LARVAL BEHAVIOR OF *AGATHYMUS*, INCLUDING A DIVERGENT GROUP IN BAJA AND SOUTHERN CALIFORNIA (MEGATHYMIDAE)

DON B. STALLINGS[1] AND VIOLA N. STALLINGS
Caldwell, Kansas

This is the first of a series of papers based on our studies of the immature stages of the Megathymidae. Particular consideration is given to the first and last larval instars, as we find significant characters and behavior patterns in many instances in these instars at both the species level and at higher levels.

By 1965 we had made studies in the field of the larvae of all of the described species of *Agathymus* except *indecisa* (Butler & Druce), *escalantei* Stallings, Turner & Stallings, *stephensi* (Skinner), *comstocki* (Harbison), and *dawsoni* Harbison.

Our studies covered all of the species observed in the final instars and about half of the species in the first instar. Some of our observations have been recorded for individual species in our previous papers. From these observations we reached the following conclusions in regard to larval behavior of *Agathymus*.

1. Newly emerged larvae proceed to the upper portion of the leaf and bore in to commence feeding activities. We noted that the fiber portion of the leaf was regurgitated by the larvae. After a few days the larvae leave this feeding cavity and proceed towards the leaf base where they either again enter the leaf to feed, or transfer to another plant. In many instances after making the second entry they may come out and reenter the plant for a third time or transfer to another plant. If the plant produces too much fluid in the larval cavity the larvae may be overwhelmed and die, and if too little fluid is produced the larvae will suffer from lack of food. The larvae feed on the fluid of the plant; this is evident from the small size of the cavity. The pulp removed seems to be insufficient to have produced the larvae.

2. When the larvae have made their final entry they form a tube-like cavity parallel with the length of the leaf (see plate I, figures 1–4). In some species the cavity is in a single leaf; in other species the cavity may involve more than one leaf; and in some instances the cavity may extend into the caudex of the plant. All species form a tube-like cavity, but each species usually has its own particular variation of the cavity. While cavities are usually at the base of the leaf, some species place them lower than

[1] The research for this paper was made possible to a large degree by Research Grant #GB 1190 from the National Science Foundation, made available to the first named author.

others, and some place the cavity towards the edge of the leaf while others place it near the center. The cavity is enlarged as the larvae grow. A tiny hole is made to the outside from the upper part of the cavity, through which frass is expelled. Some species place this hole on the upper side of the leaf, others on the underside, and some may place it on either side. During this period the interior of the cavity is bright red. Shortly before pupation the larvae produce a white, waxy powder and cover the interior of the larval cavity so that it appears to be white. At the same time the excrement hole is enlarged to provide an exit for the adults when they emerge. The exits are covered with silk "trap-doors." Most species have their own particular color, shape and texture for the trap-doors.

As a result of variation of the above mentioned characters from species to species, nearly every species of *Agathymus* can be identified in the field during its larval period, and in many instances can be identified from the larval cavity after it has been abandoned. Nearly all species of *Agathymus* use only one species of *Agave* as a food plant. (Note that *Aegiale* does not powder the cavity, see plate II, figure 4).

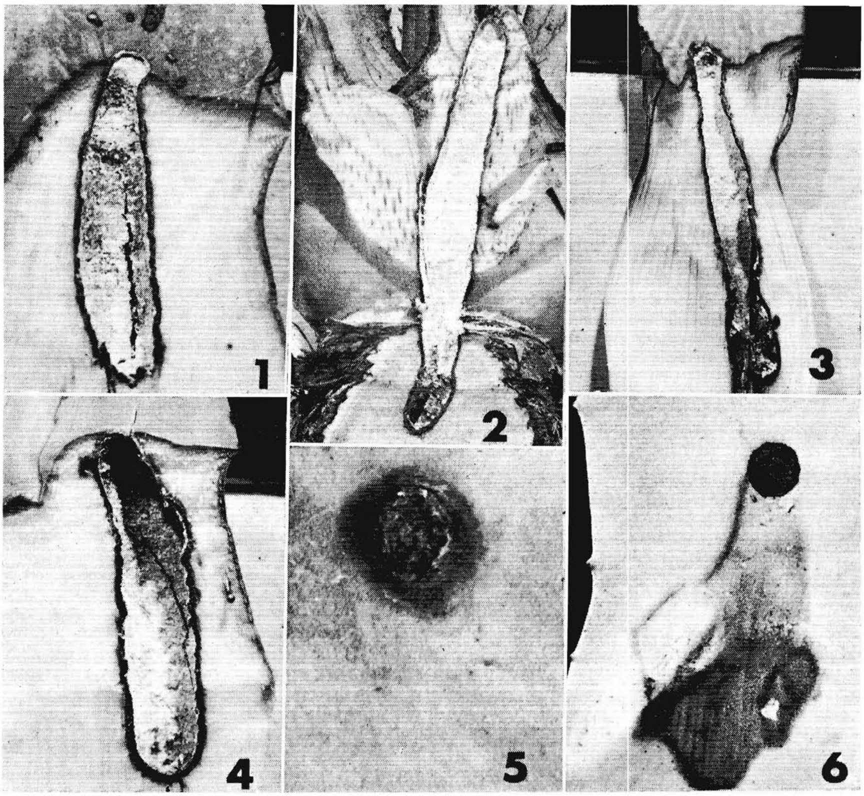
3. Normally the activities of the larvae in the final larval cavity do not damage the plant to the extent that there is visible evidence from the outside. The only evidence of the infestation is the tiny excrement hole, or later the trap-door (see plate I, figure 5). In contrast, the activities of the larvae of the related genus *Aegiale* cause so much injury around the excrement holes that the leaves turn brown in those areas (see plate II, figure 5).

