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OBSERVATIONS ON THE BIOLOGY OF TWO SPECIES OF *ORASEMA* (HYMENOPTERA: EUCHARITIDAE)[1]

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Abstract.—Brief descriptions of life history are given for *Orasema coloradensis* and *Orasema viridis* from Idaho and Arizona, respectively. *O. coloradensis* was reared from nests of *Formica subnitens* and both species of *Orasema* were found in association with thrips. Descriptions of the first-instar larvae are made and the larvae compared to other Eucharitidae.

Members of the genus *Orasema* Cameron, like other members of the family Eucharitidae (Hymenoptera: Chalcidoidea), are parasitic upon ant pupae. Adult females lay their eggs into plant tissue, away from the host, and the active first-instar larvae seek adult ant hosts for transport back to the nest (Clausen, 1940). Wheeler (1907) published the first account of the in-nest habits and gave host records for three species of *Orasema.* He provided a sketch of the planidium of *O. viridis* Ashmead, a parasite of *Pheidole kingi instabilis* (Emery), and illustrated the later larval instars in detail. Wheeler and Wheeler (1937) supplied further information on the larval development of two other species, *Orasema sixaolae* Wheeler and Wheeler and *Orasema costaricensis* Wheeler and Wheeler, which parasitize the ants *Solenopsis tenuis* Mayr and *Pheidole flavens* Roger, respectively.

The out-of-nest habits of *Orasema* sp. (near *aenea* Gahan) were first described by Parker (1942) in Argentina. He wrote that adults deposited their eggs in serpentine rows into leaves of a *Muehlenbeckia* (Polygonaceae) and provided descriptions and figures for the planidium and egg (one egg per puncture) as well as details on the oviposition behavior. Das (1963) supplied similar information for *Orasema assectator* Kerrich, which is parasitic on a species of *Pheidole* in India. Again, eggs were deposited in serpentine rows on tea leaves, and although not stated explicitly, Das implies that a single egg is deposited per oviposition puncture. *Orasema costaricensis* was reported to oviposit into young banana fruits (Kerrich, 1963).

Since the host ants of *O. assectator* do not forage on the tea bushes, Das (1963) mentions a possible role for *Empoasca flavescens* (F.) (tea leafhopper) or *Scirtothrips dorsalis* Hood (tea thrips) as intermediate carriers of the planidia. Other

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associations have been suggested between planidia and thrips but no direct evidence of thrips as necessary intermediates has been made (Clausen, 1940; Wilson and Cooley, 1972).

The almost simultaneous discovery and observation of populations of *Orasema coloradensis* Gahan in Idaho (JBJ, TDM, FWM), and *O. viridis* in Arizona (JMH) offered an opportunity to study the biology of this genus.

