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CLASSIFICATION AND LIFE HISTORY OF *ACSALA ANOMALA* (ARCTIIDAE: LITHOSIINAE)

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ABSTRACT. The immature stages and female of *Acsala anomala* Benjamin are described for the first time from material collected in the Yukon Territory, Canada, during 1980. The position of the genus within the Noctuoidea is reassessed on the basis of adult and larval characters. It is concluded that the genus *Acsala* should be transferred from the Lymantriidae to the subfamily Lithosiinae in the Arctiidae. The life history of *Acsala anomala* is described and the immature stages illustrated.

In 1980 J.D.L. had the opportunity to collect in the Yukon Territory with Dr. D. M. Wood, also of the Biosystematics Research Institute. The purpose of the trip was to initiate a study of the insects and arachnids of northwestern North America, particularly those of the unglaciated Beringian refugium area.

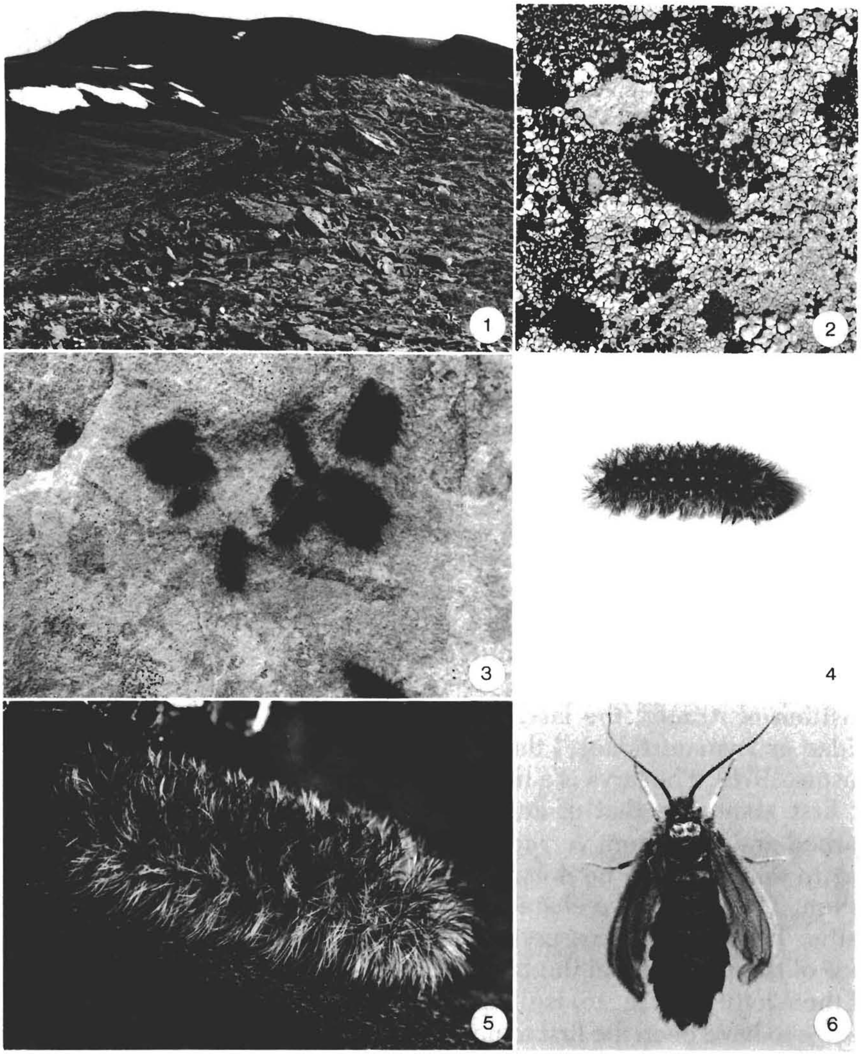
During the summer, Lafontaine and Wood devoted a considerable amount of time to a study of the immature stages of the little known moth *Acsala anomala* Benjamin. This was done because of uncertainty of the phylogenetic position of *Acsala* within the Noctuoidea based on characters of the adult male and because of interest in its classification by J.G.F. and D.C.F. Previous to 1980 the species was known from less than a dozen specimens, all males. Collections of *Acsala anomala* were made in the northern Ogilvie Mountains in north-central Yukon and in the Richardson Mountains in northern Yukon. Adults of both sexes and immature stages were collected and their habits were recorded in the field. The following discussions on the classification and life history of *Acsala anomala* are based on these specimens and field data.

CLASSIFICATION

Benjamin (1935) in describing *Acsala* put it in the Arctiidae, although he suggested that it should probably be in a separate family.

