Biological Notes on the Pelagic Water Striders (Halobates) of the Hawaiian Islands, with Description of a New Species from Waikiki (Gerridae, Hemiptera)

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Halobates sericeus Eschscholtz has long been known from Hawaiian waters where it occurs on the surface of the open ocean or in the channels between the various islands. However, collections have more frequently been made after "Kona" storms when the bugs are swept up onto the beach at Waikiki by strong winds from the South. In an attempt to collect them under more placid conditions I had occasion to investigate the waters at Waikiki with the Marine Laboratory of the University of Hawaii as a base. Dr. C. H. Edmondson was a constant source of help and encouragement during the course of the investigation for which I am most grateful. Mr. W. E. China very kindly supplied a pair of *Halobates flaviventris* Eschscholtz from the collection of the British Museum of Natural History, thus greatly facilitating the establishment of the systematic position of the new species which was discovered.

ECOLOGY

As mentioned above, *Halobates sericeus* appears to inhabit the open ocean between the various islands. I have never encountered it within the protecting reefs near shore except during or right after severe storms when hundreds of stranded individuals may be found hopping about on the beach. Hadden[1] has recorded this at Waikiki during the southern "Kona" storms and Mrs. Violet Fosberg found them under the same circumstances at Kailua on November 30, 1935, after a storm from the North.

Halobates hawaiiensis, the apparently new species described below, occurs under very different conditions. Characteristically gregarious, thousands of nymphs are to be seen swimming about in compact groups within only a few feet of shore at Waikiki, especially in protected places. Adults are less frequently met with and may be seen coursing about individually out in deeper water but evidently always within the protecting reef which is here located about one quarter of a mile from shore. From September 1935 to April 1936 semi-weekly observations were made during which time the bugs were always to be found. There seemed to be no seasonal or tidal fluctuation in numbers but during heavy seas the nymphs

[1] Hadden, F. C. The Pelagic Halobates. Proc. Haw. Ent. Soc., 7:457, 1931.

in particular retreated to protected coves where they were sometimes collected within a few inches of the sea wall.

During most of the period mentioned some specimens were kept in an aquarium approximately four feet long and one foot wide equipped with running sea water. Although such confined conditions were obviously very unsatisfactory for the bugs, certain interesting facts were noted. An initial population of several hundred first instar nymphs usually resulted in three or four adults, as *Halobates* are fiercely cannibalistic. Indeed, the only feeding I ever observed either in captivity or under natural conditions was of this sort. As soon as a bug weakens and is seen to falter it is attacked by its fellows. Flies and other insects recently killed and pieces of fresh crab meat were provided at various times but I never saw a bug feed on this material. It is possible that feeding occurred during darkness, however. Copulation occurred frequently but the females never laid eggs on any of the objects such as pieces of cork, feathers, pieces of wood, etc., provided for the purpose. That an egg must have been laid, however, is obvious from the following incident. During a two weeks trip to another island the rearing was discontinued, the bugs were removed and the water was turned off in the aquarium. Upon my return a single very small first instar nymph was seen swimming on the smooth surface of the water which had been undisturbed for two weeks. From this I conclude that there must have been at least one egg hidden perhaps in a rough coral rock at one end of the aquarium. It is interesting in this connection that no eggs were ever observed on floating objects such as feathers, etc., as described for certain of the species occurring in the open ocean. Fully formed eggs were dissected from gravid females of this and another reef-frequenting species in the Pacific so it is inconceivable that among the thousands of individuals some eggs would not have been laid. A fruitless search was made for eggs concealed along the shore but it is still believed that they will be found in cracks and holes in the rough coral rocks. Delsman[2] has described *Halobates* eggs in great detail and has observed hatching as well as certain embryological details.

