Biology of the Idaho Lava Tube Beetle, *Glacicavicola*

Stewart B. Peck *

ABSTRACT

Glacicavicola bathyscioides Westcott beetles were kept in laboratory culture. Indirect evidence suggests that the beetles in culture fed on arthropod remains. Of 52 individuals, eight still were alive two years after capture. They may live, in nature, at least 3 years as adults. Immature stages are not known. Some of the caves in which the beetle is presently known to occur probably were occupied less than 2,000 years ago. Their present range, 186 km maximum diameter, was attained during the Wisconsinan glaciation by overland dispersal.

Introduction

The known fauna of lava tube caves consists only of a few specialized animals, contrasting sharply with the rich faunas which have been discovered in limestone caves. Of these few, virtually nothing is known about the general biology and ecology. This note reports aspects of the biology of the unique eyeless beetle *Glacicavicola bathyscioides* Westcott (Coleoptera, Leiodidae). *G. bathyscioides* is known only from cold lava tube caves in Idaho, where it usually is found in association with permanent ice (Fig. 1). The name *bathyscioides* refers to the fact that this beetle bears a striking resemblance to the Bathysciine cave beetles of Europe, even though there is no evidence that these two groups are closely related.

In 1969, I observed the beetles in their natural habitat (Peck, 1970). A total of 52 beetles were captured alive in caves in Craters of the Moon National Monument, Idaho. These were transported to and kept alive in laboratory culture at Harvard University and, later, at Carleton University.

Fig. 1. *Glacicavicola bathyscioides* Westcott from Beauty Cave, Craters of the Moon National Monument, Idaho.

Culture Methods

The beetles were kept in a clear polystyrene plastic box 26 cm wide, 32 cm long, and 11 cm deep with a tight-fitting lid. The bottom of the box was covered with a hardened mixture of equal parts of plaster of paris and powdered wood charcoal. Flat pieces of basaltic lava from the beetles' cave were embedded in the plaster-charcoal substrate; other pieces rested free on the surface. The substrate and the atmosphere above it were kept near saturation by periodic additions of distilled water. The culture box was kept in a refrigerator at 40°F (4.5°C).

Feeding

In nature, the beetles have been observed feeding only on portions of a dead individual of the same species (Westcott, 1968). They have been found aggregating around human dung and decayed meat, possibly for feeding (Peck, 1970). In culture, the beetles were never observed to feed on or to pay any attention to potential food items. Items offered as food were live bakers' yeast, fresh and decayed chicken liver, human dung, freshly killed Phorid and Drosophilid flies, portions of mealworm larvae and pupae, limburger cheese, freshly removed roach heads, Tetramin tropical fish food, and freshly killed terrestrial isopods.

Behavior that could be called exploratory feeding activity was limited to two individual beetles, which were observed to randomly approach a freshly cut fragment of a mealworm larva and place their mouthparts in the haemolymph fluid for four seconds. They then withdrew without palpation or other indications of excitement. Three other beetles walked over the same fragment without stopping or seeming to notice it. There is no other direct evidence of feeding activity. However, indirect evidence of feeding exists. Of the offered potential food, some was moved about the box and dragged under rocks. This happened to the Phorids, Drosophila, roach heads, and isopods. The soft foods (dung, cheese, etc.) were examined for marks of mouthparts, but none were observed. Although not conclusive proof, the above data indicate that the beetles are scavengers on arthropod remains and do not favor other decomposing organic material, such as dung or carrion, for feeding.

Other evidence besides the movement of arthropod remains suggests feeding. Six months after capture, the living beetles (32) were anesthetized with CO_2 and the conditions of their abdomens were observed. Full abdomens, with the tergites fully pressed against the elytra, were found in 14 beetles; half-full abdomens, with tergites only about one half in contact with the elytra, were found in 13 beetles; reduced abdomens, with the tergites entirely free from the elytra, were found in five beetles. Full or partially full

* Department of Biology, Carleton University, Ottawa, Ontario, Canada.

abdomens in 27 out of 32 beetles a half-year after capture suggests that feeding was maintaining the population at or close to a replete condition. The same conclusion was reached with an examination of the beetles which survived to 24 months after capture. Of these, six had maintained a full abdomen.

Longevity

Figure two is a plot of the survival of the original 52 beetles. Seventeen died in the first month, during transport in an ice chest from the cave to the laboratory in Massachusetts. Thereafter, a fairly uniform death rate is encountered. Of the 35 that survived transport to the laboratory, eight (25%) were still alive 23 months later, at which time they were killed. Since the age structure of the initial sample was unknown, a maximum and a mean longevity cannot be determined. An extrapolation of the death rate curve into 1973 suggests that the beetles may live three years or more at their natural cave temperature (which ranges from at least 0° to 4°C). A longer life is indicated if the winter temperatures of the caves fall lower and the beetles' metabolism is thereby further decreased.