Benjamin believed that *Acsala* was a remnant of a primitive group that gave rise to the Arctiidae and Lymantriidae. McDunnough (1938) put *Acsala* in the subfamily Arctiinae next to *Dodia albertae* Dyar, presumably because of convergent similarities resulting from similar adaptations to an arctic environment (e.g., dark coloration; hairy, translucent wings; aborted proboscis). Ferguson (1978), however, showed that structural characters do not support classification of *Acsala* within the Arctiinae. Lack of ocelli, a character of *Acsala*, is a distinguishing feature of the arctiid subfamily Lithosiinae and of the Lymantriidae. Wing venation of *Acsala* could be either arctiid or lymantriid. It has a long discal cell, sometimes regarded as a character of the Lithosiinae and of other Arctiidae, but various exotic Lymantriidae (e.g., species of *Eloria* Walker) have discal cells that are as long or longer. Characters more clearly suggesting an affinity with the lithosiines are: presence of an orange prothoracic collar and lack of long terminal spinules on the male antenna; the female antenna is filiform. Ferguson classified *Acsala* within the Lymantriidae on the basis of venation, especially the relationship of veins Sc and R in the hind wing, which is unusual for an arctiid; however, he expressed considerable reservation, pointing out that characters of the larva were needed in order to resolve the problem.

The discovery of the larva makes possible a reassessment of the position of *Acsala*; the larval characters resolve the dilemma, "Arctiidae or Lymantriidae?," that so troubled Benjamin (1935) and Ferguson (1978). The larva is a lithosiine arctiid. The general appearance, at first glance, is that of an ordinary arctiid (Fig. 5); the setae are barbed and arise from verrucae. It differs from known lymantriid larvae in that there are no dorsal glands on abdominal segments six and seven. The distinctive character that it shares with other known lithosiine larvae is the possession of a conspicuous mola on the inner face of the mandible at the base (Fig. 15). The mandible of a member of the Arctiinae (Fig. 16) is illustrated for comparison. Gardiner (1943) seems to have been the first to notice this character and to have stressed its importance in characterizing the lithosiines. *Acsala* larvae, like those of some other lithosiines, e.g., *Eilema* species and *Lithosia quadra* (Linnaeus), have the crochets heteroideous (Fig. 13) as do the larvae of the Arctiinae and Ctenuchinae. It must be noted that many Lithosiinae, e.g., *Asura anomala* (Elwes), *A. calamaria* (Moore), *Chionaema bianca* (Walker), *C. detrita* (Walker), *C. peregrina* (Walker), *Hypoprepia miniata* (Kirby), *Clemensia albata* Packard, *Eudesmia* species, *Crambidia* "white species," and *Agylla* species, have the larval crochets homoideous. However, in all these larvae the man-



FIGS. 1–6. *Acsala anomala.* **1,** habitat—Km 465 Dempster Hwy., Yukon Territory; **2,** larva feeding, 1.5×; **3,** larvae resting under rock, 0.6×; **4,** third instar larva, 2.5×; **5,** mature larva, 4×; **6,** adult female, 3×. (Photographs by J. D. Lafontaine and Biographic Unit, Agriculture Canada.)