Halobates have been collected at sea during the night time by lowering a lantern near the surface, thus suggesting a positive phototropism. Attraction to light was frequently observed in my aquarium, one end of which was next to a window while the remaining portion extended along the wall in comparatively poor light. Whenever a new group of bugs was introduced they all crowded toward the light, jumping over each other and repeatedly bumping against the glass side of the aquarium.

The reputed diving ability of these bugs is a subject of consid-

[2] Delsman, H. C. On the propagation of Halobates. Treubia, 8:384, 1926.

erable controversy. Thus Murray,[3] Walker,[4] and Henry[5] state positively that these bugs dive beneath the surface, while Hay[6] and Delsman[7] were unable, under any circumstances, to induce them to dive. My own observations are as follows. Neither in captivity nor under natural conditions was I ever able to force *Halobates* nymphs or adults to dive beneath the surface. In Micronesia I have stood in shallow water amidst many thousands of these bugs and have tried in every way to frighten them or force them to dive. They jump frequently and may move in this way so quickly that they seem to disappear. On the other hand I took a glass plate and forced a number of individuals a foot or two below the surface, holding them there to observe their actions. They were able to swim with very jerky, awkward movements first downward, thence out beyond the edge of the glass and up toward the surface where they quickly broke through the surface film to freedom.

TAXONOMY

Halobates species have long attracted the attention of voyaging naturalists. Literature on the group was brought together by Buchanan-White in 1883 in his well known Report on the Pelagic Hemiptera of the Challenger Expedition. Since that time a good many names have been proposed, many of which have since been relegated to synonymy. It seems likely that others are destined to a similar fate when the types of inadequately described species are examined. On the other hand recent exploration seems to be turning up many new and perfectly valid species which suggests a much more local distribution than was formerly thought to be the case with these bugs. The recent work of Imms[8] has set a style for more precise descriptions which, in the future, should do much to place the taxonomy of these bugs on a sound basis. The apparently undescribed Hawaiian species is characterized below.

Halobates hawaiiensis Usinger, n. sp.

A large, relatively slender, steel-gray species with the apical three antennal segments in the proportion 13:9:11 in the male and 11:9:12 in the female. The basal segment of the anterior tarsus is shorter than the second, 9½::12½. The mesonotum bears short, scattered, stiff black bristles on either side of the middle while the posterior acetabula are beset with long black bristles dorsally which become quite dense posteriorly. The styliform processes of the male are bent asymmetrically (figures 1 and 2). The ochraceous markings

[3] In Buchanan-White, F. Report on the Pelagic Hemiptera. Rept. Voy. Challenger, p. 73, 1883.

[4] Walker, J. J. On the Genus Halobates and Other Marine Hemiptera. Ent. Mo. Mag., (2) 4:227-232, 1893.

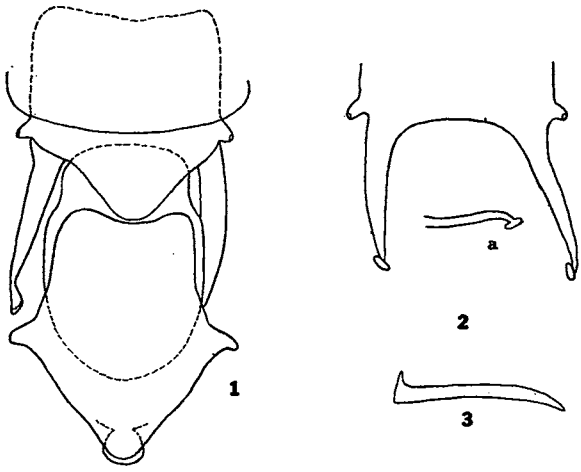
[5] Henry, G. M. Note on the Diving Powers of Halobates. Spolia Zeylanica, 16:353-354, 1932.

[6] In Buchanan-White, F. Report on the Pelagic Hemiptera. Rept. Voy. Challenger, p. 74, 1883.

[7] Delsman, H. C. On the Propagation of Halobates. Treubia, 8:384-388, 1926.