Methods

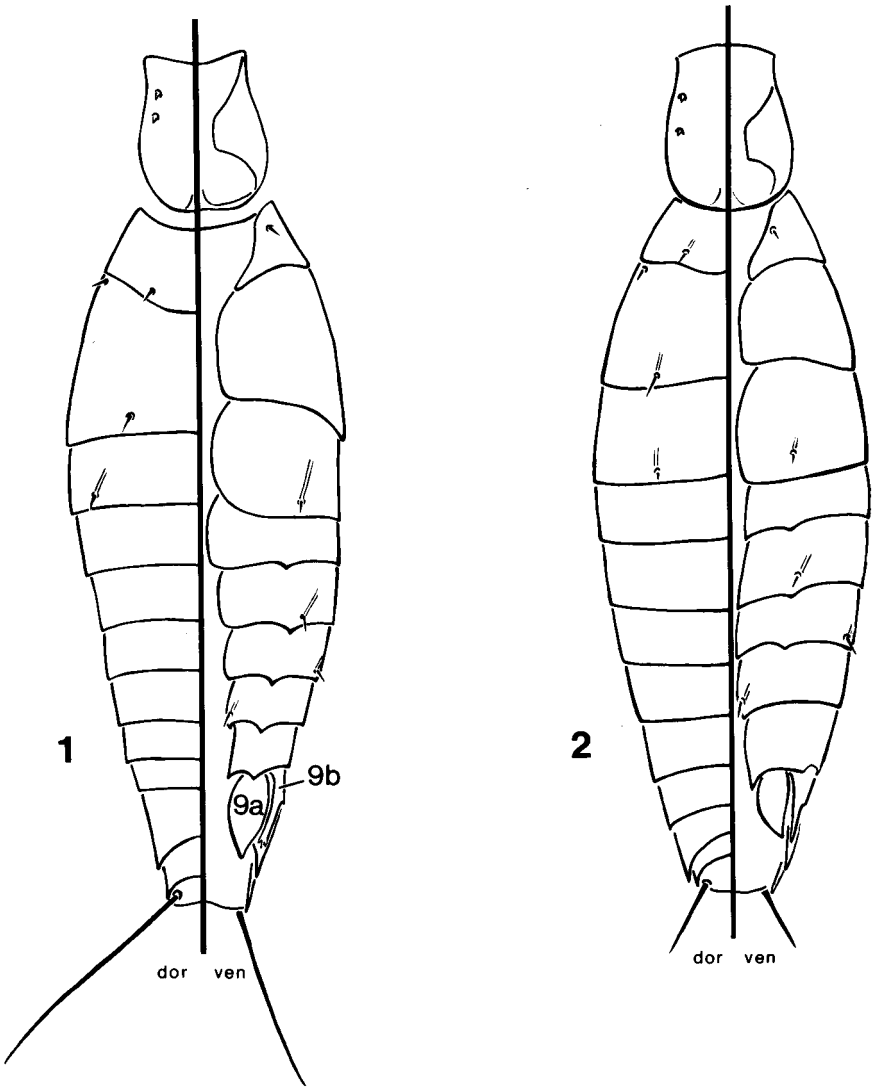
Identification of adults.—The adults were identified through the use of Gahan's (1940) key to the genus *Orasema*. Unfortunately, Gahan's revision may represent only a preliminary treatment of a very diverse and widespread genus. *Orasema coloradensis* is defined as the only *Orasema* with a smooth mesosoma dorsally; however, there are many morphological deviations from the type which could represent distinct species. This makes it difficult to compare the *O. coloradensis* observed by Clausen (1940) in Virginia to those observed in Idaho. Gahan (1940) raised the possibility that *O. viridis,* for which Wheeler (1907) described the life history in the ant nest, may actually be *O. wheeleri* (based on the representative material in the USNM collection), so the two species may be synonymous. To compensate for the taxonomic problems with the genus, representative material from this study have been deposited at the University of Guelph, the University of Idaho and the National Museum of Natural History (Washington, D.C.).

***Orasema coloradensis* Gahan**

Figs. 1, 3, 4

Location and habitat.—Adults were collected from Hells Gate State Park, 5 miles south of Lewiston, Nez Perce Co., Idaho, from 10 June to 7 August, 1983 and 1984. Adult *O. coloradensis* were most commonly swept from gray rabbitbrush, *Chrysothamnus nauseosus* (Pall.) Britt., but they also occurred on green rabbitbrush, *C. vicidiflorus* (Hook.) Nutt. (Asteraceae). Scattered clumps of *C. nauseosus* occur in the relatively undisturbed grasslands of undeveloped portions of the park on the slopes above the Snake River. The vegetation in this area is predominantly grass with the most abundant species being cheat grass, *Bromus tectorum* L., and sand dropseed, *Sporobolus cryptandrus* (Torr.) Gray. The two species of *Chrysothamnus* are the dominant shrubs. Other Astereaceae in the area included: *Erigeron* sp., *Grindelia* sp., *Gutierrezia* sp. and *Haplopappus bloomeri* Gray.