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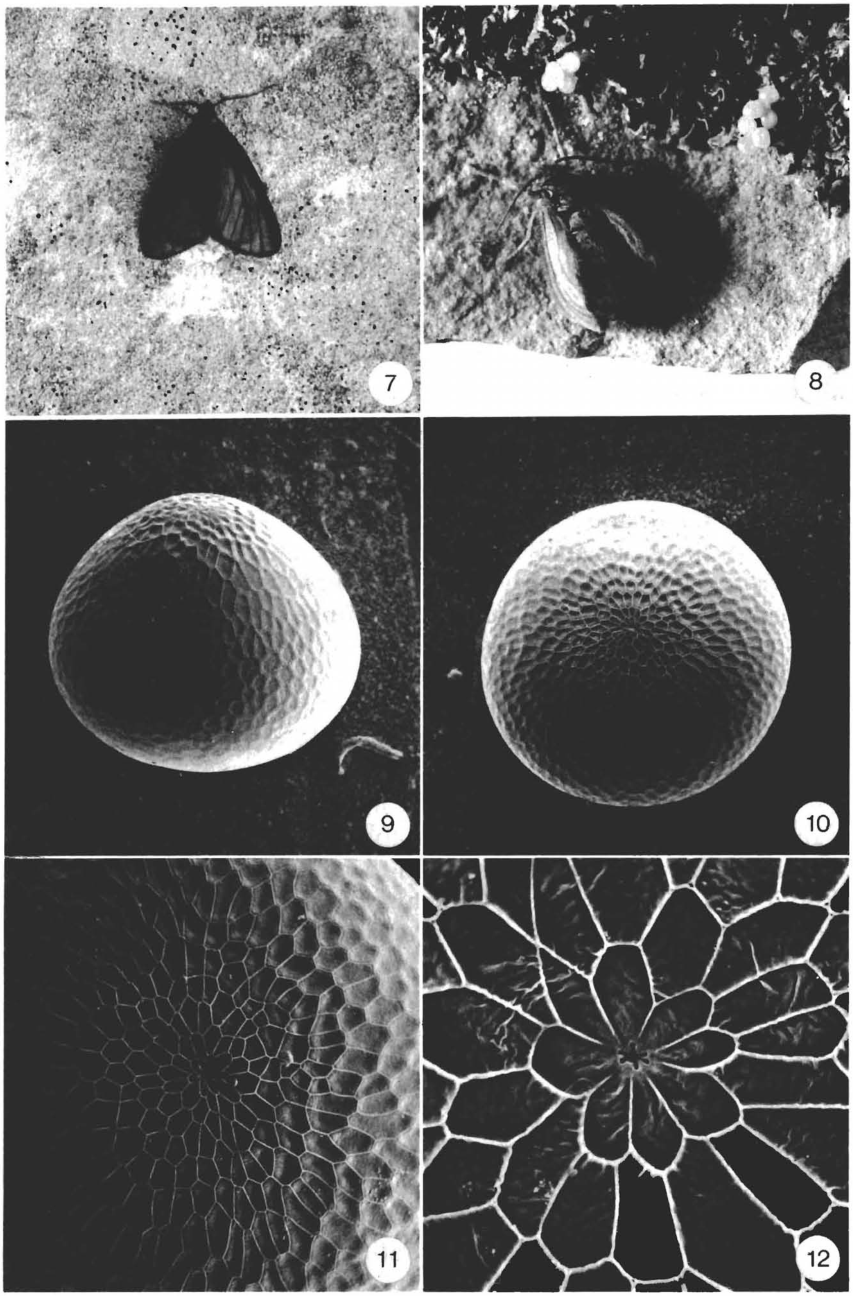
FIGS. 7–12. *Acsala anomala.* **7,** adult male, 1×; **8,** female laying eggs, 1.7×; **9,** lateral view of egg, 40×; **10,** dorsal view of egg, 40×; **11,** details of egg microsculpture, 80×; **12,** micropylar region at apex of egg, 400×. (Photographs by J. D. Lafontaine and Bio-graphic Unit, Agriculture Canada.)



dible has a basal mola. The larval foodplants, various species of lichens, are also typical of lithosiine arctiids.

The first instar larva of *Acsala* has single, barbed setae arising from inconspicuous, raised pinacula; there are two prespiracular setae on T_1, and each of the thoracic segments has two setae, group vii or vi, above the leg.

In the last larval instar T_1 has a moderately large prespiracular verruca with many setae. T_3 has one dorsal verruca, that is there are two verrucae above the prespiracular line and two below the prespiracular line and above the leg. A_3 has three verrucae above the spiracle, a small verruca just behind and slightly below the spiracle, and two large verrucae below the spiracle and above the proleg, the latter with numerous secondary setae. There is no indication of viii on the four proleg bearing segments. Verruca pattern on A_3 is similar to that shown for *Eilema* sp. by Gardiner (1943, Fig. 9) but the small verruca behind the spiracle has several setae. A_1 and A_2 as in A_3, but with small verrucae at the vii and viii positions. A_7 and A_8 similar to A_1 and A_2.

On the basis of our analysis of larval characters, the genus *Acsala* was transferred in the North American Lepidoptera check list from the Lymantriidae to the subfamily Lithosiinae in the Arctiidae (Franclemont, in press).

In the adult only the venation seems to warrant consideration because Benjamin and Ferguson discussed other characters so thoroughly. Considerable emphasis has been placed on the relative position of Sc and R of the hind wing in the Noctuoidea. However, it becomes evident when many species of the various families are studied that this relationship is more variable than keys and characterizations of the venation would imply. In the lithosiines the relationship is highly variable; the base of R is missing, or fused with Sc, in most lithosiines but in the genus *Hypoprepia* the base of R is present but weak. In *Acsala anomala* the venation is variable within the species. In 23 of 40 specimens examined, Sc makes a sharp bend down to R, touches, and then separates immediately before the middle of the discal cell; in nine specimens the relationship is much as described by Benjamin, Sc and R are connected by a bar. The drawing in Ferguson (1978) shows Sc with a sharp bend, but it does not touch R; this condition occurs in eight specimens. Except for the relationship of Sc and R, the hind wing venation of *Acsala* is similar to that of the lithosiine *Clemensia albata* Packard; in most specimens R and M_1 of the hind wing are long-stalked, separating a short distance before the wing margin. In one specimen vein R is absent and in another vein M_3 is missing. The forewings have no accessory cells in about one quarter of the specimens. Many specimens show differences in length of stalking and in size of the accessory cell in the wings on the opposite sides of the same moth. Such variation in wing venation may be related to a tendency toward flightlessness in both sexes. The female is flightless (Fig. 6) and wing size in males is variable. The wing venation of the female is similar to that of the male but the veins are crowded together because of smaller size.