[8] Imms, A. D. Sci. Rept. John Murray Exped., 4:71-78, 7 figs., 1936.

of the ventral surface are confined to portions of the abdomen, the acetabular sutures only appearing slightly pale while the rest of the mesosternum and acetabula are concolorous.



Halobates hawaiiensis

Figure 1, apical abdominal segments of male seen from above.
Figure 2, posterior portion of eighth abdominal segment, ventral view, showing styliform processes, 2a, lobed tip of a styliform process in side view.
Figure 3, paramere in side view.

Male. Antennae less than two thirds as long as body, 71::117, the proportion of segments one to four as 39:13:9:11. Pronotum with sides subrounded, much shorter than head on median line, 9::21, the posterior margin shallowly, concavely arcuate. Mesonotum anteriorly abruptly roundly angled; width just behind anterior angles greater than width of head including eyes, 35::33, gradually increasing in width posteriorly, 35::43, the sides subrectilinear and superficially appearing subparallel; short, stiff, postero-laterally directed black bristles sparsely scattered anteriorly and laterally on dorsal surface and sometimes extending almost to bases of posterior acetabula on either side. Posterior acetabula with longer black bristles becoming quite dense posteriorly. Anterior tarsus with basal segment distinctly shorter than second, 9½::12½. First segment of intermediate tarsus three and one half times as long as second, 46::13. Intermediate femora distinctly longer than posterior femora, 27::23. With only a half a dozen short, stiff bristles on posterior surface of intermediate femora and a much shorter fringe on tibiae and tarsi than in *flaviventris*. Eighth abdominal segment above asymmetrically produced, roundly emarginate on left side of apex and roundly produced a little to the right of middle (figure 1). Styliform processes (figures 1 and 2) very asymmetrical, the left process scarcely longer than the right, bent outward beyond the level of lateral projection at middle of ninth segment, sinuate and partially visible from above. Right process turned inward and consequently invisible at apex as seen from above. Apices of styliform processes lobed (figure 2a). Ninth segment (figure 1) about as broad as long, distinctly,

narrowly, and slightly backwardly produced, the posterior portion with sides nearly rectilinear and distinctly converging, apex subrounded. Parameres very small and apparently alike (figure 3).

Color in great part blue-black with fine gray pubescence, an obscure longitudinal line at middle of dorsum of thorax and base of abdomen, the rostrum, antennae, spots of dorsum of head characteristic of the genus, gula, legs, outer margins of anterior acetabula and genital segments black. Basal markings of head characteristic of the genus and third to seventh abdominal segments below ochraceous, the coloration of venter largely confined to center, the first two segments and sides of segments three to seven as well as bases of seventh and eighth segments brown to black. The eyes and sutures of intermediate acetabula brown. Length 4.87 mm., greatest width 1.79 mm.

Female. Differs from the male in its very much broader form, the sides of mesonotum being more strongly dilated posteriorly and more rounded throughout and the stiff bristles of mesonotal disk longer and more confined to anterior region. Antennae proportionately a little shorter than in the male, length compared with body length 61::102, the proportion of segments one to four as 30:11:9:12. Posterior trochanters each densely provided with stiff black hairs which are backwardly or inwardly directed and longer than greatest diameter of a trochanter.

Color much as in the male but with abdominal segments one to six yellow, seven ochraceous at middle and brownish laterally, the terminal segments black. The sutures and interior margins of intermediate acetabula narrowly ochraceous. Length 4.25 mm., greatest width 2.17 mm.

Holotype, male, Waikiki, Oahu, T. H., Nov. 6, 1935, R. L. Usinger collector. Allotype, female, same locality as type, Sept. 23, 1935. Paratypes: three males, same data as holotype; one male and one female, same data as allotype; two males, Oct. 26, 1935; and one female, Sept. 16, 1935, all collected by the writer; one male, Dec. 21, 1927, M. Maneki collector. A single damaged specimen from the same locality has been seen in the collection of the United States National Museum. Type material deposited in the collection of the B. P. Bishop Museum except for paratypes which are deposited in the British Museum (Natural History), the United State National Museum and my own collection.

