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A REVISION OF THE SPECIES OF *NEMATOCAMPA* (GEOMETRIDAE: ENNOMINAE) OCCURRING IN THE UNITED STATES AND CANADA

DOUGLAS C. FERGUSON

Systematic Entomology Laboratory, Agricultural Research Service, USDA,
% U.S. National Museum of Natural History, Washington, D.C. 20560

ABSTRACT. The three nearctic species of *Nematocampa* are revised, with special emphasis on the biology and complex nomenclatural history of the type species, *N. resistaria* (Herrich-Schäffer, 1855). Of the two names most commonly applied to this species, *limbata* Haworth, 1809, is a primary homonym, and *filamentaria* Guenée, 1857, is a junior synonym of *resistaria*. *Nematocampa resistaria* is transcontinental; *N. brehmeata* (Grossbeck, 1907) is limited to California; ***N. baggettaria*, new species**, is southeastern; and *N. expunctaria* Grote, 1872, is synonymized under *N. resistaria*. The well-known larva of *N. resistaria* feeds on plants of at least 20 families, but the larvae of the others are unknown. About 20 additional species occur in the neotropics.

Additional key words: taxonomy, nomenclature, host plants.

Nematocampa Guenée is a New World genus of at least 23 species, a few of which apparently are undescribed. Although concentrated in the tropics and occurring southward to Argentina, three species are present in the temperate zone of the United States, and one reaches Canada. The neotropical species are diverse and may not all be congeneric. A few other neotropical Ennominae, perhaps most notably *Melinodes conspicua* Schaus from Brasil, have a reticulate wing pattern suggestive of that of *Nematocampa* but are not closely related.

Although the type species, *N. resistaria* (Herrich-Schäffer), has a large literature that goes back to 1809, was found and drawn by John Abbot perhaps even earlier (Abbot drawing copied by Guenée 1857:9, p. xlvi; 1858:pl. 2, fig. 3), and is widely known because of its distinctive appearance and unusual, filament-bearing larva, its nomenclature and taxonomy have not been interpreted correctly. It was described under eight names, two of which, *N. limbata* (Haworth) and *N. filamentaria* Guenée, have competed incorrectly for priority in all of the more recent literature. Despite that long history, another very distinct species of the southeastern U.S. remained undiscovered until the 1980's and is described in this paper.

Originally I intended only to describe this new species, *Nematocampa baggettaria*, and perhaps verify the correct name for the type species. However, the paper assumed the proportions of a revision as more material and more literature were examined, and the full complexity of the problem unfolded. Every name referring to *Nematocampa* species in the fauna of America north of Mexico is here applied differently except that of *N. brehmeata*.