4. When an *Aegiale* enlarges the excrement hole and builds its trap-door it makes a substantial silk "collar" around the exit hole before building the trap-door. *Agathymus* does not build this collar.

5. Unlike other genera of the Megathymidae, the *Agathymus* do not glue their ova to the leaves of the food plant, instead they drop their ova among the leaves of the food plant where they lodge or fall out onto the ground.

In June of 1965 we had the opportunity to make field studies of *A. stephensi* (Skinner) in San Diego County, California near Jacumba, and at the type locality on the old Stephen Ranch. We had been in the field at Jacumba only a few minutes when we both paused to exclaim "Looks like *Aegiale*." For most of the infested plants were showing distinct discoloration around the excrement holes, unlike any *Agathymus* that we had previously examined (see plate I, figure 6).

When we exposed a larval cavity we found a second major difference from other *Agathymus*. At the upper end of the cavity there was a distinct lateral bulge (see plate II, figure 1). For more figures of the larval cavity



EXPLANATION OF PLATE I

1–4, Larval cavities of *Agathymus*. 1, *A. aryxna* (Dyar), Chiricahua Mts., Arizona. 2, *A. micheneri* Stall., Turn., & Stall., Saltillo, Coahuila, Mexico. 3, *A. judithae* (Stall. & Turn.), Hueco Mts., Texas. 4, *A. aryxna*, Peloncillo Mts., New Mexico. 5–6, Trap-doors of *Agathymus*. 5, *A. carlsbadensis* (Stall. & Turn.), Guadalupe Mts., New Mexico. 6, *A. stephensi* (Skinner), Stephens Ranch, La Puerta Valley, California.

of *stephensi* see (Comstock and Dammers, 1934). In the area of this bulge the cavity extended to just below the surface of the leaf, much closer to the surface than the remainder of the cavity.

Our first thought as to the reason for this bulge was that the larvae of this species were not as agile as other members of the genus and needed a turn-around area in order to reverse their position in the cavity. However a careful study of a large number of larval cavities disclosed that in more than half of them the bulge area was not large enough to be used for this purpose, at least not in the last instars.

We noted that while *stephensi* cut excrement holes on either side of the leaves, about 80% were on the upper side. There was a strong tendency for the cavity bulge to be to the right of the excrement hole when on the upper side of the leaf and to the left when on the under side of the leaf (*i.e.*, to the right or left of the observer facing the side of the leaf with the excrement hole). In a few instances we found little evidence of the bulge.

A third difference that we noted was that the amount of waxy powder covering the cavity interior was reduced so that the red of the cavity showed through so as to appear slightly pinkish.