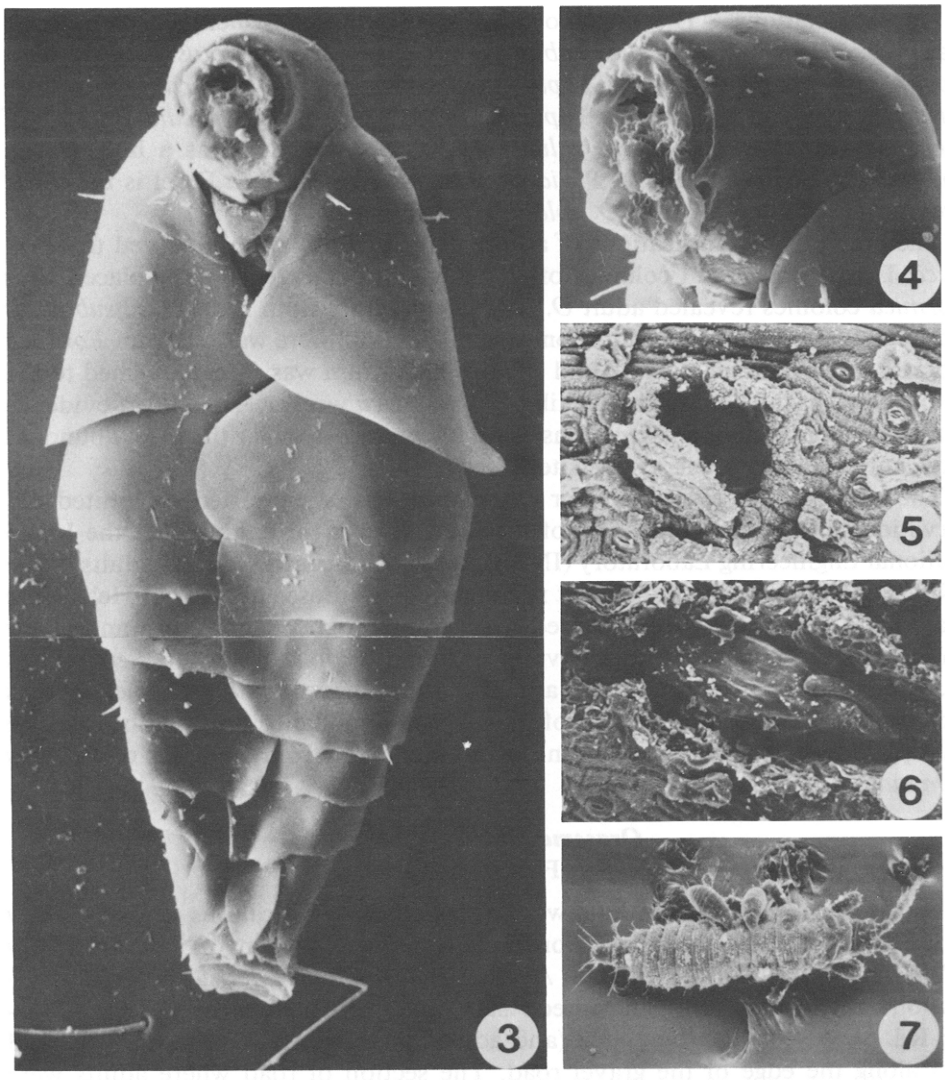
Behavior.—Males and females of *O. coloradensis* were found hovering above rabbitbrush plants, but no mating was observed. Females were often seen flying slowly along suberect branches, apparently searching for oviposition sites. Eggs were usually deposited in leaves, but oviposition into buds and stems also occurred. Oviposition was observed between 9:30 am and 6:10 pm. Ten females were observed for 5 minutes each on 21 July, 1984. A total of 23 ovipositions were observed or about once every 2 minutes per female. An average of 478 [$\pm$18 SD] eggs were found in 10 field collected females that were dissected. Based on field observations and a sample of 100 branches, oviposition occured more or less sporadically within 19 cm of the branch apices, singly or in a series of 2 or 3 punctures per leaf. One egg was deposited each time the leaf was punctured. Planidia were found on all portions of branch apices, often clinging to a trichome,



