

Terrestrial Adaptations of Crustacea

In the past five years there has been an increasing interest in the adaptive characteristics of crustaceans that have invaded the intertidal zone and the land above the tides. Considerable research on these animals is now under way. Almost all of the investigators currently active in this field of zoological research will convene for the first time at a six-session symposium to be held 27–29 December 1967 during the AAAS annual meeting in New York City. The symposium is dedicated to the memory of Warren J. Gross, who for a number of years was a leading investigator in the field of crustacean terrestrial adaptations.

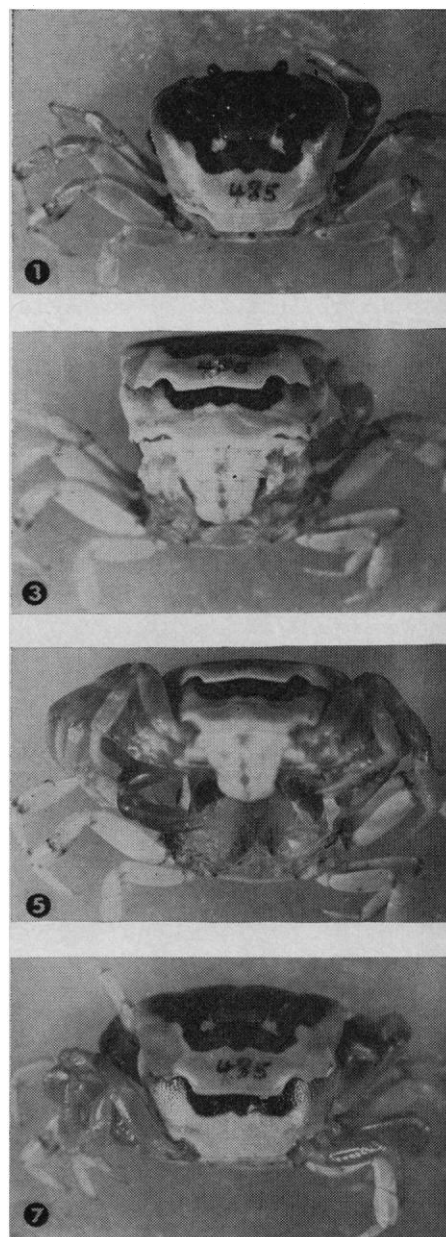
The principal adaptations involved in migration from water to land will be considered. These adaptations relate to osmoregulation, water conservation, and water balance; temperature, respiration, and circulation; metabolism; sensory perception; and behavior. Reflecting this wide range of topics is the broad sponsorship of the symposium. The principal sponsor is the Division of Invertebrate Zoology of the American Society of Zoologists. Cosponsors are the Divisions of Comparative Physiology and of Animal Behavior and Sociobiology of the American Society of Zoologists, the Animal Behavior Society, and the Ecological Society. The National Science Foundation is providing financial support for the symposium through grant GB-6613.

Varying degrees of terrestriality have been achieved by three major groups of crustaceans. E. B. Edney (University of California, Riverside) will review the ways in which the most successful group, the order Isopoda, has accomplished its terrestrial goals. Certain morphological, physiological, and behavioral characteristics of isopods (their running mode of locomotion, their flatness of body, and their capacity for internal fertilization and for brooding their young) have preadapted them for

terrestrial life. Subsequent gains have included a reduction in the rate of transpiration, a modification in the structure of the pleopods, and alterations in modes of sensory perception and in behavior. Significantly, terrestrial isopods have also developed the capacity to brood and raise their young entirely on land, something that no other crustaceans can do.

Much less accomplished in their terrestriality have been members of the order Amphipoda, as Desmond E. Hurley (New Zealand Oceanographic Institute) will point out. These cryptozoic forms, all members of the family Talitridae, are found extensively in the supralittoral zone. From this zone, certain species have invaded the leafmold in areas where the supralittoral debris and leafmold merge. These truly terrestrial forms display few adaptive features, other than a tendency toward loss of pleopods. Thus, these species maintain their terrestriality mainly by remaining within an insulated environmental niche that provides food and moisture.

Falling somewhere between the isopods and the amphipods regarding their success in migrating landward are certain members of the order Decapoda. A number of crayfishes, one family of hermit crabs, and representatives of several families of true crabs have been able not only to colonize the littoral and supralittoral but also in some cases to penetrate far inland into regions where the soil is dry, ground water is unavailable, and rain showers are infrequent. Dorothy E. Bliss (American Museum of Natural History) will show how a reliance upon stringent measures of water conservation and the development of nocturnalism characterize these forms. An important adaptive feature is the capacity of some terrestrial crabs to seize water by contact and move it into the branchial chambers for uptake by the gills. The