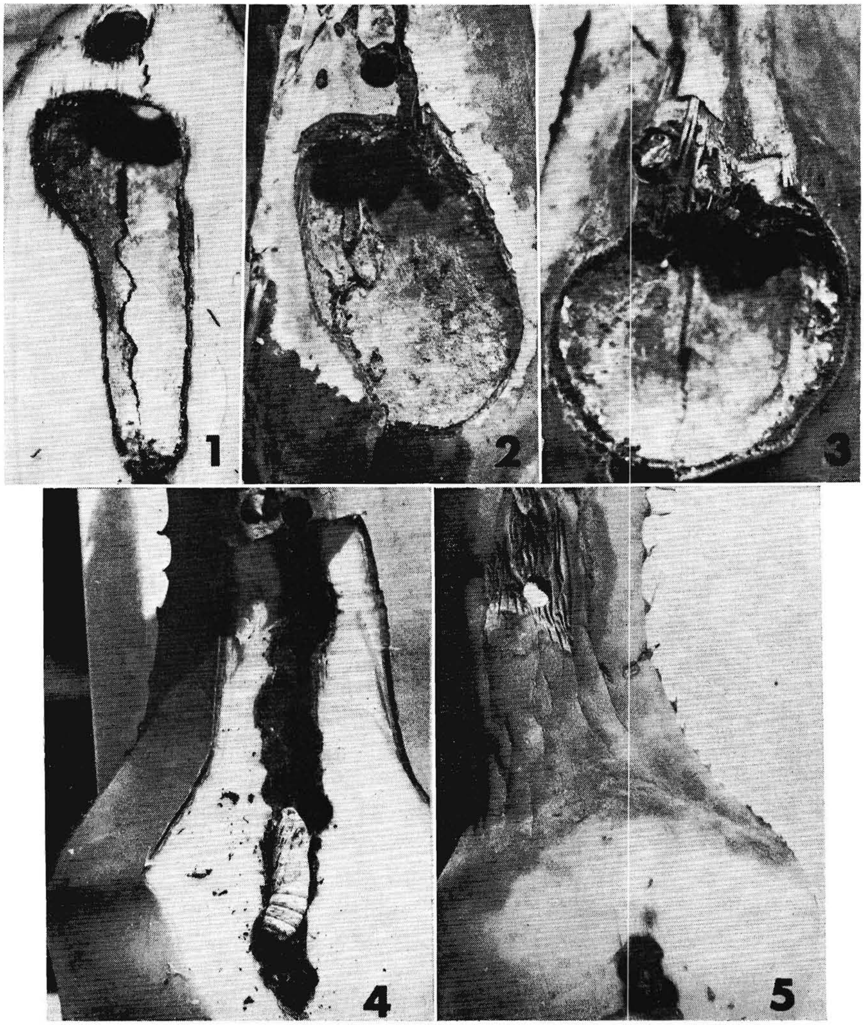
We visited Charles F. Harbison at San Diego, California, who had taken us to visit the *stephensi* type locality. He let us examine a number of leaves of *Agave* that had been infested by *A. comstocki* (Harbison), which he had described from Baja California, Mexico. Again, we found major differences in the larval cavity:

1. The larvae had formed discoid cavities, with the circular dimension being parallel with the leaf (see plate II, figures 2 & 3). In the other *Agathymus* the circular dimension of the larval cavity is perpendicular to the length of the leaf.
2. There was only a minute amount of white waxy powder, and this was concentrated around the exit hole and adjacent area.
3. The exit hole had a silk collar similar to that of *Aegiale* but not as prominently developed.
4. The leaves exhibited discoloration around the exit hole similar to that of *Aegiale* and *stephensi*.

Mr. Harbison indicated to us that a second Baja California species, *A. dawsoni* Harbison, has the same general characters as those described above for *comstocki*.

From the foregoing it is evident that the *Agathymus* occurring in southern California and southward into Baja California has distinctive differences in larval habits from other *Agathymus*. In these and in morphological characters they appear to represent a distinctive group within *Agathymus*. While this group of species of *Agathymus* is distinct from *Aegiale* they do show more characters in common with *Aegiale* than do other members of the genus *Agathymus*.

Since the discovery of this situation we have speculated as to the adaptive significance for these differences and have discussed this with other biologists. Dr. C. D. Michener suggested that since the area occupied by *comstocki* and *dawsoni* is more arid than the locales of other *Agathymus*, there may be some moisture-conserving advantages in the discoid larval cavity. Dr. C. L. Remington pointed out that a sphere is the strongest "anti-collapse shape" which could become important in ex-



EXPLANATION OF PLATE II

1–4, Larval cavities of *Agathymus*. 1, *A. stephensi* (Skinner), Stephens Ranch, La Puerta Valley, California. 2–3, *A. comstocki* (Harbison), 2 mi. NE San Simon, Baja California, Mexico. 4, *Aegiale hesperiaris* (Walker), Casa Blanca, Nueva Leon, Mexico. 5, Trap-door, *A. hesperiaris* (Walker), Casa Blanca, Nueva Leon, Mexico.

tremely arid habitats. In this respect it will be noted that in *comstocki* and *dawsoni* the circular dimension is the major dimension, while in the other *Agathymus* it is the minor dimension. We have wondered if the leaves of the food plants of *comstocki* and *dawsoni* are structured so that there is only a small, localized area that is suitable for the feeding, and therefore the cavity is disc-shaped in order to encompass more of the suitable feeding area.

