The Larva, Pupa and Female of *Agapetus jocassee* Morse (Trichoptera: Glossosomatidae)[1]

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ABSTRACT *Agapetus jocassee* is a "Species of Concern" on the lists of the U.S.D.I. Fish and Wildlife Service because it is known from only three streams of the Lake Jocassee catchment in Oconee and Transylvania counties, South and North Carolina. To assist in solving identification problems and to contribute to knowledge of the distribution of this species, larvae and pupae of *A. jocassee* were collected from mountain streams in North and South Carolina, reared to adulthood and identified. The larva, pupa, and female of the species are described for the first time. Characters were found in those ontogenetic stages that distinguish this species from other *Agapetus* species whose immature stages and females are known. The species was collected from two streams other than the type localities, suggesting that it may be more widely distributed in streams of the Blue Ridge Escarpment than previously thought.

KEY WORDS Appalachian Mountains, streams, taxonomy, endangered species, caddisflies, saddle-case makers

The genus *Agapetus* consists of 33 known North American species (Morse 1993) whose larvae are found in freshwater habitats where small rocks are easily accessible. Like those of the other genera of the family Glossosomatidae, the larva of *Agapetus* constructs a case of small rocks with a strap of fine sand along the underside of the case (Anderson and Bourne 1974, Wiggins 1996a). The strap along the bottom is cut away in preparation for pupation and the case is cemented to a rock. Then the larva spins a semipermeable cocoon inside the case, in which it pupates (Wiggins and Wichard 1989).

Larvae of *Agapetus* spp. often occur in the same habitat as those of a related genus, *Glossosoma*. There are several characteristics found in the larvae to differentiate these two genera. An obvious difference is that larvae of *Agapetus* species are generally smaller than those of *Glossosoma*. *Agapetus* species also have a smaller case (Figs. 13, 14), consisting of two large stones on the sides and

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smaller stones across the top while the case of *Glossosoma* species consists of uniform-size stones. The ventral apotome on the head of the larva (Fig. 4) is wider in *Agapetus* species than in *Glossosoma* species. There are two sclerites on the mesonotum of *Agapetus* species (Fig. 5) which are absent on *Glossosoma* species (Wiggins 1996a, Morse and Holzenthal 1996).

Because the larval stage of trichopterans is common through most of the year and is of most use in ecological studies and water-quality assessments, the ability to identify species in the larval stage is of great importance. Ability to identify larvae and other ontogenetic forms also is very useful for determining the distribution and abundance of a species. However, of the 33 North American species of *Agapetus,* the larvae of only three of these species, the pupa of only two species, and the females of only 13 species have been described with illustrations (Table 1).

Agapetus jocassee Morse is known only from adult males and only from Coley Creek and Bearcamp Creek, tributaries of Lake Jocassee, Oconee County, South Carolina, and Transylvania County, North Carolina (Morse et al. 1989). Because its range is limited to one catchment, this species has been shown on the U.S.D.I. Fish and Wildlife Service's "Species of Concern" list (formerly "Category 2," U.S.D.I. Fish and Wildlife Service 1994) and is being considered for citing as an endangered species.

Table 1. North American species of *Agapetus* for which the larva, pupa, and female genitalia have been described with illustrations.

LARVA
Agapetus diacanthus Edwards - Edwards 1956
Agapetus illini Ross - Ross 1944
Agapetus minutus Sibley - Sibley 1926

PUPA
Agapetus illini Ross - Ross 1944
Agapetus minutus Sibley - Sibley 1926

FEMALE GENITALIA
Agapetus alabamensis Harris - Harris 1986
Agapetus arcita Denning - Denning 1951
Agapetus avitus Edwards - Harris 1984
Agapetus boulderensis Milne - Denning 1948
Agapetus diacanthus Edwards - Edwards 1956
Agapetus hessi Leonard and Leonard - Schmid 1980, 1982
Agapetus illini Ross - Ross 1938, 1944
Agapetus iridis Ross - Schmid 1982
Agpaetus malleatus Banks - Denning 1966
Agapetus montanus Denning - Denning 1949
Agapetus orosus Denning - Denning 1950
Agapetus pinatus Ross - Schmid 1982
Agapetus rossi Denning - Schmid 1982
Agapetus vireo Ross - Ross 1941

The purpose of this study is to describe the larval, pupal, and female forms of this potentially endangered species and to discover whether its distribution may be broader than the Lake Jocassee catchment.