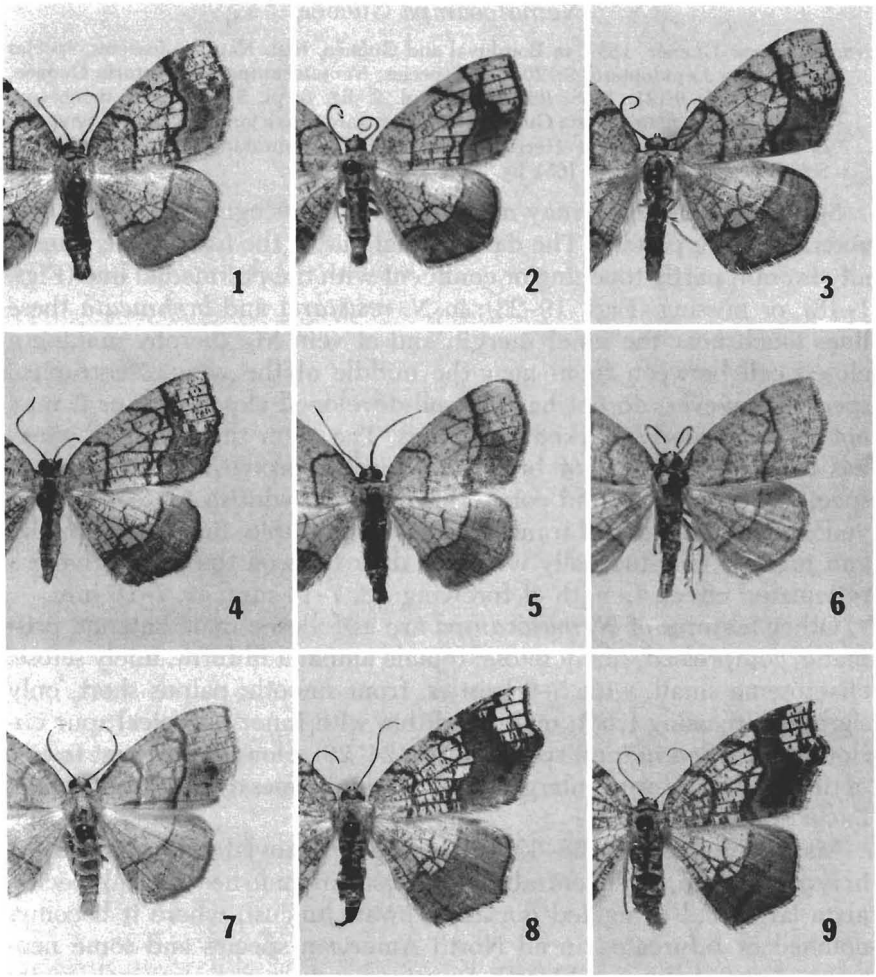
Nematocampa Guenée

Nematocampa Guenée, 1857, *in* Boisduval and Guenée, Hist. Nat. des Insectes, Species général des Lépidoptères 9:120. Type species: *Nematocampa filamentaria* Guenée, 1857, *ibidem* 9:121; 1858, *ibidem* Atlas:pl. 2, fig. 3; pl. 5, fig. 1, by monotypy. *Nematocampa filamentaria* Guenée is herein regarded as a junior subjective synonym of *Microgonia resistaria* Herrich-Schäffer, 1855, Sammlung Aussereuropäischer Schmetterlinge, p. 41, pl. [65], fig. 368.

Species of this genus may nearly always be recognized by the characteristic wing pattern. The dark medial line of the forewing is unusually far out, partly touching or confluent with the postmedial line (Figs. 1–18), or missing (Figs. 19–23); in *N. resistaria* and *brehmeata* these lines touch near the inner margin and at vein M_2, thereby making a closed cell between them near the middle of the wing. Neotropical species, however, do not have a well-developed closed cell, or it may not show in poorly marked specimens. The outer third of both wings has conspicuous areas of brown or purplish-brown shading in most species. The pale ground color, varying from whitish to deep orange yellow, is often striated transversely with multiple, fine, short streaks, and marked longitudinally with fine dark lines on the veins, giving a reticulated effect. Length of forewing: ♂♂, 7–14 mm; ♀♀, 7–16 mm.