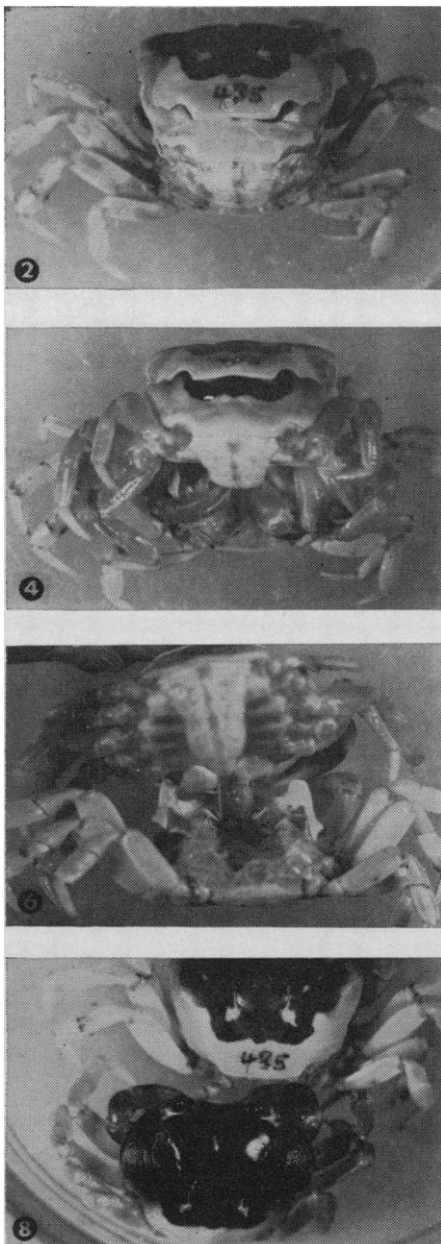


Gecarcinus lateralis, a land crab from Bermuda, Bahamas, and the Caribbean, shown in the process of ecdysis (shedding)

development of organs for the storage of water, notably the pericardial sacs, are features of certain of the more terrestrial crabs.

With the groundwork for the symposium presented by the previously mentioned speakers, the remaining sessions of the symposium will then consider in more detail various aspects of the physiology, ecology, and behavior of terrestrial crustaceans. The papers will deal mainly with isopods and decapods, on which most experimental research has been and is being done.

Thus, the session on osmoregulation and water balance will begin with a paper on the effect of environmental



of the shell). The entire process took about 75 minutes. [Dorothy E. Bliss, American Museum of Natural History]

factors on larval development in the land crab *Cardisoma guanhumi* by John D. Costlow, Jr. and C. G. Bookhout (Duke University). A paper on sodium and water balance in the freshwater crab *Potamon edule* by Paul P. Rudy, Jr. (University of Lancaster) will follow. Two succeeding papers will deal with one of the most terrestrial of crabs, *Gecarcinus lateralis*, which is a tropical and subtropical, primarily insular, form that inhabits very dry, sandy areas. Recent research by D. Eugene Copeland (Tulane University) has implicated in quite different ways both the gills and pericardial sacs of this crab in water uptake. Investigations by Linda Habas Mantel (American

Museum of Natural History) have shown that the foregut of this crab plays an important role in water balance at ecdysis.

Winona B. Vernberg and F. John Vernberg (Duke University Marine Laboratory) will discuss respiratory adaptations of three species of crabs (one from deep water, a second from shallow water, and a third from the beaches between and above the tides). Don Curtis Miller (Union College) and F. John Vernberg will describe how low temperatures can limit the northward distribution of tropical species of the fiddler crab *Uca*, while temperate zone species, which can acclimate to cold, can survive northern temperatures. James R. Redmond (Iowa State University) will discuss oxygen transport in the blood of *Gecarcinus lateralis*, and Leonard Stutman and Marilyn Dolliver of (St. Vincent's Hospital, New York City) will describe the coagulation mechanism in the hemolymph of this same species.

The session on adaptations of metabolism will include a paper by Wolfgang Wieser (Zoologisches Institut der Universität in Innsbruck) on the uptake of food and digestion in terrestrial isopods. Roy Hartenstein (College of Forestry at Syracuse University) will discuss nitrogen metabolism in the terrestrial isopod *Oniscus asellus*. Additional metabolic investigations on land crabs will be included with papers by Charles A. Gifford (Alfred University) on uric acid deposition in *Cardisoma guanhumi* and by John D. O'Connor and Lawrence I. Gilbert on lipid metabolism in *Gecarcinus lateralis*.

The final sessions will be devoted to physiological and behavioral adaptations of terrestrial crustaceans, primarily as such adaptations relate to the conservation of water and to the maintenance of inter- and intra-specific

social contacts, such as courtship and agonistic behavior. Michael R. Warburg (Israel Institute for Biological Research in Ness-Ziona) will describe physiological and behavioral aspects of water conservation in terrestrial isopods, a subject that will be explored further for the crab *Ocypode* by K. Ranga Rao (Andhra University, Visakhapatnam, India). Franklin H. Barnwell (Northwestern University) will describe the role of rhythmic systems in terrestrial adaptations of fiddler crabs, and William Herrnkind (University of Miami) will report on the development of celestial orientation during ontogeny in the same genus of crabs.

In the final session Helen Ghiradella, James Cronshaw, and James Case (University of California, Santa Barbara) will report on their investigations of aesthetasc pegs on the antennules of crabs, the pegs of terrestrial species appearing to be specifically adapted to prevent loss of water. There will follow papers on courtship and agonistic behavior in gecarcinid, grapsid, and ocypodid crabs. Two papers, one by Howard O. Wright (University of Houston) and another by Hermann Schöne (Max-Planck-Institut at Seewiesen) will feature motion pictures. Michael Salmon (University of Illinois) and Samuel Atsides (University of Maryland) will present both motion pictures and tape recordings.

A feature of each session will be a general discussion that is planned for the final 30 to 40 minutes. Such discussion periods will include the physiology, ecology, and behavior not only of crustaceans but also of other arthropods.

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