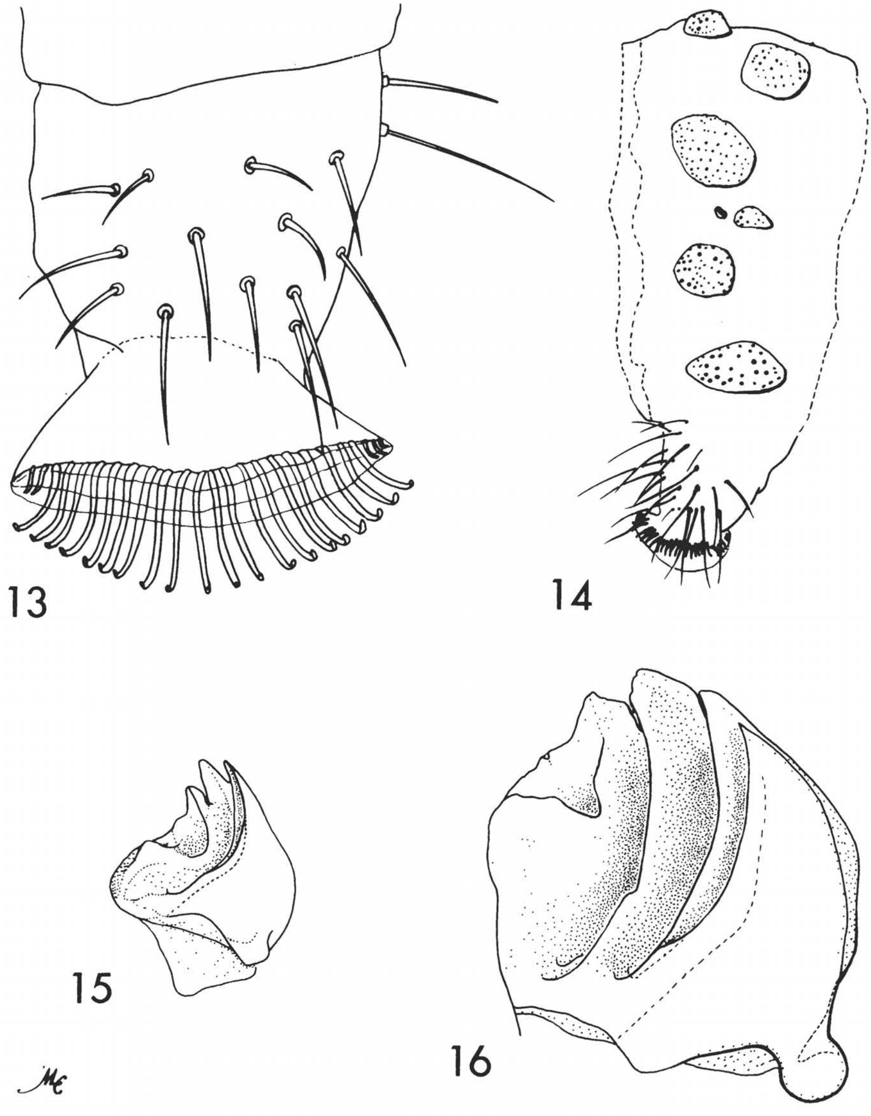
Interpretation of Characters of *Acsala*

Although many of the characters of *Acsala* are typical of the Arctiidae, most of them cannot be used, at present, for phylogenetic interpretation. The absence of dorsal glands on abdominal segments six and seven is a character state of the larvae that is primitive in the Noctuoidea and cannot be used for phylogenetic interpretation within the superfamily. Other character states of *Acsala*, the configuration of larval verrucae, male antennae characters, and adult wing venation characters, may be derived in the Arctiidae and phylogenetically significant. Assessment of these characters will not be possible until the relationship of the Arctiidae and the Lymantriidae has been determined. Two definitive character states of *Acsala* that allow it to be placed in the lithosiine arctiids are the heteroideous crochets of the larva (Fig. 13) and the presence of a mola on the inner face of the mandible (Fig. 15). These derived character states are restricted to the Arctiidae and the Lithosiinae respectively. The absence of ocelli is more difficult to interpret because their loss may have occurred a number of times in the Noctuoidea.