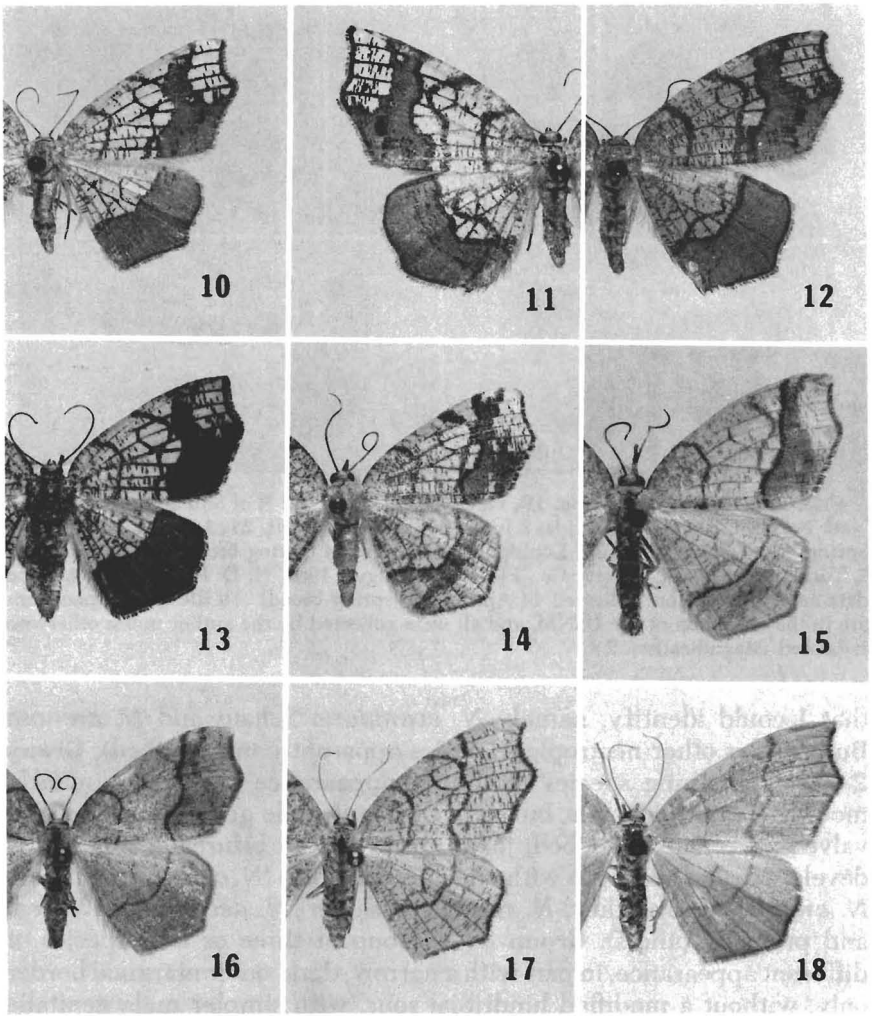
Other features of *Nematocampa* are as follows: male antenna prismatic, compressed, finely setose; female antenna filiform, finely setose; chaetosema small, with 5–6 bristles; front smooth; palpus short, only slightly surpassing front; male hindtibia with inner preapical spur curiously modified in most species (Figs. 24–26), elongated almost to end of tibia and claviform, enlarged distally to 2–4 times thickness of normal, linear spurs.

Male genitalia (Figs. 28–33) with end of gnathos laterally compressed in typical group, dorsoventrally compressed in some neotropical species; juxta large and elongated dorsally (toward uncus), where it becomes notched or bifurcated in all North American species and some neotropical ones; valve in all North American and some neotropical species divided into a long costal lobe and shorter, rounded, saccular lobe, as in Ennominae of the tribe Semiothisini; other neotropical species, presumed to be more primitive ones in this respect, have valve undivided; most neotropical species, those with undivided valve, have a pair of short spinose processes (resembling a furca) arising from juxta, one on each side; in those with a bilobed valve, the spinose processes have degenerated to a pair of simple sclerites flanking juxta and apparently forming narrow bridges between juxta and transtilla. A long, hairy corema (Fig. 28) arises laterally from near the base of each valve in most species, but may be reduced or vestigial (Fig. 30). Female genitalia typically with a longitudinally ovate signum, with an indeterminate number of dentate processes radiating from its margin.

