a pond net.

This paper presents evidence for active net avoidance by ocean-striders, based on analyses of catch data.

I wish to thank A. Longhurst and the staff of the National Marine Fisheries Service, La Jolla, for making the samples available, and C. Love for providing much useful information and other assistance. I am grateful to M. Bartley for helping to sort the samples and M. M. Mullin for critical comments on the manuscript.

MATERIAL AND METHODS

The material used in this study was collected during the EASTROPAC project coordinated by the National Marine Fisheries Service (NMFS) at La Jolla, California. There were seven cruises, during each of which a variety of chemical, physical, biological, and meteorological measurements and samples were routinely collected. Preliminary information on station locations, types of observations, participating ships, and area surveyed was published by the NMFS in a number of EASTROPAC information papers. Detailed results of the various properties are being published in a series of EASTROPAC atlases. The results reported here have not been included in any of these publications.

The investigations took place between January 1967 and April 1968. Of the seven cruise periods (series 10–70) five were of about 2 months' duration, but the first and the last were about 3 months long. Series 10, 40, and 70 surveyed an area between 20°N to 20°S latitude, extending from the coasts of the American continents to 119° W longitude. Series 20, 30, 50, and 60 covered as wide an area but only extended from 20°N to 5°S.

Variations of sampling procedures, times, and locations may present difficulties in comparative studies of two or more sets of samples. The methods for collecting the samples in this study were standardized. At each station usually two night and two day samples were collected; thus each night sample had a corresponding day sample, taken at the same station on the same day.

The *Halobates* samples studied were all collected by horizontal surface plankton hauls. A circular net, 1 m in mouth diameter, was towed half-submerged, on one side of the ship, for about 20 min at a speed of 2.5–3.5 km hr^{-1}, thus covering an area of about 1,000 m^2 during each tow.

[1] This work was partly supported by a research grant from the Academic Senate, University of California, San Diego.

Table 1. Duration of sampling period, total number of surface samples collected during each series, and number and percentages of samples containing Halobates

Series	Duration of sampling (1967-68)	Total No. surface samples	No. of samples with *Halobates*	Percentage containing *Halobates*
10	28 Jan-1 Apr	477	175	36.7
20	13 Apr-26 May	128	52	40.6
30	16 Jun-27 Jul	127	26	20.5
40	1 Aug-23 Sep	241	56	23.2
50	20 Oct-27 Nov	169	45	26.6
60	21 Dec-29 Jan	124	31	25.0
70	31 Jan-18 Apr	383	113	29.5

During stormy sea conditions the net was sometimes completely submerged, since it had no floats, and thus sampled the ocean surface only intermittently. Under such conditions population densities of these surface-dwelling insects tend to be underestimated.

A total of 1,649 surface samples were examined for *Halobates*; half (822) were collected during the day (between 0600 and 1800 hours) and the others at night. Although the exact time when the nets were towed varied from sample to sample, about 90% of the day samples were taken between 0800–1100 or between 1400–1700 hours, and 90% of the night samples were collected between 2000–2300 or 0200–0500 hours. Fewer than 10 samples were collected around 0600 or 1800 hours and in most cases it was fairly easy to distinguish each as either a "day" or a "night" sample.

ANALYSES OF DATA

In the area studied, four *Halobates* species occur: *H. micans, H. sericeus, H. splendens,* and *H. sobrinus.* No attempts are made here to separate the data according to species, ages, or sexes, since the purpose is to investigate the general net avoidance behavior of these insects.

At least 20% of the samples collected at all times of the year contained *Halobates* (Table 1). They are evidently rather common ocean surface organisms. Since each series covered a different period of time, the data have been broken down on a monthly basis to facilitate comparison (Table 2). The numbers for January 1967

Table 2. Total number of surface samples, percentages of day and night samples, and percentage of each type of sample containing Halobates

	Surface samples		Day samples		Night samples	
(1967-68)	No.	%positive	% of total	%positive	% of total	%positive
Feb	288	32.6	50.3	24.8	49.7	40.5
Mar	178	40.4	51.1	26.3	48.9	55.1
Apr	63	39.6	46.0	27.5	54.0	50.0
May	66	42.4	50.0	24.2	50.0	60.6
Jun	46	17.4	50.0	8.7	50.0	26.1
Jul	81	22.2	48.1	7.7	51.9	35.7
Aug	137	25.5	50.3	18.8	49.7	32.3
Sep	104	20.1	51.9	13.0	48.1	28.0
Oct	41	22.0	51.2	0.0	48.8	45.0
Nov	128	28.1	52.3	22.3	47.7	34.4
Dec	36	22.2	50.0	0.0	50.0	44.4
Jan	92	25.0	48.9	22.2	51.1	27.6
Feb	133	29.3	47.3	20.6	52.7	37.1
Mar	156	32.7	48.7	11.8	51.3	52.5
Apr	90	25.5	48.9	15.9	51.1	34.7

