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A NEW SPECIES OF *ANICETUS* (HYMENOPTERA: ENCYRTIDAE)
PARASITIZING TERRAPIN SCALE, *MESOLECANIUM NIGROFASCIATUM*
(HEMIPTERA: COCCIDAE)

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ABSTRACT

Anicetus carolinensis Meyer (Hymenoptera: Encyrtidae) is proposed as the name of a new species found parasitizing terrapin scale, *Mesolecanium nigrofasciatum* (Pergande) (Hemiptera: Coccidae), in North Carolina. Both sexes are described and illustrated together with notes on the life history, host range, and reproductive behavior of the species.

Key Words: *Anicetus carolinensis*, blueberry, Encyrtidae, terrapin scale, Coccidae, *Mesolecanium nigrofasciatum*

RESUMEN

Proponemos *Anicetus carolinensis* Meyer (Hymenoptera: Encyrtidae) como el nombre de una nueva especie encontrada en Carolina del norte parasitizando la escala terrapin, *Mesolecanium nigrofasciatum* (Pergande) (Hemiptera: Coccidae). Describimos e ilustramos ambos sexos, y damos notas sobre el ciclo de vida, sobre el rango de los insectos hospederos, y sobre el comportamiento reproductivo de la especie.

Terrapin scale, *Mesolecanium nigrofasciatum* (Pergande), is an occasional pest of tree fruits and shrubs throughout much of the southern and eastern United States. It is considered a sporadic pest in commercial blueberry plantings (*Vaccinium* spp.) where it produces copious honeydew that coats the foliage and promotes growth of sooty mold in late summer (Milholland & Meyer 1984). Simanton (1916) provided a comprehensive summary of the terrapin scale's life history. The species is univoltine and overwinters as mated females on host plant stems.

Numerous predators and parasites have been reported attacking the terrapin scale (Simanton 1916; Williams & Kosztarab 1972). These include ladybird beetles, lacewings, a predaceous pyralid, a predatory bug and more than 25 species of parasitic wasps in the families Aphelinidae, Encyrtidae, Eulophidae, and Mymaridae (Simanton 1916; Thompson 1944; Peck 1963). In an effort to assess the potential for biological control of terrapin scale in North Carolina, a survey for endemic parasites was conducted from 1990-1998 in commercial and abandoned blueberry fields in four southeastern counties: Bladen, Duplin, Sampson, and Pender. During the course of the survey we collected a new species of encyrtid wasp, which is here described.

MATERIALS AND METHODS

Each spring, beginning in early March, blueberry branches infested with terrapin scale were

collected and confined under laboratory conditions in cardboard emergence cages (Meyer & Nalepa 1991). Collections continued on a bi-weekly schedule until the overwintered generation of scale could no longer be found in the field (late June). All collected material was held at $21 \pm 2^\circ\text{C}$ for at least 60 days under ambient photoperiod. Parasites were harvested daily as they appeared in emergence cages or from debris at the bottom of the cage after disassembly. Adults were fixed in Kahle's solution and stored in 70% ethanol or mounted on paper points. After stepwise dehydration to toluene through absolute ethanol, some specimens were mounted on glass slides in Kleermount® (Carolina Biological Supply Co., Burlington, NC 27215) for microscopic study.

More than 1200 individual parasites were reared from terrapin scale during the 9-year survey. Representative specimens of unknown species were sent to the North Carolina Department of Agriculture (Kenneth Ahlstrom) or Systematic Entomology Laboratory, PSI, USDA (Michael Schauff or Paul Marsh) for identification. Of these, 62% were identified as *Metaphycus californicus* (Howard), 10% as *Coccophagus lycimnia* Walker, and 8% as other species presumed to be incidentals or hyperparasites (e.g., *Marietta* sp.). The remaining 20% were Encyrtidae belonging to an undescribed species in the tribe Cerapterocerini (Noyes 1984).