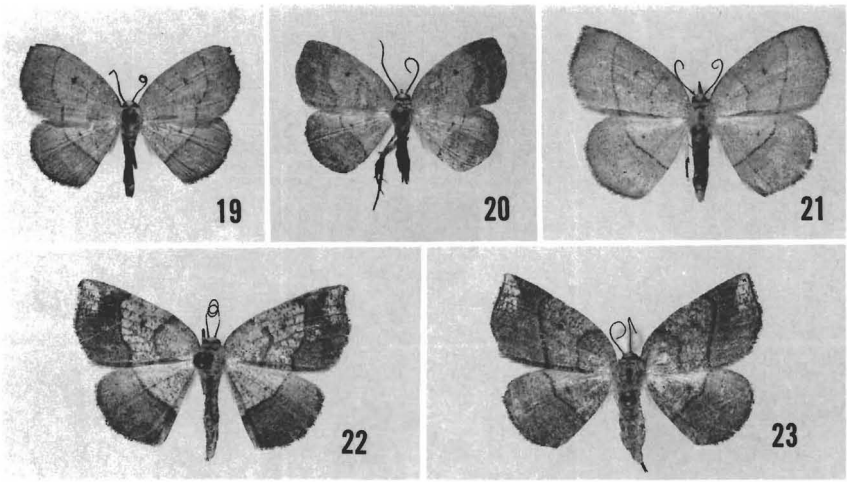


FIGS. 1–9. *Nematocampa resistaria*. **1,** ♂, Armdale, Halifax Co., Nova Scotia, 12 Aug. 1948. **2,** ♂, Seton Cr., Lillooet, British Columbia, 4 July 1991. **3,** ♂, Beaverton, 9 mi W of Portland, Oregon, 14 June 1963, C.W. Nelson. **4,** ♂, Oak Zone, 5 mi SW of Midway, Wasatch Co., Utah, 29 July 1971. **5,** ♂, Sycamore Landing, nr. Seneca, Montgomery Co., Maryland, 28 May 1977. **6,** ♂, McClellanville, Charleston Co., South Carolina, 20 May 1974, R. B. Dominick. **7,** ♂, Eagle L., Colorado Co., Texas, 27 April 1978, A. & M. E. Blanchard. **8,** ♀, Baddeck Bridge, Victoria Co., Nova Scotia, 29 July 1970. **9,** ♀, Sycamore Landing, Seneca, Montgomery Co., Maryland, 24 July 1976. Magnification: 2×.

Remarks. *Nematocampa* in the broad sense has three main species groups. **Group 1**—those with or without a modified hindtibial spur, but always with a bilobed valve, degenerate furca, strongly bifurcate juxta, and one cornutus; group 1 includes the three North American species treated in this revision and two closely related neotropical species



FIGS. 10–18. *Nematocampa* species. **10,** *N. resistaria* ♀, Oak Zone, 5 mi SW of Midway, Wasatch Co., Utah, 29 July 1971. **11,** *N. resistaria* ♀ (white ground color), nr. Elsie, Clatsop Co., Oregon, 2 Sept. 1968, S. G. Jewett. **12,** *N. resistaria* ♀ (yellow ground color), same locality, 6 Sept. 1968, E. L. Griepentrog. **13,** *N. resistaria* ♀, Withlacoochee State Forest, Hernando Co., Florida, reared from larva on *Myrica* 7 May 1983, H. D. Baggett. **14,** *N. brehmeata* ♂, Mt. Shasta (city), Siskiyou Co., California, 1 Aug. 1990. **15,** *N. brehmeata* ♂, Anderson Springs, Lake Co., California, 3 July 1949, W. R. Bauer. **16,** *N. brehmeata* ♂, same data as for Fig. 15. **17,** *N. brehmeata* ♀, same data as for Fig. 15 but collected 26 July 1952. **18,** *N. brehmeata* ♀, San Antonio Cr., Sonoma Co., California, 21 July 1939, W. R. Bauer. Magnification: 2×.



FIGS. 19–23. *N. baggettaria*. **19,** Holotype ♂. **20,** ♂, 8 mi N of Sumatra, Apalachicola Natl. Forest, Liberty Co., Florida, 2 June 1990, H. D. Baggett. **21,** ♂, 4.2 mi NE of Abita Springs, St. Tammany Parish, Louisiana, 25 April 1984 (spring brood), V. A. Brou. **22,** ♀, Torreya State Park, Liberty Co., Florida, 19 August 1982, H. D. Baggett. **23,** ♀, Same data as for Fig. 21 but collected 14 April 1984 (spring brood). All illustrated specimens are in the collection of the USNM, and all were collected by the author unless otherwise indicated. Magnification: 2×.

that I could identify, namely *N. evanidaria* Schaus and *N. arenosa* Butler (plus other neotropical species apparently undescribed). **Group 2**—the remaining species of similar appearance and with similarly modified hindtibial spur, but with different male genitalia, as follows: valve entire, not two-lobed; juxta not or hardly bifurcate; furca fully developed; and aedeagus with one or two cornuti (*N. completa* Warren, *N. angulifera* Oberthür, *N. reticulata* Butler, *N. decolorata* Warren, and probably others). **Group 3**—a group of three or four species of different appearance, in part with a narrow, dark, outer marginal border only, without a modified hindtibial spur, with simpler male genitalia and reduced juxta, no remnants of a furca, numerous cornuti in the vesica, and many other differences (e.g., some with bipectinate male antennae). This group includes *N. falsa* Warren, *N. confusa* Warren, and possibly *N. benescripta* Warren and *N. interrupta* Warren, although the last two seem different again. There is little to tie group 3 to *Nematocampa*, and these species will almost certainly be removed to other genera after further study. Certain species of other ennomine groups, most notably *Melinodes conspicua* Schaus from Brasil, may have a pattern suggestive of *Nematocampa* but are probably unrelated.

