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SCIENTIFIC NOTE

Notes on Flight and Respiration at the Water Surface by *Hygrotus salinarius* (Wallis) (Coleoptera: Dytiscidae)

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It is a widely known, but rarely published, observation that no aquatic beetles are known to take flight from the water surface except the subaquatic Heteroceridae (Clarke 1973). This is true of diving beetles (Coleoptera: Dytiscidae) with most required to first crawl from the water onto the shoreline or emergent objects or vegetation where they rest and dry before flying. This paper documents the first published observations of an aquatic beetle, *Hygrotus salinarius* (Wallis, 1924), emerging through the surface film in open water and taking flight.

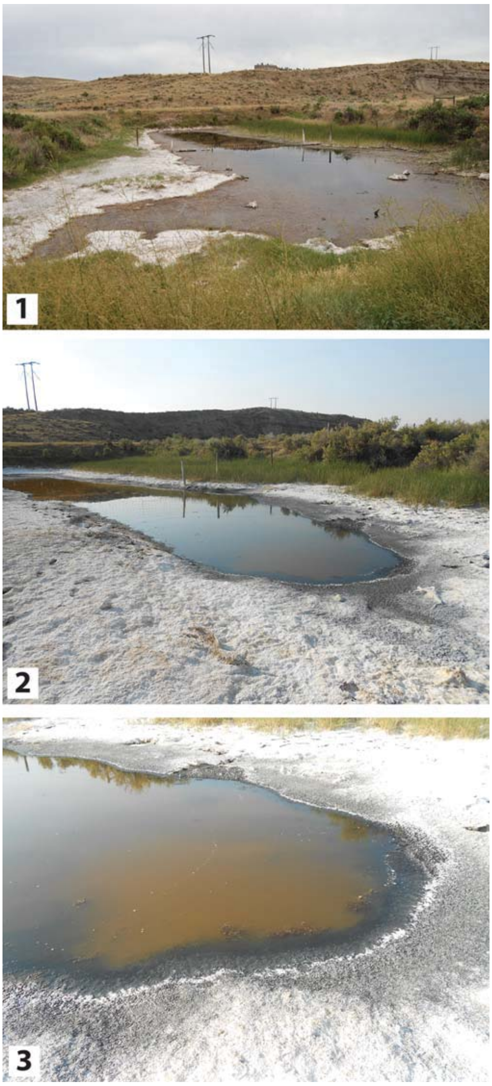
Specimens of *H. salinarius* were observed at a small, hypersaline pool (Figs. 1–3; locality data: USA: Wyoming, Natrona Co, 12.8 km S Midwest, N43.293711°, W106.272979°). Observations were made on two different dates, 8 August 2008 (Fig. 1) and a return collecting trip on 25 August 2012 (Figs. 2–3). Specimens were collected with a standard D-frame aquatic net, removed from the net and placed in a small plastic container with water from the pool for observation. Numerous specimens (>15) were observed on the 2008 date. On the 2012 date, six specimens were observed. The pool was substantially smaller in 2012 (Figs. 2–3) than in 2008 (Fig. 1), which may explain the fewer specimens despite an extensive search at the site. Notes were made in the field on the beetle behavior described here. Vouchers were deposited in the Museum of Southwestern Biology Division of Arthropods (MSBA) at the University of New Mexico, Albuquerque, New Mexico, USA.

Numerous specimens (>15) in 2008 and one specimen in 2012 were observed to fly from the water surface. When placed in the container of water, these specimens immediately swam swiftly and erratically underwater for a few seconds before swimming to the surface where they oriented their bodies horizontally to the water surface and extended each of the three pairs of legs laterally and up into the water surface film. The beetles then slowly rose above the surface film of water by extending the legs ventrally under the body to raise the ventral surface of the body above the surface film. At this time, the beetle immediately spread the elytra and metathoracic wings and flew.

During the first observations (in 2008), each observed beetle actively breached the surface film and flew as described above. During the second observations (in 2012), most of the beetles remained underwater and did not attempt to leave the water. These beetles behaved more typically of other members of *Hygrotus* Stephens in swimming around under the water surface. However, unlike most diving beetles, which extend the apex of the abdomen and elytral apices through the surface film of the water to replenish the air beneath the elytra, these individuals behaved differently. A beetle swam to the water surface, rolled to one side or the other, extended the legs of the upward side through the surface of the water, and rolled over until the ventral surface extended upward. At this point, the entire ventral surface of the beetle extended above the water line, including the apex of the abdomen where it presumably replenished the air under its elytra. It then quickly swam back under the water and righted itself using thrusting movements of the metathoracic legs.

Additional species of *Hygrotus* found at this site in 2008 included *Hygrotus infuscatus* (Sharp) and *Hygrotus sellatus* (LeConte). Only *H. salinarius* specimens were found there in 2012. Specimens of both *H. infuscatus* and *H. sellatus* were placed in the collecting container, but none of these were observed leaving the water in the way described above for *H. salinarius.*

Hygrotus salinarius is one of several halotolerant diving beetle species in the genus that are found in small lentic habitats, including hypersaline pools, in central and western North America (Rawson and Moore 1944; Larson 1975; Tones 1978; Anderson 1983; Lancaster and Scudder 1987; Timms and Hammer 1988; Larson *et al*. 2000).



Figs. 1–3. Hypersaline habitat of *Hygrotus salinarius*, Wyoming, Natrona County, 12.8 km S Midwest. **1)** Site on 2008 collecting date; **2** and **3)** Site on 2012 collecting date.

Hygrotus salinarius specimens can withstand an exceptional range of salt concentrations, from 12–71 gL^{-1} (Timms and Hammer 1988).

It is well known that dissolved inorganic salts can increase the surface tension of water which may make it more difficult for insects to move through it. The degree to which dissolved salts affect surface tension depends, at least in part, on temperature and the concentration of the dissolved salts at the water surface which may be different from the bulk of the water. Temperature and concentration of salts at the water surface were not measured in the *H. salinarius* habitat documented here. Nevertheless, it seems likely that *H. salinarius* specimens experience, at least at certain times, greater surface tension in this habitat type than other species of diving beetles in less saline environments. This may make movement through the surface film more difficult, but it may also make it easier for these beetles to use the surface tension to elevate themselves above the water surface to escape using flight.

Diving beetles must traverse the surface film to enter a body of water as well, and small beetles may have particular difficulty doing so and become trapped. Certain groups have developed techniques for moving through the surface film when first entering a water body (Brancucci 1977; Dettner 1985), and their ability to do so, and to stay under water, may be related in part to the wettability of their cuticle and use of pygidial gland secretions to improve this (Dettner 1985). *Hygrotus salinarius* specimens did not appear to engage in any activities that could be interpreted as the use of glandular constituents to help facilitate moving out of the water through the surface film.

The ability to fly from the water surface may provide an advantage in the temporary habitats typical of this species, which are shallow, usually hypersaline, temporary pools prone to rapid drying. Many of these sites lack emergent structures or vegetation and have extremely low-gradient, muddy shorelines (Figs. 1–2). In these habitats, water beetles that need to crawl out of the water to leave the pool may have difficulty evacuating the water as it dries, whereas *H. salinarius* specimens can leave directly through the water surface.

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