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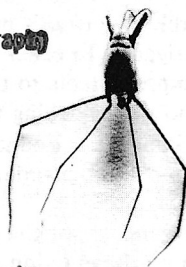
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SKATERS OF THE SEAS

THERE IS SOMETHING romantic about the thought of a drifting, rudderless craft tossing on the sea, at the mercy of wind, waves, and weather. All maritime peoples have tales of such vessels, some more authentic than others. The vicarious excitement invoked by the cruise of KONA TIKI provided a recent example. The plight of an insect blown out to sea would seem even more hopeless than that of a floating raft like KONA TIKI; surely such a creature would be doomed to a watery grave, if it isn't eaten first. And yet, there are insects which have deliberately chosen to make the high seas their home, and which must at all costs avoid being beached if they are to survive. These are the ocean striders (*Halobates*), hardy bugs closely related to the more familiar pond skaters (*Gerris*) of inland waters. They spend their whole lives afloat at sea, skating over the surface of the water. Lacking the ability to fly, they are precluded from the extra dimension which constitutes the aerial world of most winged insects. Nonetheless, by some miracle they survive, and in some areas they even abound. They certainly deserve to be better known. An account of what little we know about this insect, the miraculous *Halobates*, and its undulant, two-dimensional habitat is long overdue. How much we still have to learn about these enigmatic animals will soon be apparent.

About 150 years ago, a young Estonian by the name of Johann Friedrich Eschscholtz sailed around the world on the Russian research vessel RURIK, under the command of Captain Otto von Kot-

zebue. During the three-year cruise he apparently became the first to observe and record scientifically the existence of insects in the open ocean. He named the genus *Halobates* and described three species—*H. micans*, *H. sericeus*, and *H. flaviventris*. Following Eschscholtz's discovery, other marine scientists found several more species of *Halobates* and made some general observations on their biology. It was not until 1883, however, some sixty years after the first discovery, that a monograph of these curious oceanic insects was prepared. In that year the British entomologist Buchanan White produced an 82-page review, describing all eleven species known at that time together with keys, references, and illustrations. During the famous CHALLENGER expedition Sir John Murray also made some notes on the biology of these bugs, which were subsequently published in the narrative of the voyage in 1885.

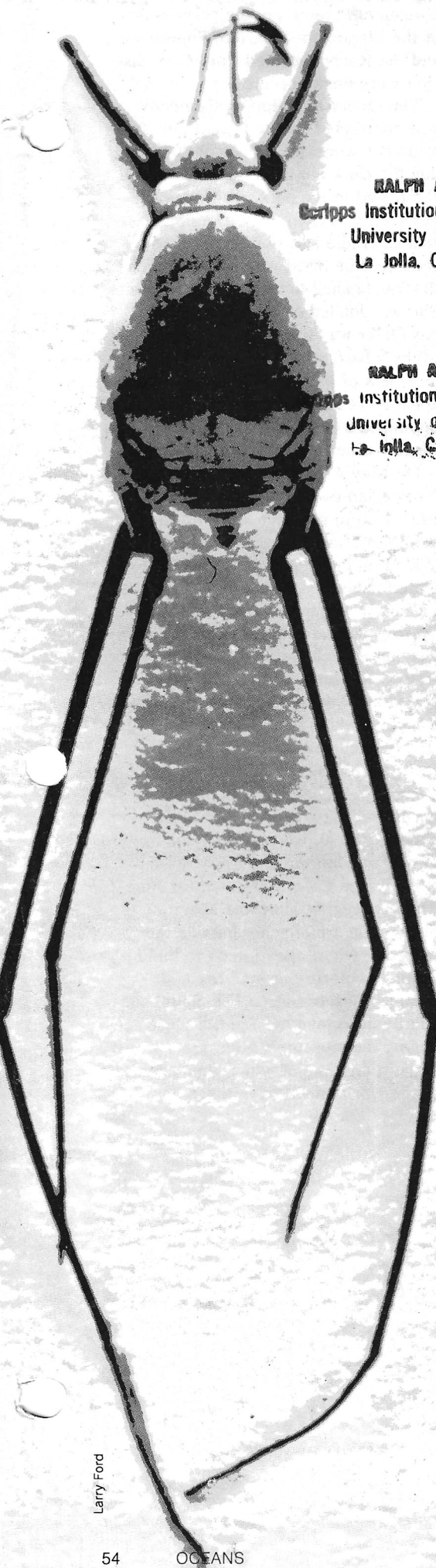
Although time and again these curious little creatures have attracted the attention of seagoing scientists and naturalists, so far no comprehensive study of their biology has been published. Their taxonomy, however, has already been resolved, thanks to the efforts of Jon Herring in 1961. We now recognize some 39 species of *Halobates*, although many of them are known only from a few museum specimens.

Distribution

At least one species, *Halobates micans*, is cosmopolitan, distributed widely in the Pacific, Indian, and Atlantic oceans. In some parts of the sea, specimens of this insect have been caught by the hundreds within fifteen or twenty minutes' collecting. It is the only known species of ocean skater in the Atlantic, but a dozen or so species have been found in the Indian Ocean. The Pacific Ocean has by far the greatest variety of *Halobates*: no fewer than twenty species have been reported, though many are rather restricted in their distribution to single islands or island groups. Only five of these species are known to venture into the distant parts of the Pacific, hundreds of miles from land. In conclusion, all we can say is that some species of *Halobates* stay close to land but others seem to keep away from coasts; some are widely distributed in the oceans while others are not. The determining factors limiting their distributions in this way have yet to be resolved.