This new species has a mixture of the features used by Annecke (1967) to separate the genus *Paracercoprocerus* from *Anicetus*: both the shape

of the antennal scape and length of the antennal club conform to his description for *Paraceraptrocercus*, but all other features including articulation of the pedicel, wing chaetotaxy, surface sculpturing of the head, and segmentation of the antennal club resemble *Anicetus*. Because the name *Anicetus* has priority and Noyes (1984) has already suggested that these genera may be synonymous, the new species is here assigned to the genus *Anicetus*. In Annecke's (1967) key to this genus, females of the new species key out to *A. toumeyellae* (Milliron) but differ notably in shape of the antennal scape, coloration of the legs, and patterning of the forewing. In *A. annulatus*, the only other North American species in this genus, females are paler in color, the antennal scape is triangular, and wings are more uniformly fuscous with a longer marginal vein. No key to the males has been published.

Anicetus carolinensis Meyer, new species

Adult Female

Color generally straw yellow to dark honey brown, metasoma (abdomen) darker than head and thorax. Body length 1.0-1.4 mm (exclusive of ovipositor); width 0.4-0.5 mm at mesosoma (thorax).

Head: Sparsely setaceous and cellulose-reticulate above and between compound eyes, smoother from median ocellus to frontal-facial carina; scrobal basins bare and cellulose (Fig. 1A). Ocellar triangle isosceles, 3:4 base to height ratio. Compound eyes large with ventral and medial margins nearly linear; ommatidia hexagonal, arranged in horizontal rows.

Antennae laterally flattened (Fig. 1B). Scape subrectangular, darkly margined; inner aspect convex, reticulate, and setaceous; outer aspect concave, smoother, and more glabrous except for single row of setae along dorsal margin. Pedicel small, triangular, articulated within subapical cleft on outer dorsal margin of scape. Flagellum composed of funicle with six distinct, articulating units (flagellomeres) and clava with three distinct, conjoined units. Clava darkly pigmented, matching dorsal margin of funicle and edges of scape, remainder of antenna golden brown. Funicle I more than 1.5× longer than funicle II, scissoring behind scape during antennal flexion; funicles II-VI subequal in length, always exposed. Each funicle unit longer dorsally than ventrally, partially nested, and asymmetrically articulated about 1/3 below dorsal margin. Setae present on both aspects of entire flagellum, shorter and mixed with peg-like sensilla on ventral margin of clava III.

Mouthparts characteristic of the genus: labrum small and triangular, mandibles tridentate, maxillary palpi 4-segmented, labial palpi 3-segmented.

Mesosoma (Thorax): Pronotum narrow, collar-like. Mesoscutum broadly convex, sparsely setaceous, and dusky brown to fuscous with metallic highlights; notaular lines absent. Axillae and scutellum with fine reticulations; color light yellow to dark honey brown with fuscous setae. Propodeum with lateral posterior corners acute; surface texture smooth; color straw yellow to dark honey brown.

Legs without special modifications, color straw yellow; mesothoracic leg with tibial spur nearly as long as tarsomere I.

Forewing with submarginal vein slender, length equal to greatest width of wing; parastigma slightly thickened. Marginal vein short, length 5-7× its width. Stigmal vein shorter than marginal vein but longer than postmarginal vein. Three circular sensilla present on uncus (Fig. 1E). Costal cell hyaline, glabrous except along leading edge. Basal cell subtriangular, surrounded by single row of setae, truncated apically near base of parastigma by dark, setaceous band (band perpendicular to submarginal vein, fading into linea calva). Remainder of basal triangle hyaline, devoid of setae. Second dark spot, arising from marginal vein, fading apically into a hyaline streak, blending posteriorly into smoky pigmentation. Main blade of wing clothed with short, dark setae; mostly smoky brown in color except for hyaline patches in apical fourth and along trailing edge (Fig. 1D).