Another reason for this difference in larval cavity construction could be that in each case the shape of the larval cavity represents the easiest way to construct a cavity that will produce sufficient food. In most *Agave* the leaves have tough fibers running the length of the leaves. In constructing the tube-like cavity, less of the fibers would be intersected, hence this cavity would be easier to construct, as less of the fibers would have to be cut. However, in the more arid locales, such as Baja California, this tube-like cavity could be unsatisfactory, since it would at the same time intersect less of the plant fluids that flow through the length of the leaf. The discoid cavity would intersect more of the plants fluids, which could be necessary in order for the Baja California populations to survive. If the foregoing is true it would not be unexpected to learn that the mouth-parts of the Baja California larvae are differently developed than the mouthparts of the populations that construct the tube-like cavities.

Harbison was familiar with the fact that first instar *Agathymus* go to the tip of the leaf to do their initial feeding. He advises us that he has made repeated examinations of plants infested with *comstocki* and *dawsoni* for evidence of this larval entry site, but has not found any such indications. Perhaps the larvae of *comstocki* and *dawsoni* enter the plant but once and form the discoid cavity. If this is true then we can speculate as to what *stephensi* is doing.

If *stephensi* represents a northern extension of the group which form discoid larval cavities but has moved into an environment in which the tubular cavity is more adaptive, the first instar larva of *stephensi* may enter the leaf like its Baja California relatives and form a small discoid cavity. At this stage *stephensi* would diverge from its relatives and thereafter resemble the rest of the *Agathymus* species, as it moves to the right or left, as the case may be, of the initial small discoid cavity and proceeds to build a tubular cavity. Thus, it would produce the bulge in a tubular cavity that we in fact observed in *stephensi*.

While the foregoing is speculation, we feel that it has ecological and evolutionary interest. We hope that lepidopterists in southern California will make some field studies which would either prove or disprove this idea. Such studies would be rather simple to conduct and could be completed in one or two seasons.

The larval biologies of *A. escalantei* Stallings, Turner & Stallings and *A. indecisa* (Butler & Druce) are still unknown.

Literature Cited

Comstock, S. A. & C. M. Dammers, 1934. The metamorphoses of three California diurnals. Bull. So. Calif. Acad. Sci., 33: 79–92.

Stallings, D. B. & J. R. Turner, 1954. Notes on *Megathymus neumoegeni* with description of a new species. Lepid. News., 8: 77–87.

1956. Notes on *Megathymus polingi*. Lepid. News., 10: 109.

1957. Four new species of *Megathymus*. Ent. News., 68: 1–17.

1958. A review of the Megathymidae of Mexico with a synopsis of the classification of the family. Lepid. News., 11: 113–137.

Stallings, D. B., J. R. Turner, & V. N. Stallings, 1961. A new subspecies of *Agathymus mariae* from Mexico. J. Lepid. Soc., 15: 19–22.

1964. Notes on five Megathymidae. J. Lepid. Soc., 18: 45–47.

1966. Two new species and two new subspecies of Megathymidae from Mexico and the United States. J. Lepid. Soc., 20: 163–172.

COLLECTING AND OBSERVING *THYMELICUS LINEOLA* FORM "PALLIDA" (HESPERIIDAE) IN NEW JERSEY

Joseph Muller
R.D. 1, Lebanon, New Jersey

Since the discovery of *Thymelicus lineola* Ochsenheimer in Ontario in 1910, this butterfly has become distributed over most of the northeastern United States. In many localities it has become abundant; however, no recent paper mentions the capture of the form "pallida." The first individual of "pallida" collected at Lakehurst, New Jersey was on July 1, 1967 by B. Ziegler and myself. Strangely, this site is about the last one in the area where *lineola* has established itself.

Dr. and Mrs. dos Passos and I went to this locality June 21, 1968 to search for this pale skipper. The collecting site is about 15 acres of grassland bordered on three sides by highways and on the other by woods. Several small patches of milkweed (*Asclepias*), dogbane (*Apocynum*), and daisies (*Compositae*) are found there. At this time only about a tenth of all the flowers were in bloom. Individuals of *T. lineola* were swarming over the whole area. Wherever there was a milkweed in bloom as many as a dozen individuals could be found feeding. Not a single "pallida" was found among them; I did not catch a single individual on milkweed. The first "pallida" were caught on dogbane and among grasses. Mrs. dos Passos then noted that the "pallida" were easily distinguishable when visiting the composite flowers, since most were feeding with expanded wings. Taking her advice we collected thirty specimens in two hours. When their wings are folded it is more difficult to identify "pallida" since the underside of normal *lineola* is also pale. The difference is also evident with individuals in flight.