Figs. 1, 2. Dorsal and ventral view of the first-instar larvae of *Orasema coloradensis* (1) and *Orasema viridis* (2).

and on nymphs of thrips (*Sericothrips* sp.). As many as 7 planidia were found on a single thrips. Planidia attached to thrips were distinctly larger and more globose than individuals collected from foliage. On two occasions in the laboratory, planidia apparently consumed enough fluid to cause the thrips to shrivel and die. A sample of 100 branches of gray rabbitbrush collected in the field revealed 0–38 planidia/branch (mean of 1.28 ± 4.40 SD). Eggs deposited by adults brought into the laboratory hatched in 4 to 6 days at approximately 22°C, and planidia lived for as long as 18 days [mean of 8.8 ± 3.7 SD, n = 25] without access to thrips.

Description of the egg.—The eggs are white with a smooth chorion. The overall length was about 0.12 mm including a 0.05 mm stalk. They are similar to the eggs of other Eucharitidae described by Heraty and Darling (1984).



Figs. 3–7. 3, 4, First-instar larva of *Orasema coloradensis*. 3, Ventral view (1000×). 4, Ventrolateral view of head (200×). 5–7, *Orasema viridis*. 5, Oviposition puncture in involucral bract of *Haplopappus* (300×). 6, Egg in dissected chamber (200×). 7, Two first-instar larvae on immature thrips (65×).

Description of planidium (Figs. 1, 3, 4).—The morphology of the first-instar larva is virtually identical to that described for *Orasema* sp. described in Heraty and Darling (1984) except for the following features: two pairs of dorsal cranial spines (Fig. 4) and four small peg-like sensilla around the anterior margin of the cranium (Figs. 3, 4); presence of a pair of pleurostomal spines fused to the margin of the cranium (Fig. 4); posteroventral margin of tergites IV to VIII are less angulate, and tergites VIII and IX are more modified than was suggested from slide preparations, tergite IXb is finely serrate at apex of ventral extension (Figs. 1, 3). All of the above are variations on the planidium described in Heraty and Darling (1984), and were verified with planidia of *O. viridis* (see below).

Host associations.—The ants known to occur in the area where *O. coloradensis* was collected include: *Formica subnitens* Creighton, *Camponotus vicinus* Mayr, *Pogonomyrmex owyheei* Cole, *Tapinoma sessile* (Say), *Pheidole californica californica* Mayr, and *Solenopsis* (*Diplorhopterum*) *molesta validiscula* Emery. Of these species, only *S. molesta validiscula* has been reported as a host for *O. coloradensis* (Wheeler, 1907). *Pheidole bicarinata vinelandica* Forel is the other previously recorded host for *O. coloradensis* (Wheeler, 1907).

The only positive indications of a host-parasite association involved the *Formica*. Excavation of ant colonies of all genera and emergence traps placed over *Formica* colonies revealed adult *O. coloradensis* only from nests of *F. subnitens* (through both methods). In addition, several planidia were washed from *Formica* workers by shaking in alcohol, and a single planidium was found attached to the conjunctiva at the base of the maxilla of a *Formica* worker. This direct evidence is further supported by observations that *F. subnitens* is by far the most abundant large ant on rabbit brush at this site.

The basic outline given here for *O. coloradensis* is supported by limited observations of another population of the same species (or complex) at the Idaho National Engineering Laboratory (INEL) site in southcentral Idaho. Adults of the INEL population were similar, but not identical, to those collected at Hells Gate State Park. They also were observed ovipositing on gray rabbitbrush and rarely on green rabbitbrush. Planidia have been found on foliage and on *Sericothrips* sp. Though many ants occur in this area, *Formica oreas comptula* Wheeler appears likely to be the host on the basis of its size and abundance on rabbitbrush. The only planidium washed from an ant at this site came from a worker of *F. oreas comptula*.