Where are they found?

These skaters live exclusively on the surface of the ocean. Since they never possess wings at any stage of their life, they are either carried passively by surface



currents or actively "walk" on the waves. Some of them are found in tropical lagoons among mangrove roots or near the seashore. Others are commonly seen as silvery specks hopping over the surface in the open ocean, being especially conspicuous in calm weather. The adults of most species are black or dark brown with pale markings. Their silvery appearance is due to the layer of air trapped by the velvety body covering.

What do they eat?

Like all other members of the insect order Hemiptera, they suck their food in liquid form, feeding on body fluids of various marine animals such as jellyfishes (*Portia*), by-the-wind sailors (*Veleva*), and Portuguese men-of-war (*Physalia*). We don't know how they find their food: whether they "smell" their prey from afar or whether they just wait until they bump into it. Once they have found a victim, they hang onto it by their front legs, which are specially adapted for grasping. They then run their cone-shaped proboscis over the body until they locate a suitable point of penetration. The cutting mandibles are released and used to puncture the skin; the feeding tube, formed by two long, thin, flexible maxillae, is then inserted; and with the help of muscular pumps food is sucked into a "crop" in the thoracic region. Freshwater bug species, which feed on land insects, liquefy much of their prey's body fluids with digestive juices secreted by well-developed salivary glands, before sucking them up. Presumably the same is true of their oceanic relatives.

We are not sure whether the young nymphs, with tiny bodies only about one millimeter long, also feed on the same relatively gigantic coelenterates as do the adults. Alternatively, it is possible they might be able to utilize nutrients from the rich organic surface film of the ocean,

but this point needs to be studied "in the field."

What eats them?

Until a study carried out and published by Ashmole and Ashmole in 1967, we had no definite information as to what might feed on ocean skaters. These authors found *Halobates* in the stomachs of two species of seabirds, the phoenix petrel (*Pterodroma alba*) and the blue-gray noddy (*Procelsterna cerulea*). I, too, have recently found parts and even intact specimens of *Halobates* in the stomachs of the blue-gray noddy. In a few cases, the stomach contents consisted entirely of such insects. Since these observations are rather limited in terms of the numbers and species of seabirds examined and the localities where they were collected, we still can't say whether any seabird feeds regularly on these ocean striders. A much more extensive study of bird stomach contents needs to be carried out.

There is no apparent information in the literature as to whether any of the surface-feeding fishes take ocean striders. The flying fishes and myctophids (lantern fishes) are likely predators—many myctophids are known to feed on land insects blown out to sea—but to date the stomachs of none have been examined for *Halobates*. I have found no fish or amphibian (except for a species of frog found by John Bullock on Pulau Tioman, an island off Malaysia) which feeds on gerriids in any freshwater habitats. Since some species of skaters, especially the larger ones, have a noticeably unpleasant odor, we can postulate that they may be generally unpalatable to animals.

What do they do?

We know very little about what these insects do in the ocean. Their freshwater relatives spend quite a lot of time preening themselves—running their front or middle legs over their antennae, hind legs, and the rest of the body; this may serve to clean the body surface of dust particles as well as to spread some water-repellent substance yet to be identified. They also spend a lot of time skating up and down stream, probably in search of food. The adults, as in all other insects, are concerned primarily with propagating the species. Mating takes place when a male finds a receptive female who will allow him to ride on her back while she carries on with her everyday activities, feeding or skating as the case may be. The pair stays in copula for fifteen to twenty minutes. Whether the oceanic skaters behave in the same way is not known. They have been observed to

preen, but attempts to feed and rear them in the laboratory have not yet been successful. Herring, who was able to rear one of the coastal species in Hawaii, found that they fed readily on land insects much in the same way as do their freshwater relatives. He was not able to induce any of the open-ocean species to feed on land insects, though they readily sucked at sea anemones.

Mature females accumulate up to 25 to 30 eggs in their body cavity. In such cases much of the thoracic region as well as the abdomen is packed with eggs, leaving little room for anything else. Whether the females lay only one or several batches of eggs is not known. Females of coastal species, like their freshwater cousins, deposit their eggs on some kind of fixed substrate such as coral or rock, usually several millimeters below the water surface. The open-ocean females must often have trouble finding suitable substrates for their eggs, which they attach to all kinds of floating objects—wood, cork, empty seashells, seeds, feathers, and even tar lumps. In one instance some eggs were found to have been laid on the back of a younger nymph!

In the freshwater species studied, the male usually dies a few days after mating, while the female matures her eggs and dies shortly after laying them. Sex-ratio data suggest this may be true also of the oceanic species.

The eggs are oval and approximately one millimeter long when laid. They take about ten days to hatch, but the period depends very much on the ambient temperature. Although the nymphs presumably often hatch underwater, they soon break the surface by swimming actively. The young hatchlings, also about one millimeter in length, are pale brown with dark brown patterning. How these tiny nymphs manage to molt and how long each stage lasts is not known. In all, there are five nymphal stages. Since the attempts to rear ocean striders in the laboratory have been unsuccessful, further studies of their life history may have to be carried out on board research vessels.

We certainly have a lot more to learn about these unique and curious little creatures, which represent the only members of the otherwise almost ubiquitous class Insecta to brave the ever-changing oceans.

I should like to express thanks to Mr. Larry Ford, of the Scripps Institution of Oceanography, for photographic assistance, and to the Academic Senate of the University of California, San Diego, for a research grant.

Eggs of *Halobates* on a floating feather (the scale is in millimeters).