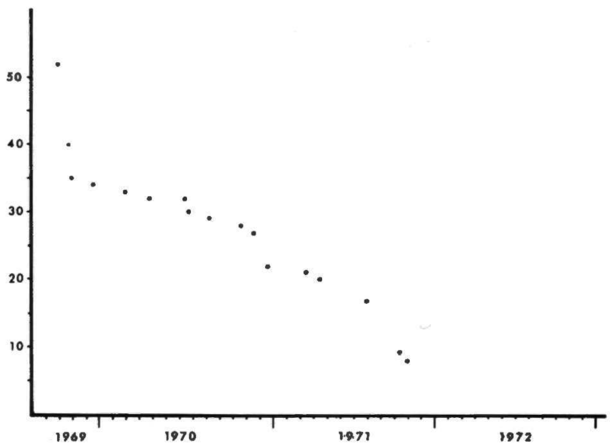

Fig. 2. Population decline in *G. bathyscioides* in culture.

Reproduction

The beetles originally were kept in culture for the principal reason that, if life cycle and larval characteristics could be obtained, these might help to solve the problems of the taxonomic relationship of the beetle. During the 24 months that the beetles were held in captivity, no reproductive behavior and no immature life cycle stages were observed. The culture contained a mixture of both sexes, although females were three times more abundant than males. Successful culture of the beetles may be possible only in one of their native caves.

Due to the lack of larvae, their characteristics cannot be used in solving the problem of relationship. Westcott (1968) erected a new subfamily to hold the genus within the family Leiodidae (sensu latu). This classification still seems best. Although Barr (1968, p. 81) placed this beetle in the family Brathinidae, this possibility now seems very slight as a result of the review of *Brathinus* by Hammond (1971) and of his placement of *Brathinus* in the staphylinid subfamily Omaliinae.

Evolution and Dispersal

Prinz (1970) reported a radio-carbon date of 2,130±130 years BP based on sagebrush charcoal found under the Kings Bowl lava flow. This flow contains Crystal Ice Cave, in which *G. bathyscioides* occurs. The flows (hence, the caves) (Boy Scout and Beauty caves) to the north in Craters of the Moon National Monument are comparable in age to the Kings Bowl flow, judging from their similar degrees of weathering and stages of vegetational succession. A tree ring date of 1,650 years BP in the Monument provided a minimum date for one of the flows. It can be concluded from these dates that the beetles probably have occupied these caves for less than 2,000 years. It is interesting to ask, where they were before that? Their high degree of troglobitic modification indicates that the beetles have had a very long history of cave occupation. Undoubtedly, the immediate sources of colonizers for the young lava tubes were older tubes in the immediate vicinity. New caves probably can be occupied via cracks from older caves as early as a score of years after their formation. New caves have to reach temperature equilibrium with their surroundings, and suitable moisture and food input mechanisms have to be established. This dynamic process of faunal migration from older into younger lava tubes has potentially been going on for a long time in many suitable sets of caves in the western United States. It may have begun as early as the Pliocene, as indicated by the diverse fauna of terrestrial and aquatic troglobites and troglophiles found in these caves. The list is too extensive to present here.

But, what was the original source of the beetles before they colonized lava tubes? It seems most likely that the lava tubes were colonized originally by preadapted *Glacicavicola* ancestors from nearby montane localities. Westcott (1968) suggests the mountainous vicinity where Idaho, Montana, and Wyoming come together. Once the beetles entered the caves, dispersal overland became less likely than dispersal through abundant cracks in the basaltic bedrock.

There are arguments against this interpretation, however. The present range of the beetle is not connected by continuous and suitable basalts, there are intermediate regions which are unsuitable for subterranean dispersal, the maximum diameter of the range (184 km) is very large for a beetle that ecologically and physiologically seems to be restricted to caves and there is a lack of substantial variation between the populations. These considerations suggest a fairly recent overland dispersal, probably during the cooler and wetter Wisconsinan glaciation, from either a montane or a cave habitat.

What would the climate have been like at this time? Unfortunately, there are virtually no data that can be used to answer this paleoclimatological question for the unglaciated Snake River Lava Plain during the late Pleistocene and Recent. Hence, it is very difficult to make any firmly based speculations upon the possible times and conditions of overland dispersal. Conditions may have been somewhat similar to those in western Oregon and western Washington (reviewed by Heusser [1965] for Liberty Lake, Washington in the late Wisconsian glacial and postglacial). There, a lodgepole pine parkland or, perhaps, a treeless tundra-like vegetation existed during the Wisconsinan glacial stage. With glacial retreat and the onset of warmer and dryer climates about 8,000 years BP, the vegetation changed to grasses, composites, and chenopods. This vegetation has persisted until today in an assemblage dominated by *Artemisia* sagebrush and *Agropyron* grass.

Such a vegetation would not seem to be suitable for overland dispersal of the beetle, but the size of the range and the lack of differentiated local populations favor overland acquisition of the present range during the Wisconsin. If the dispersal of *G. bathyscioides* was this recent, we may yet expect to find the beetles in other caves over even a greater area and, perhaps, in montane epigean habitats such as deep, wet talus slopes.

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