Materials and Methods

Larvae and pupae were collected from undersides of rocks in streams and rivers of the Blue Ridge Escarpment in North Carolina and South Carolina. Living specimens were placed in Ziplock® bags containing stream water and put on ice in a cooler for the 1-hr return trip to Clemson Univ., Clemson, S.C. At the lab, the larvae and pupae were placed in a plexiglass artificial stream and allowed to mature. This stream is a rectangular trough through which recirculating water is pumped; the trough is divided into compartments that are separated by plastic screen through which the water passes. The artificial stream was checked daily, any emerged adults were removed with their associated cases (containing larval sclerities) and discarded pupal exuviae, and these were preserved together in alcohol. Each specimen was labeled according to date and location of collection. Males of *A. jocassee* were identified, permitting positive identification of their associated larval sclerites and pupal exuviae. Mature male pupae were identified by examination of fully-developed genitalia visible through the transparent pupal exuviae. Reared females with similar larval sclerites and pupal exuviae were considered to be the same species. Larvae were identified by comparing them with larval sclerites from reared specimens. Potentially diagnostic characteristics were investigated in larvae, pupae, and females and compared with characters of specimens of other *Agapetus* species in the Clemson Univ. Arthropod Collection and of published illustrations of these ontogenetic forms for other North American *Agapetus* species (Table 1).

Voucher specimens noted in "material examined" below have been deposited in the Clemson Univ. Arthropod Collection.

Agapetus jocassee Morse, 1989

Larva: Head (Fig. 1) very lightly colored, almost white. Number and arrangement of setae on the head typical of the genus. Mandibles (Fig. 2, 3) of the same off-white color with darkened apical half; each mandible with row of six setae along mesal ridge. Ventral apotome (Fig. 4) relatively wide, typical of the genus.

Thoracic nota (Fig. 5) lightly colored; pronotum slightly darker than other two segments. Irregular row of about 15 secondary setae near each anterolateral corner of pronotum, three ventrolaterally at basal expansion, and irregular transverse row of about nine pairs of setae subbasally. Pair of subdorsal mesonotal sclerites, each with two setae (sa1 and sa2 setae), and pair of subdorsal metanotal sclerites (at sa3 ?) without setae. Tarsal claws for all legs (Fig. 6) each with seta occurring at tip of small process. Legs (Figs. 7-9) of same light color as thoracic nota and with dark markings at joints.

Abdomen lightly colored. Ventral side of abdominal segment II with pair of patches of minute spines (Fig. 10). Subdorsal setae on abdominal terga VIII and IX equidistant (Fig. 11). Sclerite on tergum IX slightly darker than surrounding membranous portions, its shape, setation, and markings typical of genus. Anal hook (Fig. 12) on each anal proleg with two accessory hooks.