There is some variation in the extent of the stiff black bristles of the sides of the thorax. In the paratype collected by Maneki three small bristles are to be seen on the sides of the pronotum and they extend along the entire length of the mesonotum on either side to the bases of the posterior acetabula.

Hawaiiensis runs to the group including *flaviventris, hayanus,* and *proavus* in Buchanan-White's key but differs from all of these in the possession of stiff black bristles of the thoracic disk and posterior acetabula. I know of these bristles only in a species from the Marianas Islands in Micronesia and in an apparently undescribed Polynesian species. *Flaviventris* differs in addition in its more robust form, subequal anterior tarsal segments and flavous under surface of intermediate acetabula. *Hayanus* differs in its smaller size, shorter basal segment of anterior tarsus, yellowish under sides of intermediate acetabula and symmetrical styliform processes.

Other species which might be confused with *hawaiiensis* differ as follows: *micans* has the left styliform process bent abruptly upward; *proavus* differs in its smaller size, especially the male, yellow intermediate acetabula below, very stout styliform processes and (see Esaki, 1926 and 1930)[9] much smaller basal tarsal segment of front leg; *sobrinus* has the eighth abdominal segment above much more strongly produced laterally while the under side of the abdomen is much darker in color; *germanus* is smaller with the bases of the legs reddish brown and the eighth abdominal plate above with rounded sides; *sewelli* differs in the shorter and inwardly directed left styliform process and subrounded sides of eighth abdominal plate; *splendens* has subequal anterior tarsal segments and the second segment of intermediate tarsus is only one sixth as long as first; the Australian *whiteleggei* is smaller with the yellowish color of abdominal area greater in extent, with a shorter basal segment of anterior tarsus and with symmetrical styliform processes; *regalis* differs in its larger size and symmetrical styliform processes.

As mentioned above, the only other species as yet met with in Hawaiian waters is *sericeus,* a species which is only three mm. in length with the second antennal segment scarcely more than one half the length of fourth segment. The first segment of the anterior tarsus is much shorter than the second and the styliform processes are long, slender, and symmetrical. The color is uniform gray with black appendages, eyes, genital segments, etc. while only the two obscure markings of vertex are ochraceous.

During the course of this investigation it was necessary to draw up a list of the described species and their synonyms. Previous lists have been published by Bergroth[10] and Lethierry and Severin[11] toward the close of the last century. So much additional information has accumulated since that time that I have considered it advisable to offer my list in the hope that it will facilitate further work in this group. Only original citations are given except in cases where subsequent papers contain new synonymic or descriptive matter. The localities are often given in rather general terms because many detailed records are certainly based upon misidentification. More specific localities are given for the Pacific where these are fairly certain. Original sources have been checked in all cases except Dahl (1893), Nasonov (1897), and Schadow (1922).

List of the Species of Halobates with Synonymy and Distribution

1. FLAVIVENTRIS Eschscholtz, 1822, Entomographien, 1:109, Tab. II, fig. 5. Esaki, 1928, Ann. Mag. Nat. Hist. (10), 2:513 (=*herdmani* Carpenter).
   herdmani Carpenter, 1906, Ceylon Pearl Oyster Fisheries: Suppl. Rep. 32:151-156, 1 plate.
   Distribution:—Atlantic and Indian Oceans.

[9] See synonymic list below.
[10] Bergroth, E. Revue d'Ent., 12:206, 1893.
[11] Lethierry, L. et Severin, G. Cat. Gén. Hémiptères, 3:65-66, 1896.