Orasema viridis Ashmead

Figs. 2, 5–7

Location and habitat.—Adults were collected at two locations in the vicinity of the Southwestern Research Station of the American Museum of Natural History (SWRS), 5 mi W Portal, Arizona, August 17, 1984, and almost always in association with a small, yellow-flowered Asteraceae, *Haplopappus* sp. On Herb Martyr Rd. above SWRS, the plants (and adults) were restricted to a narrow band just along the edge of the gravel road. The section of road where adults were collected was open with mixed species of grass on one side and a drywash slope on the other. The second location was on the grounds of SWRS, where *Haplopappus* sp. occurred in patches in well-travelled and mowed areas. *Orasema viridis* was also collected on the SWRS grounds from a dense stand of *Viguiera* (Asteraceae) and also on *Spheralcea* (Malvaceae), but were found in largest numbers on *Haplopappus* sp.

Behavior.—Both males and females of *O. viridis* were collected from *Haplopappus* sp., although no mating was observed. While ovipositing, females were oriented head down on the unopened flower buds of *Haplopappus* sp., with oviposition lasting several seconds. Upon completion, females would either reorient themselves on the same flower bud or fly to another plant. Occasionally females would oviposit on the same involucral bract just below the last puncture. Each female made a single puncture in the upper third of the involucral bract (Fig. 5) on the flower head and laid a single egg in the smooth chamber hollowed out by

the ovipositor (Fig. 6). The egg is oriented with the stalked end upwards. On the SWRS grounds, where *O. viridis* was abundant, all of the flower heads had at least one oviposition puncture and many had punctures in a large proportion of the involucral bracts on a single head. The planidia were found on the opened flower heads either among the involucral bracts or more commonly on the surface of the flower disc. No planidia or empty eggs were found on the unopened flower buds, but this was probably a reflection of the amount of time that the bud had been developed and available for oviposition. Several immature thrips were found in the flower heads, with attached planidia (Fig. 7).

Description of egg (Fig. 6).—The eggs are white with a smooth chorion. The overall length was about 0.13 mm. Caudal stalk less than half length of egg body with a small bulbous apical thickening. Similar to the egg described for *O. coloradensis.*

Description of planidium (Fig. 2).—Identical to the planidium of *O. coloradensis* except for the following features: the two pairs of dorsal cranial spines are smaller; the extended apex of tergite IXb is acute and not serrate; the caudal cerci are rigid and equal to the dorsal length of only 2–3 terminal tergites.

Host associations.—No direct associations were made with any ant hosts. In the area of both locations cited above, colonies belonging to several genera of ants (*Acanthomyops, Aphaenogaster, Camponotus, Odontomachus, Solenopsis* and *Trachymyrmex*) were excavated but none contained *Orasema.* However, there was a species of *Formica* (*fusca* group) commonly found walking over the open flower heads on the SWRS grounds which was of a suitable size to act as a host of this species of *Orasema.* There were also some stray *Pheidole* walking on the ground among the plants. No nearby colonies of *Formica* or *Pheidole* could be located for excavation.

Discussion

Ant hosts.—The two species of *Orasema* observed in this study were found to oviposit mostly on restricted species of Asteraceae, and *O. coloradensis* was reared from the nest of *Formica subnitens.* Previously, *Orasema* spp. have been reared from only the ant genera *Pheidole* and *Solenopsis* (Wheeler, 1907; Wheeler and Wheeler, 1937; Clausen, 1940; Gahan, 1940; Das, 1963). The rearing records from *Solenopsis* may be accidental, as members of the subgenus *Diplorhopterum* are small thief ants which live in close proximity to, and steal brood from, colonies of other ants. Wheeler (1907) states that at least one colony of *Solenopsis molesta* was "living in cleptobiosis with a large colony of *Formica ciliata* Mayr," although he feels that the *Orasema* were probably parasites of the sexuals of *Solenopsis* (the only *Solenopsis* pupae of a proper size).