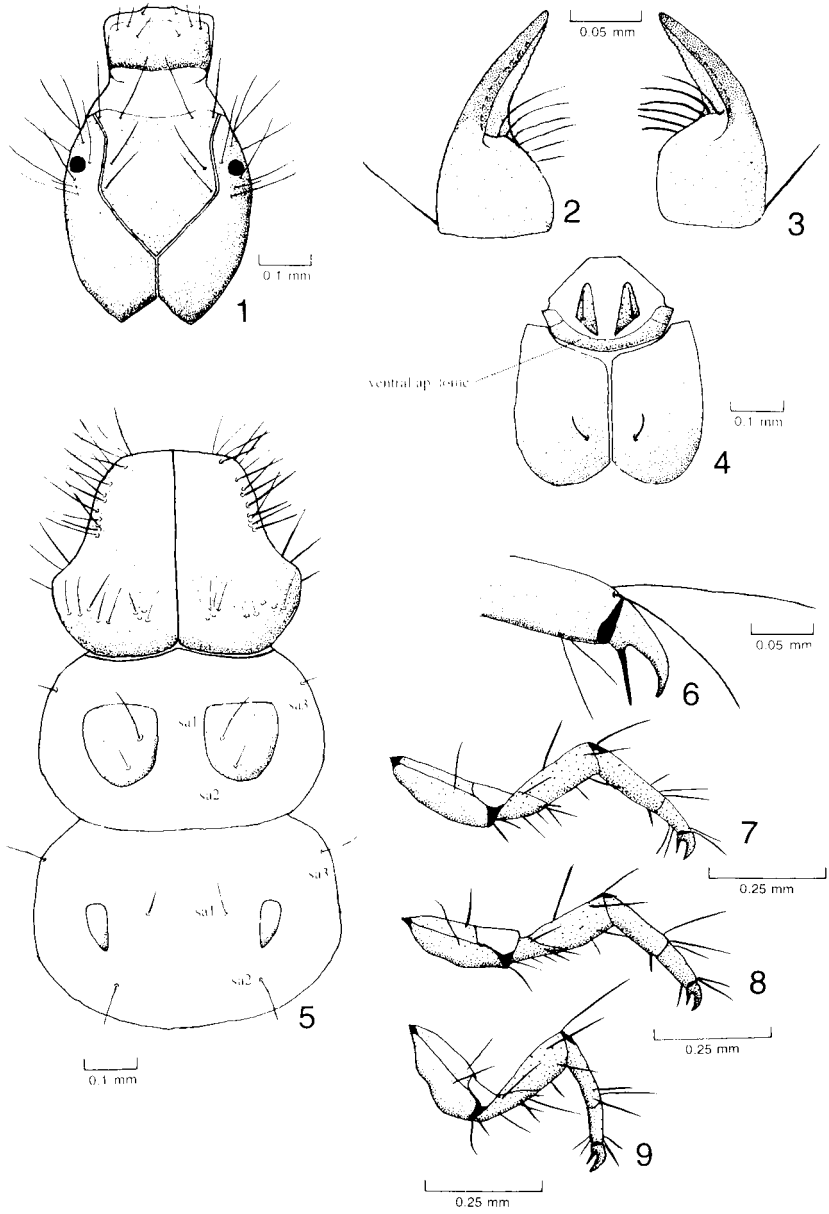

Fig. 1-9. Larva of *Aapetus jocassee* Morse. 1, head, dorsal; 2, right mandible, ventral; 3, left mandible, ventral; 4, head, ventral; 5, pronotum and mesonotum and metanotum, dorsal; 6, right foreleg tarsal claw, caudal; 7, right foreleg, caudal; 8, right middle leg, caudal; 9, right third leg, caudal.

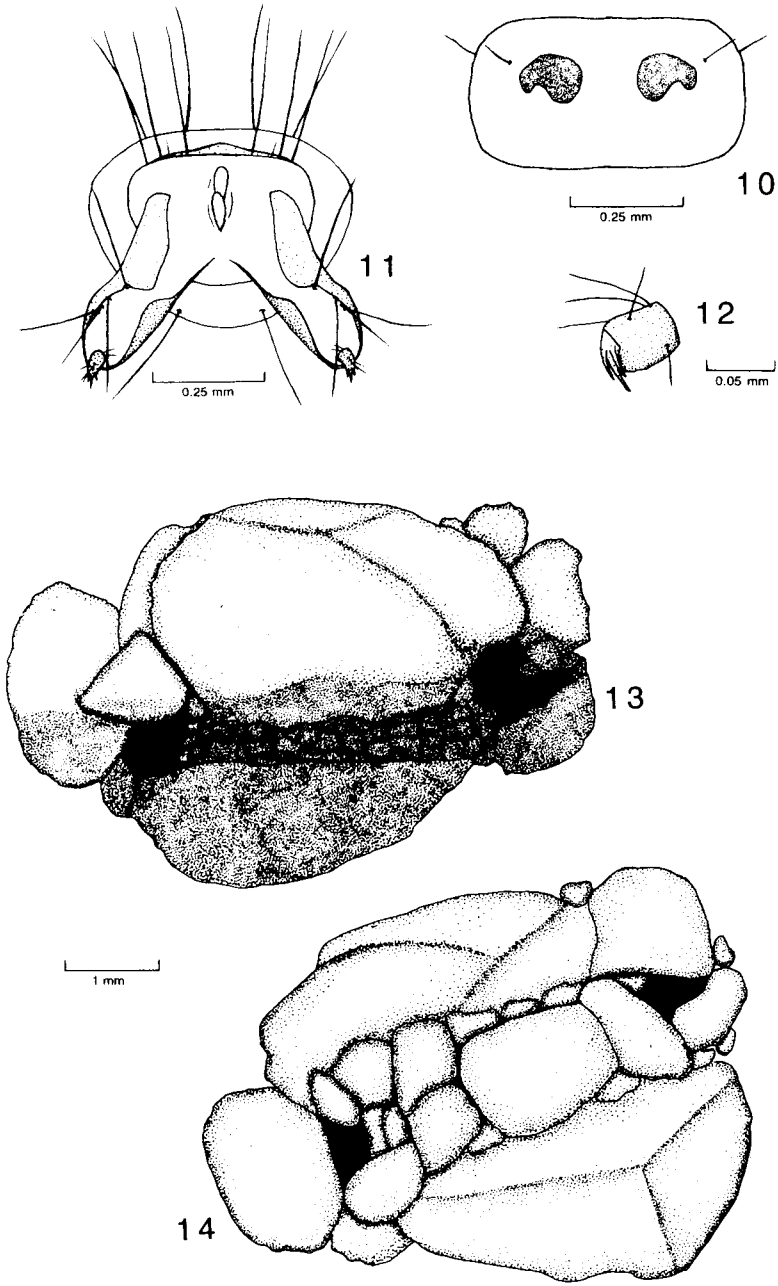

Fig. 10-14. Larva and larval case of *Agapetus jocassee* Morse. 10, abdominal sternum II, ventral; 11, end of abdomen, caudal; 12, claw of right anal proleg, right lateral; 13, larval case, ventrolateral; 14, larval case, dorsal.