Metasoma (Abdomen): Gaster smoky brown in color, dorsal aspect generally heart-shaped, acute apically, longer than wide. Base of gaster produced anteroventrally, fitting into propodeum between metathoracic coxae. Cercal plates retracted to anterior third of abdomen; each plate with three bristles. Ovipositor long, 0.50-0.65 mm in length, arising near base of gaster, extending beyond apex by about half length of mesothoracic tibial spur.

Adult Male

Adult Male

Head and body color predominantly black with weak metallic reflections of green or blue; length 0.9-1.2 mm (exclusive of aedeagus), width 0.3-0.4 mm at mesosoma.

Head: Cellulose-reticulate, lightly setaceous above median ocellus and below antennae. Scrobal basins subcircular, separated by a median ridge. Ocellar triangle equilateral. Compound eyes smaller than in female, separated by more than radius of eye, rounded on ventral and medial margins. Ommatidia hexagonal, arranged in oblique rows.

Antennae light brown in color, with darker setae and sensilla. Scape clavate with globose radicle; inner aspect lightly reticulate, and sparsely setaceous; outer aspect deeply grooved and glabrous. Pedicel globose, articulating within socket on outer apex of scape, sparsely setaceous. Flagellum composed of funicle with six distinct, articulating units (flagellomeres) and clava with three

