THE ABILITY OF AN ARTIFICIAL DIET TO SUSTAIN LARVAE OF EXAPION ULICIS (COLEOPTERA: APIONIDAE) AND THE OCCURRENCE OF PTEROMALUS SEQUESTER (HYMENOPTERA: PTEROMALIDAE) FROM FIELD-COLLECTED LARVAE IN OREGON

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THE ABILITY OF AN ARTIFICIAL DIET TO SUSTAIN LARVAE OF *EXAPION ULICIS* (COLEOPTERA: APIONIDAE) AND THE OCCURRENCE OF *PTEROMALUS SEQUESTER* (HYMENOPTERA: PTEROMALIDAE) FROM FIELD-COLLECTED LARVAE IN OREGON

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Many introduced plants have become invasive, in part, due to the lack of natural seed feeders that contribute to the reduction of seed production. This has led to the introduction of biological control agents (arthropod seed feeders) from the introduced plant area of origin into the invaded countries. Often during the process of importation these agents are debilitated as a result of food contamination and/or the wait over days (often many) while fulfilling quarantine requirements (Fisher & Andrés 1999; Norambuena et al. 2001). Use of artificial diets could reduce losses while in shipment. Artificial diets also allow for collection of the introduced agent and completion of the life cycle in the laboratory. An additional benefit could be that parasitoids of the biocontrol agent would be collected and identified.

The gorse weevil, *Exapion ulicis* (Foster) (Coleoptera: Apionidae) was imported from France in 1953 to California for the control of the invasive legume, gorse (*Ulex europaeus* L.) (Rees et al. 1996). In the United States it is now established in California, Oregon, Washington, and Hawaii (Rees et al. 1996). These weevils are univoltine: eggs are oviposited in seed pods in the spring, larvae feed in the pod for 6-8 weeks, pupate in the seed pods, and the adults emerge in mid-summer and feed on the plants. In California, Oregon, and Washington, 30-90% of the seed pods are attacked but they do not destroy the plants (Rees et al. 1996).

Here we present the results of our study to determine the usefulness of rearing *E. ulicis* on artificial medium. We used eggs and second and third instars of *E. ulicis* extracted from the seeds of *U. europaeus*. Branches with pods were collected in May and Jun, 2004 near Baker Beach, Oregon, USA (44°05'N, 124°08'W) and taken to the USDA laboratories in Corvallis.

We did two experiments. In the first, the suitability of an artificial diet (Fisher & Bruck 2004) originally developed for rearing *Otiorhynchus sulcatus* (F.) (Coleoptera: Curculionidae) was tested for rearing *E. ulicis* by observing the pre-imaginal stages of *E. ulicis* fed on the diet. Eggs (196) were gathered from the pods of 28 plants (average 7.93 ± 4.80/plant). Thereupon an individual egg was placed in one of many small (~3 mm) holes that had been made in a cup (6 cm diam. × 2 cm) of diet These were maintained at 21 ± 0.5°C with a L16:D8-hour photoperiod in controlled growth chambers. Fifty seven larvae (29.08%) hatched but only 7 (12.28%) made it through the second instar. However, none reached the third instar due to molting problems. The time from collection until hatch on the diet was 8.21 ± 0.67 d and the time to develop from the first to second instar was 23.04 ± 1.30 d. A second group of 111 eggs were placed on diet as above and maintained at 24 ± 0.5°C in total darkness. Thirty eggs hatched (27.03%) of which 6 (20%) reached the second instar, but none reached the third instar due to problems with molting. The length of time from collection in the field until egg hatch was 4.71 ± 2.31 d; time from first to second instar was 10.79 ± 4.97 d.

In the second experiment we examined the possibility of obtaining adult *E. ulicis* and their natural parasitoids by rearing field-collected second and third instars on the same diet with controlled environment growth chambers maintained at 24 ± 0.5°C in total darkness. Two hundred and eight second and third instars were individually placed in holes cut in the diet of each of 12 cups (~17-18 larvae/ cup). Overall 34.13% (71) or the average of 33.07 ± 16.12% / cup developed into pupae. Of these pupae, 87.32% (62) or the average of 88.27 ± 27.31%/cup eclosed as adults. Survival from larvae—adult per cup was 27.68 ± 16.14%. Additionally, we obtained 3 pupae of the parasite, *Pteromalus sequester* Walker (Hymenoptera: Pteromalidae). All pupae of the parasitoid developed normally, corresponding to an overall level of parasitism of 1.44% (4.84% of the pupae only). *Pteromalus sequester* is a solitary ectoparasitoid that oviposits on the larvae and pupae of its host (Davies 1928). It develops in the alimentary cavity of the host while it is inside the seed. The adults emerge from the puparium 18-20 days after oviposition (Parnell 1964). *Pteromalus sequester* has been found to parasitize *E. ulicis*, *E. fuscirostre* (F.), *E. compactum* (Desbrochers), *E. laufferi* (Schylsky), *E. putoni* (Brisout, Ch.), and *Bruchidius ater* (Marsham) (Davies 1928; Syrett et al. 1999; Gurrea et al. 1991). In 1997, field studies indicated that 10% of *E. fuscirostre* was parasitized by *P. sequester* (Syrett et al. 1999). They suggested that *P. sequester* may be a factor limiting the effectiveness of *E. fuscirostre*.

We present this note to demonstrate that an agar based diet and controlled environments may

be used successfully for developing *E. ulicis* from the egg phase to the second instar and for feeding and development from second instar to the adult stage. Our study also confirms that *P. sequester* is present on *E. ulicis* in Oregon. In addition we found that *P. sequester* may develop in mature larvae of *E. ulicis* at a temperature of 24 ± 0.5°C while the host is maintained on an artificial medium.

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Summary

Our investigations with *Exapion ulicis* (Foster) indicated that an agar-based diet was adequate for the study of development of *E. ulicis* under controlled conditions. We also confirmed that the parasitoid *Pteromalus sequester* (Walker) was present on *E. ulicis* in Oregon, and that it may develop successfully in mature larvae of *E. ulicis* that have been reared on an artificial diet under controlled conditions.

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