2. FORMIDABILIS (Distant), 1910, Ann. Mag. Nat. Hist. (8), 5:147 (*Euratas*).
   Distribution:—Andaman Sea, India.
3. FRAUENFELDANUS B. White, 1883, Rept. Voy. Challenger, Zool., VII, pt. 19, pp. 57-58, Pl. II, fig. 3.
   Distribution:—Indian Ocean.
4. GERMANUS B. White, 1883, Rept. Voy. Challenger, Zool., VII, pt. 19, pp. 50-52, Pl. I, fig. 6.
   Distribution:—Pacific Ocean (New Caledonia), China Sea and Celebes Sea.
   var. BANKAE Griffini, 1895, Boll. Mus. Torino, X, No. 213, p. 3.
   Distribution:—Stretto di Banka.
5. HAYANUS B. White, 1883, Rept. Voy. Challenger, Zool., VII, pt. 19, pp. 52-54, Pl. I, fig. 8. Dahl, 1893, Ergebn. d. Plankton Exped., II, G. a, pp. 6-7 (=*incanus* Witlaczil).
   incanus Witlaczil, 1886, Wien. Ent. Zeit., 5:179-181, fig. 2.
   Distribution:—Red Sea, New Guinea, and Malay Peninsula.
6. INERMIS Dahl, 1893, Ergebn. d. Plankton Exped., II, G. a, pp. 6-7, figs. 4, 5, 7, and 8.
   Distribution:—Atlantic Ocean.
7. JAPONICUS Esaki, 1924, Psyche, 31:115-116, Pl. V, fig. B.
   Distribution:—Japan (Coast of Provinces of Sagami, Kii, and Tosa).
8. KUDRINI Nasonov, 1893, Ent. Researches, Warsaw, pp. 1-24, 1 Plate, figs. 11 and 12 (as var. of *flaviventris*). See Zool. Centralb., 1:702, 1894. Esaki, 1928, Ann. Mag. Nat. Hist., (10), 2:513 (as a distinct species).
   Distribution:—India.
9. MACULATUS Schadow, 1922, Hamburg Univ. Diss., p. 2.
   Distribution:—Bismarck Arch.
10. MARIANNARUM Esaki, 1937, Tenthredo, 1:357, Pl. 31, fig. 1, text-fig. 2.
    Distribution:—Marianas Islands (Rota and Guam).
11. MICANS Eschscholtz, 1822, Entomographien, 1:107, Tab. II, fig. 3. Dahl, 1893, Ergebn. d. Plankton Exped., II, G. a, pp. 6-7 (=*wullerstorffi* Frauenfeld).
    wullerstorffi Frauenfeld, 1867, Verh. K. K. Zool. bot. Ges., Wien, 17:458, Tab. 12.
    Distribution:—Atlantic, Pacific, and Indian Oceans (Palmyra, Marquesas, Formosa, and Galapagos Islands).
12. MJOBERGI Hale, 1925, Ark. Zool., 17 A, No. 20, p. 12, fig. 7.
    Distribution:—Northwestern Australia.
13. PRINCEPS B. White, 1883, Rept. Voy. Challenger, Zool., VII, pt. 19, pp. 44-45, Pl. 1, fig. 3. Esaki, 1926, Ann. Mus. Nat. Hung., 23:133 (=*alluaudi* Bergroth). Esaki, 1928, Insects of Samoa, 2:74 (=*matsumurai* Esaki).
    alluaudi Bergroth, 1893, Revue d'Ent., 12:204-205.
    matsumurai Esaki, 1924, Psyche, 31:117-118, Pl. 5, fig. D.
    Distribution:—Indian and Pacific Oceans (Samoa).
14. PROAVUS B. White, 1883, Rept. Voy. Challenger, Zool., VII, pt. 19, pp. 54-55, Pl. II, fig. 1. Esaki, 1930, Jour. Federated Malay Museums, 16:17, (=*rotundatus* Esaki).
    rotundatus Esaki, 1926, Ann. Mus. Nat. Hung., 23:131-132, fig. 4.
    Distribution:—West Pacific Ocean and Red Sea.
15. REGALIS Carpenter, 1892, Proc. Royal Dublin Soc., 7:144, Tab. 13, figs. 1-8.
    Distribution:—Torres Straits (Island of Mabuiag).