LIFE HISTORY

When Lafontaine and Wood arrived in the Ogilvie Mountains in north-central Yukon on 18 June, males were already in flight. The flight season lasted until late June at low elevations (800–1000 meters), but adults were collected as late as 21 July at high elevations (1600 meters). Males fly over loose, rocky slopes and hilltops where vegetation is sparse (Fig. 1). Butterflies commonly found in association with it are *Erebia magdalena mackinleyensis* Gunder and *Boloria (Clossiana) astarte distincta* (Gibson). The flight of the moth is weak and fluttering, similar to that of a large caddisfly. In spite of this, they are hard to catch because of difficult footing on the rocky slopes and because males tend to move along rapidly in the wind. Most activity is confined to bright, sunny periods. Males rest during cloudy periods and at night when the sun is low on the horizon.

After collecting a series of males, an attempt was made to find a female. Males were followed in the hope that they would go to a female; however, after several days none was found. In late June we



FIGS. 13–16. Details of larval characters of *Acsala anomala*. **13**, inside view of A_3 proleg showing heteroideous crochets; **14**, lateral view of A_3; **15**, inner surface of mandible showing mola; **16**, inner surface of mandible of Arctiinae, *Spilosoma vagans* (Boisduval) for comparison.

traveled north to the Richardson Mountains where eggs, larvae, empty cocoons, and several females were found by searching under rocks on rocky slopes and hilltops. Females spend most of the time under rocks but probably crawl onto the upper surface to mate. One female that had just mated was observed on top of a rock with a male. Egg batches of 6 to 30 eggs are laid in a single layer on the underside of a rock. Eggs are reddish orange when laid. They turn pale orange after about a week. Several hours before hatching, the black larval head capsule is visible through the eggshell. Details of egg sculpturing are shown in Figs. 9–12.

Larvae hatch from the eggs in eight to ten days, eat their eggshell, and then begin to feed on lichens. The first instar larva has a yellow-orange body with a black head and is about 2 mm long. The larvae hide during the day (Fig. 3); they feed on lichens during the evening and at night when the sun is lower (Fig. 2). The larvae apparently feed almost exclusively on black colored, low, foliose lichens (*Paramelia stygia* (L.) Ach. and *Umbilicaria* cf. *proboscidea* (L.) Schrad.) and on black crustose lichens (*Orphniospora atrata* (Sm.) Poelt, *Buellia* cf. *spuria* (Schaer.) Anzi, *Lecidia armeniaca* (DC.) Fr., and *L. fuscocinerea* Nyl.).

The larvae probably take many years to mature. In June when adults are in flight, eggs and larvae of all instars except the first were found. The locations of several egg batches were marked in June; by the end of the summer most larvae had just molted to second instar. The larvae may tend to crawl upwards; abundance of larvae increases moving up a hill with the greatest densities occurring at the hilltop. Egg batches and females, however, were lower down, on the hillsides. The hilltop shown in Fig. 1 had larvae under almost every rock.

Cocoons are spun and attached to the underside of a rock. Larval hair is used in its construction. The pupa lacks excessive body hair found in lymantriid pupae but does have small clusters of hair at verrucae scars as is typical of arctiid pupae (Mosher, 1914). We could not determine whether mature larvae pupate in the fall or in the spring. When we left the Richardson Mountains at the end of the season, mature larvae but no pupae were found. After bringing them into the laboratory in late August several did pupate and adults emerged by mid-September. Larvae were relatively easy to rear on location where fresh lichens could be supplied each day. Rearing was difficult under laboratory conditions, however, because the lichens tended to dry out and if moistened, they would mildew.

Distribution and Abundance

Acsala anomala is known only from unglaciated areas in the northern half of Yukon and Alaska. It is probable that its range remained restricted following deglaciation because of habitat limitations and poor dispersal ability.

At first it seemed puzzling that a species that is so abundant as larvae should be relatively scarce as an adult. This anomaly can be explained by two factors; first, if the larvae take a number of years to mature, only a fraction of the larvae would pupate each year. Second, parasitism may take a heavy toll. Cocoons of a braconid parasite, *Meteorus* sp., were more common than were those of the moth. A tachinid parasite, *Tryphera* sp., was also present. In addition to these, an ichneumonid hyperparasite, *Gelis obesus* (Ashmead), was reared, this apparently attacking a second, uncollected, braconid parasite.

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