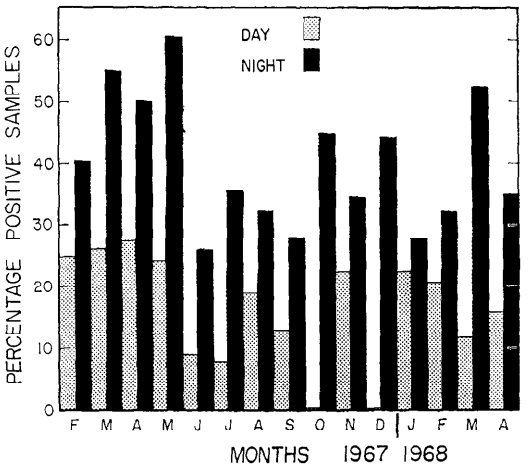

Fig. 1. Percentage of monthly samples (day and night) from the tropical Pacific containing *Halobates*.

have been omitted since only 10 samples were collected in that month.

These insects have well-developed eyes, and one might expect them to be able to perceive and perhaps to avoid nets during daylight hours. For this reason a comparison was made of the percentages of positive catches by day and by night (Fig. 1). The monthly mean positive percentage was 16.3 among day samples, among night samples it was 40.3.

DISCUSSION

The relatively lower numbers of *Halobates* collected during daylight hours can be attributed to visual avoidance of the net. Avoidance of nets is well known among planktonic animals, especially small fishes. A discussion of this subject, together with references on avoidance of sampling devices by various planktonic animals, was published by Clutter and Anraku (1968). However, the case of *Halobates* is somewhat different because these animals live entirely on the surface of the ocean, being virtually confined to a two-dimensional environment. The problem of detecting net avoidance is thereby simpler, since we do not have to consider vertical migration and other problems related to the water column.

How *Halobates* avoids being caught by surface plankton nets probably involves several factors. These insects, like their freshwater cousins, probably detect their prey by vision. When alarmed, they can jump 5–10 cm above the water surface, so it would presumably not be too difficult for them to avoid an oncoming net if they can see it. Furthermore, since the nets are towed at about the speed at which these insects move, it would be reasonable to assume that they could often dodge approaching nets. It would be interesting to compare the results reported here with others from samples collected at a faster towing speed.

The data suggest that in the daytime *Halobates* can see and tend to avoid approaching nets. Consequently, population densities of these insects, based on daytime samples, may be underestimated by a factor of 2 or 3.

LANNA CHENG

Marine Life Research Group
Scripps Institution of Oceanography
University of California, San Diego
La Jolla 92037

REFERENCES

CHENG, L. 1971*a*. Ocean-striders from Melanesia (Hemiptera:Gerridae, *Halobates* spp.). Cah. ORSTOM, Ser. Oceanogr. **9**: 513–518.

———. 1971*b*. The ocean-strider *Halobates* (Gerridae:Heteroptera), p. 125–126. [Abstr.] Proc. Symp. Indian Ocean and Adjacent Seas.

———. 1972. The ocean-strider *Halobates* (Heteroptera:Gerridae) in the Atlantic Ocean [in Russian]. Okeanologiya. In press.

———. 1973. *Halobates*. Oceanogr. Mar. Biol. Annu. Rev. **11**: 223–225.

CLUTTER, R. I., AND M. ANRAKU. 1968. Avoidance of samplers, p. 57–76. *In* D. I. Tranter [ed.], Zooplankton sampling, part 1. UNESCO Monogr. Oceanogr. Meth. 2.

HERRING, J. L. 1961. The genus *Halobates* (Hemiptera:Gerridae). Pac. Insects **3**: 223–305.

SAVILOV, A. I. 1967. Oceanic insects of the genus *Halobates* (Hemiptera:Gerridae) in the Pacific. Oceanology **7**: 252–260.

SCHELTEMA, R. A. 1968. Ocean insects. Oceanus **14**: 8–12.

Submitted: 19 October 1972
Accepted: 6 March 1973