16. ROBUSTUS Barber, 1925, Zoologica, 5:253-254, fig. 50.
Distribution:—Galapagos Islands (Conway Bay, Indefatigable Island).
17. SERICEUS Eschscholtz, 1822, Entomographien, 1:108, Tab. II, fig. 4.
Distribution:—Pacific and Atlantic Oceans (Hawaii).
18. SEWELLI Imms, 1936, Sci. Rept. John Murray Exped., IV, No. 2, pp. 71-78, 7 figs.
Distribution:—Gulf of Oman, Red Sea.
19. SEXUALIS Distant, 1903, Fascic. Malayenses, Zoology, 1:258, Pl. XV, fig. 10.
Distribution:—Malay States (Estuary of Jambu River).
20. SHIRANUI Esaki, Psyche, 1924, 31:114-115, Pl. 5, fig. C.
Distribution:—Japan (On Coast of East China Sea, Province of Hizen).
21. SOBRINUS B. White, 1883, Rept. Voy. Challenger, Zool., VII, pt. 19, pp. 46-47, Pl. 1, fig. 5.
Distribution:—Pacific Ocean (Tahiti, Marquesas, and Tuamotus).
22. SPLENDENS Witlaczil, 1886, Wien. Ent. Zeit., 5:178, fig. 1.
Distribution:—Pacific Ocean near the Galapagos.
23. STREATFIELDANUS Templeton, 1836, Trans. Ent. Soc. Lond., 1:230, Pl. 22, fig. A.
Distribution:—Atlantic Ocean.
var. MAGENTAE Griffini, 1895, Bol. Mus. Torino, X, No. 213, p. 4.
Distribution:—Mare di Valparaiso and Mare del Chili.
24. WHITELEGGEI Skuse, 1891, Rec. Austr. Mus., 1:174-177, Pl. 27, 10 figs. Skuse, 1892, Rec. Austr. Mus., 2:44 and 45.
Distribution:—East Coast of Australia.

APPENDIX

Since the above manuscript was submitted, an abstract of Schadow's paper entitled "Die Gattung Halobates Esch. und die Beziehungen der Meeres- und Susswasser-hydrometriden zueinander", Hamburg University Dissertation, 1922, 5 pages, has come to hand thanks to the exchange facilities of the University of California Library. The paper is divided into three Abschnitten: the first dealing with systematics, synonymizing *H. inermis* Dahl with *H. micans* Esch., and describing *H. maculatus* n. sp.; the second dealing with the geographical distribution of *Halobates;* and the third analysing the relationships between the oceanic and fresh water Hydrometridae [Gerridae]. The original description of *Halobates maculatus* Schadow, is copied below for the convenience of those who may not have access to the original work.

"Mittelschenkel mit vielen kräftigen Dornen zwischen den Haaren; Fühlerglieder 1-3 mit einzelnen längeren, starken Dornen zwischen den gewöhnlichen; 2. Vorderfussglied über 3 mal so lang als das erste; distales Drittel des ersten Mittelfussgliedes ohne Langborsten; gelbe Kopfflecke auffallend gross, ihre Vorderecken in Höhe des vorderen Augenrandes.

Länge: Männchen 2,1-2,3 mm, Weibchen 3,0 mm.

Breite: Männchen 1,3-1,4 mm, Weibchen 1,9-2,0 mm.

Anzahl der untersuchten Stücke: 3 Männchen, 3 Weibchen.

Fundort: Bismarckarchipel: 'St. Matthias, Ekalin, im Baumschatten auf einem Salzwasser unmittelbar am Ufer.' (Dr. Dunker.) Ekalin ist ein kleines Korallenriff mitten im Ozean."