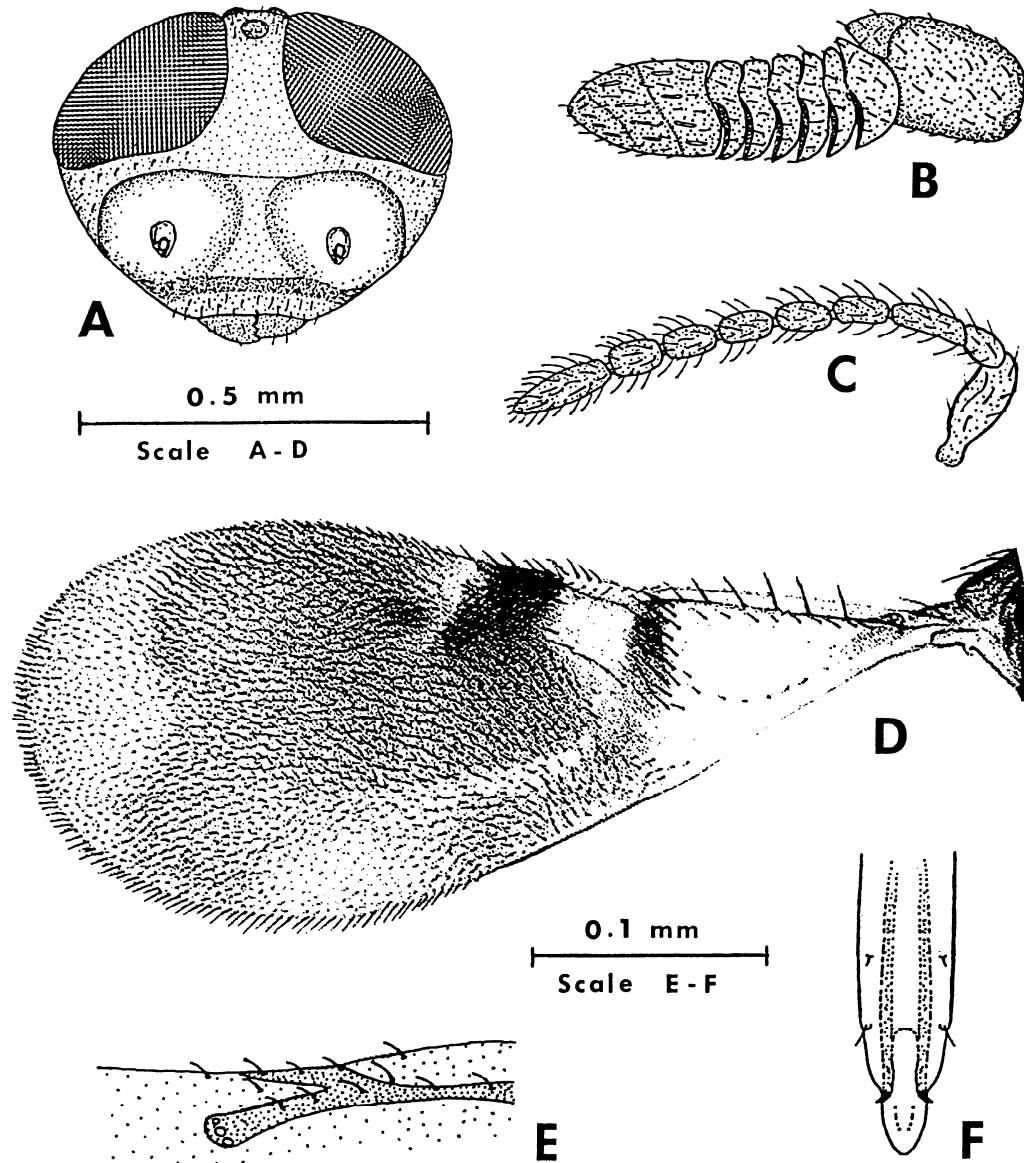


Fig. 1. Distinctive morphological features of *Anicetus carolinensis*. A, Head of adult female, frontal view with antennae removed to expose scrobal basins; B, Right antenna, adult female, inner aspect; C, Right antenna, adult male, inner aspect; D, Left forewing of female, digitally rendered from a photograph; E, Detail of stigmal vein in female's forewing, showing location of circular sensilla; F, Male genitalia, dorsal view.

indistinct, conjoined units (Fig. 1C). Funicle I cylindrical, subequal to scape in length and diameter, more than 1.5× longer than funicle II. Funicles II-VI subequal in length and diameter. Clava barely longer than scape or funicle I, subequal in diameter, pointed at apex. Funicles I-VI and clava densely clothed with long trichoform sensilla.

Mouthparts similar to female: mandibles tridentate, maxillary palpi 4-segmented, labial palpi 3-segmented.

Mesosoma (Thorax): Dark brown to black with metallic highlights. Pronotum narrow, collar-like. Mesoscutellum broadly convex, lightly reticulate, sparsely setaceous; notaular lines absent. Axillae

and scutellum cellulate-reticulate, sparsely setaceous. Propodeum with lateral posterior corners acute, surface texture smooth, color cinnamon to dark smoky brown.

Legs without special modifications; mostly creamy yellow to ivory except for black pulvilli; femur, tibia, and apical tarsomere of metathoracic legs fuscous except around joints; mesothoracic leg with tibial spur nearly as long as tarsomere I.

Forewing hyaline, venation similar to female. Costal cell and basal triangle bare except for setae around perimeter, linea calva distinct, main blade uniformly clothed with short, dark setae.

Metasoma (Abdomen): Gaster generally heart-shaped, rounded at apex, length subequal to width; dark brown to smoky black in color, lighter and more translucent between segments when distended to expose membranes. Cercal plates retracted to middle of abdomen; each plate with three bristles. Genitalia as in Fig. 1F, with digital hooklets small and bent outward.

Type Material

All type specimens were reared from terrapin scale, fixed in Kahle's solution, and preserved in 70% ethanol. Holotype: female emerged 21 V 1991 from terrapin scale collected 2 V 1991 on high-bush blueberry (*Vaccinium corymbosum* L.), near town of Ammon, Bladen Co., North Carolina, J. R. Meyer. Allotype: male emerged 20 V 1991 from above scale collection and observed courting holotype. Paratypes: 7 females, 6 males, emerged 18-31 V 1991, same scale collection as Holotype. Ho-

lotype, allotype, and 7 paratypes (4 females and 3 males) have been deposited in the NC State University Insect Collection. Six paratypes (3 females and 3 males) have been deposited in the National Museum of Natural History, Washington, DC. Additional specimens, reared from terrapin scale collected 1993-1998 in Bladen, Duplin, Pender, and Sampson Counties, have also been deposited in the NC State University Insect Collection.