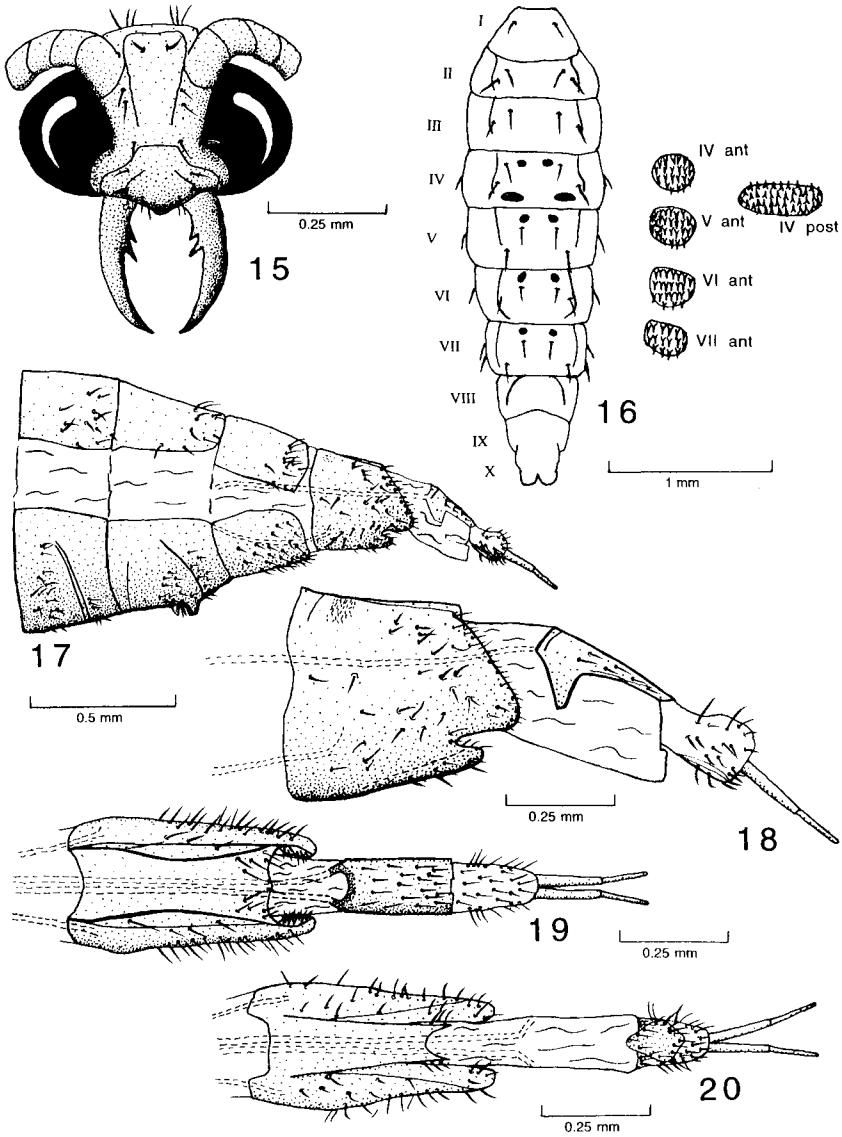

Fig. 15-20. Pupa and female of *Agapetus jocassee* Morse. 15, pupal head, frontal; 16, pupal abdomen, dorsal; 17, female abdominal segments V - XI, left lateral; 18, female abdominal segments VIII - XI, left lateral; 19, female abdominal segments VIII - XI, dorsal; 20, female abdominal segments VIII - XI, ventral.

Case (Figs. 13-14) composed of one large stone on each side, smaller stones at ends, still smaller stones dorsally, and fine sand grains in middle ventrally forming "plastron" of this "turtle-shell" or "saddle" case, relatively narrower and taller than that of *Glossosoma* species. Head and end of abdomen protruding from ventral openings interchangeably. Irregular port dorsally near each end.

Pupa: Head (Fig. 15) dark brown. Mandibles (Fig. 15) very dark brown, with two mesal teeth of similar size, relatively widely separated.