Plant hosts.—The plant hosts utilized for oviposition have been recorded as *Ilex paraguayensis* Hooker (Aquifoliaceae) for *Orasema aenea* Gahan, *Stylosanthes biflora* (L.) B.S.P. (Fabaceae) and *Ceanothus americanus* L. (Rhamnaceae) for *O. coloradensis* (in Virginia), *Casearia spinescens* Griesbach (Flacourtiaceae) for *Orasema smithii* (Calusen, 1940), and tea leaves (Celastraceae) for *O. assectator* (Das, 1963). Our observations represent the first report of *Orasema* ovipositing into Asteraceae, although, adults of *Orasema cockerelli* Gahan and *Orasema neomexicana* Gahan have been collected from *Bigelovia* and *Gutierrezia,* two genera of Asteraceae closely related to *Chrysothamnus* and *Haploppapus.*

Thrips association.—An association between the planidia of Eucharitidae and thrips (as an intermediate carrier) has been suggested by Das (1963) and Clausen (1940). Observations on the eucharitid *Psilogaster antennatus* Gahan showed that the females will only deposit their eggs in association with the eggs of the thrips, *Selenothrips rubrocinctus* (Giard) (Clausen, 1940). No association could be made between *Psilogaster* and an ant host. In both species of *Orasema* dealt with here, the planidia were commonly found attached to nymphal thrips and, in one case, the planidia appeared to have fed on the thrips.

Orasema coloradensis apparently oviposits from mid-June to mid-August. *Formica* colonies often occur at the base of rabbitbrush plants, but the ants spend little time foraging on rabbitbrush, unless aphids or flowers are present. Establishment of aphid colonies is sporadic, thus not a dependable host attractant for *O. coloradensis* planidia. The flowering of rabbitbrush plants at Hells Gate State Park is asynchronous, typically beginning in late July, peaking around 1 September and continuing through early October. This would mean that a planidium could have to wait as long as three months for *Formica* workers to be readily available. Thus, it seems likely that planidia survival would be enhanced by finding an alternate food source, in this case, *Sericothrips* sp., which is common on rabbitbrush.

Morphology.—Discovery of the characters from the planidia discussed above, such as the pleurostomal spines and structure of the terminal tergites, which appear different from the *Orasema* sp. from Costa Rica (Heraty and Darling, 1984), is the result of finer resolution through SEM techniques. The presence of dorsal cranial spines can be seen on slide-mounted material, and these are definitely not present on the *Orasema* sp. from Costa Rica. Whether or not these spines can be considered homologous to the enlarged dorsal cranial spines found in *Perilampus* (Heraty and Darling, 1984) can only be left to conjecture. Their use in supporting any relationship between the two groups (Perilampidae and Oraseminae) would require the presence of spines in other Oraseminae, or at least a demonstration that this is the plesiomorphic condition of the subfamily. In general, the larvae support the character states of the Oraseminae, as defined in Heraty and Darling (1984) and also the differences between this subfamily and the Eucharitinae.

The sclerites labelled as tergites IXa and IXb are unique in that they occur side by side. The origin of either tergite underneath tergite VIII could not be resolved. The lack of a dorsal extension of the leaf-like sclerite (IXa) makes it likely that it is not an additional tergite, but is more likely the derivative of another tergite such as IXb. Adults of *O. coloradensis* are distinguished from *O. viridis* largely by the presence of a smooth mesoscutum (dorsally) in contrast to the uniformly alveolate mesoscutum of *O. viridis.* Compared to other nearctic *Orasema,* the two species are distantly related, yet their larvae are almost identical. Except for the presence of dorsal cranial spines, these larvae are barely distinguishable from the Costa Rican species described by Heraty and Darling (1984). This similarity demonstrates the conservatism of the first-instar morphology, which is similar to that found in other eucharitids.

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