Etymology

The name of this species commemorates the state of North Carolina where it was first collected.

Life History

Based on the timing of adult emergence, at least two generations of *A. carolinensis* occur each year (Devorshak 1994). Adults of the overwintering generation emerge in April and early May, while adults of the second generation begin emerging in June and continue until all overwintered scale have dropped from the plant in early July.

Host Range

Despite extensive collections of scale insects on blueberry and other indigenous plants in the southeastern coastal plain of North Carolina, *A. carolinensis* has only been reared from terrapin scale. In the laboratory, however, it has been tested against eight species of soft scale (Devorshak 1994) and found to oviposit in three of them (Table 1). Despite oviposition, no development was detected

TABLE 1. OVIPOSITION RESPONSE OF *ANICETUS CAROLINENSIS* TO COMMON SPECIES OF SOFT SCALE (HEMIPTERA: COCCIDAE).

Scale species	Oviposition
Terrapin scale, <i>Mesolecanium nigrofasciatum</i> (Pergande)	
Adult female	Yes
Second instar	No
Indian wax scale, <i>Ceroplastes ceriferus</i> (Fabricius)	
Adult female	Yes
Second instar	Yes
Florida wax scale, <i>Ceroplastes floridensis</i> Comstock	
Adult female	Yes
First and second instars	Yes
Brown soft scale, <i>Coccus hesperidum</i> Linnaeus	
All stages	No
Green scale, <i>Coccus viridis</i> (Green)	
All stages	No
Hemispherical scale, <i>Saissetia coffeae</i> (Walker)	
All stages	No
Caribbean black scale, <i>Saissetia neglecta</i> De Lotto	
All stages	No
Pyriform scale, <i>Protospulvinaria pyriformis</i> (Cockerell)	
All stages	No

in either species of *Ceroplastes* and evidence of egg encapsulation was found in Florida wax scale, *C. floridensis* Comstock (Devorshak 1994).

Oviposition Behavior

When presented with a potential host, a gravid female criss-crosses the scale, holding her antennae very close together while tapping and brushing the entire surface of the scale with the ventral surface of her antennal clava. After one or more of these transits, she probes the lateral edge of the scale with her antennae and then, moving to one side, backs up to the scale and inserts her ovipositor beneath the lateral edge of the scale's derm. This behavior is consistently observed with overwintered terrapin scale (adult females), but never with younger stages. By contrast, oviposition behavior has been observed with first and second instars (and adults) of the Florida wax scale and with second instars (and adults) of the Indian wax scale, *C. ceriferus* (Fabricius). In both species of wax scale, female *A. carolinensis* oviposit directly through the dorsal cuticle, not under the edge of the derm.

DISCUSSION

Asynchrony between the bivoltine life cycle of *A. carolinensis* and the univoltine life cycle of its host raises several unanswered questions about the parasite's biology and behavior. When parasites emerge from overwintering scale in April or early May, terrapin scale hosts are large, full of developing embryos, and readily accepted by *A. carolinensis* for oviposition. Crawler emergence usually occurs in late May and early June. By mid-June crawlers have departed and most of the remaining scales are parasitized. When adults of this second generation emerge in late June, a suitable host is no longer present—crawlers and second-stage nymphs are not accepted for oviposition. What is the fate of these individuals? Do they survive the summer and lay eggs on mature scale in the fall? Do they have an alternate host? Or do they simply die without reproducing? Over the past 10 years, we have been unsuccessful in locating an alternative host or collecting

adults in the fall. Clearly, we have much more to learn about this insect!

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