Thorax of same dark brown color as head. Legs long and lighter in color.

Abdomen (Fig. 16) reddish brown. Pairs of subdorsal setae on abdominal terga I-VII, and along sides of terga IV-VII. Pair of small anterior hookplates on each of terga IV-VII and posterior hookplates on tergum IV. Abdominal segments IX-X without tufts of setae.

Female: Female head and thorax brown, structure identical with that of male.

Abdomen light brown. Segment VIII (Figs. 17-20) synsclerotized, with groove on dorsal side of segment (Fig. 19) and with apical subventral invaginations relatively narrow on either side of apicoventral median plate (Fig. 18); median plate with acute apicolateral angles (Fig. 20). Segment IX vestigial (Schmid 1980). Segment X (Figs. 17-19) small in comparison with segment VIII. Segment XI (Fig. 20) membranous, twice as long as wide, with pair of long, 2-segmented cerci.

Material examined: N.C., Jackson Co., Whitewater River at state route 281, 14 July 1995, 1 male metamorphotype, coll. J. S. Craft; SC, Oconee Co., East Fork Chattooga River at Walhalla State Fish Hatchery, 19 July 1995, J. S. Craft, 1 male; same, except 20 July 1995, J. S. Craft, 1 male, 1 female, 1 female metamorphotype; same, except 4 August 1995, 4 larvae, J. S. Craft; same, except 5 August 1995, 3 larvae, J. S. Craft.

Results and Discussion

An additional character that may prove useful for distinguishing larvae of *Agapetus* species from those of *Glossosoma* is the pair of patches of minute spines on abdominal sternum II (Fig. 10 and Sibley 1926); larvae of *Glossosoma* species known to us have a single band of minute spines across sternum II.

An error was found in the most recent family key for North American pupae (Wiggins 1996b). That key states that Glossosomatidae pupae possess one or two pairs of hookplates on abdominal tergum III, two pairs of hookplates on terga IV-V, one pair on each of terga VI-VII; it further states that either terga VIII and/or IX each have a pair of hookplates and/or a pair of tufts of apical setae occur on tergum IX-X. However, the *A. jocassee* pupa (Fig. 16) and the *A. minutus* pupa (Sibley 1926) lack any hookplates on terga III, VIII, and IX and lack posterior hookplates on tergum V; they also lack tufts of apical setae on tergum IX-X. Apparently, the same is true for the *A. diacanthus* Edwards pupa (Edwards 1956).

Characteristics were found to distinguish *A. jocassee* from other known species of *Agapetus* in the larval, pupal and adult female stages. The larva of *A. jocassee* differs from those of *A. illini* Ross and *A. diacanthus* in that the anal claw of *A. jocassee* has two accessory hooks (Fig. 12), those of *A. illini* and *A. diacanthus* have only one accessory hook (Ross 1944, Edwards 1956). The head and the pronotum of *A. jocassee* are very light in color (Fig. 1), unlike those of *A. minutus* Sibley, which has a head that is "very dark brown except for a pale ring around the eye"

and a pronotum that is "dark brown to black" (Sibley 1926). Each mandible of the *A. jocassee* larva (Figs. 2, 3) has a row of six setae along its mesal ridge, differing from an unnamed *Agapetus* species (from Giles Co., Va.) that has a fan-like process in a similar position (Wiggins 1996a) and from *A. minutus* that has "a curious internal brush of little ribbons" (Sibley 1926).

In the *A. jocassee* pupa, subapical teeth on the mandible (Fig. 15) are more nearly equal in size and are more widely separated than in *A. illini* (Ross 1944). Insufficient detail was given by Sibley (1926) to distinguish the *A. jocassee* pupa from that of *A. minutus*.

In the *A. jocassee* female, segment VIII has deep apical subventral invaginations relatively narrow on either side of a median sternal plate (Figs. 17, 18, 20). Most other described females of North American *Agapetus* species have either no posterior invaginations or these are broad and subdorsal, occurring above the midline in lateral view. *Agapetus montanus* Denning has both subdorsal and subventral invaginations in lateral view (Denning 1949). The subventral invaginations of *A. jocassee* are much deeper than those of *A. iridis* Ross (Schmid 1982).

Whitewater River, like the type locality streams, is a tributary of Lake Jocassee. However, the East Fork Chattooga River is part of the next catchment west of Lake Jocassee. Therefore, from this research, the range of this species was found to be less restricted than first believed. This suggests that listing as an endangered species may not be necessary. Other streams along the Blue Ridge Escarpment should be investigated in attempts to locate additional populations of this species.

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