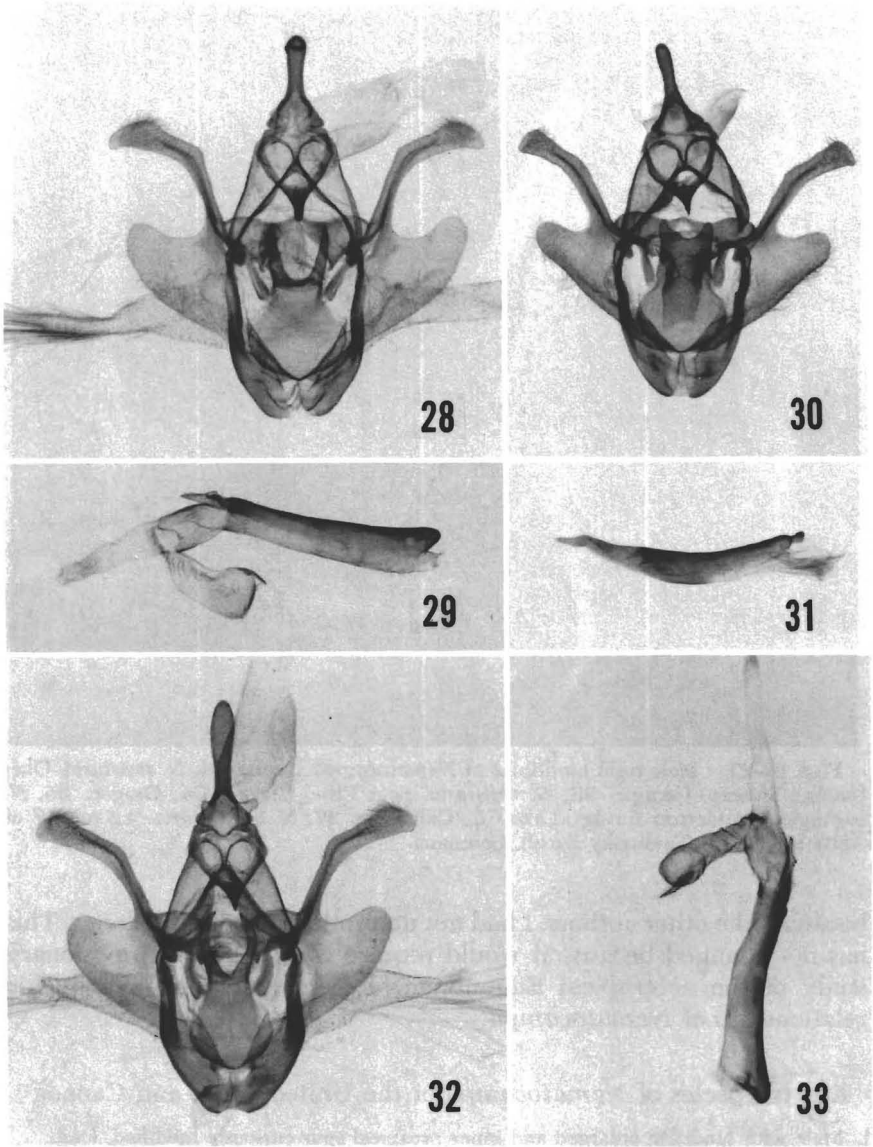
When I prepared the Check List of North American Geometridae (Ferguson 1983), I left *Nematocampa* at the end of the Ennominae

FIGS. 24–27. Male right hindtibiae of *Nematocampa* species. **24,** *N. resistaria,* Okefenokee Swamp, Georgia. **25,** *N. resistaria,* near Elsie, Clatsop Co., Oregon. **26,** *N. brehmeata,* Anderson Springs, Lake Co., California. **27,** *N. baggettaria.* 4.2 mi NE of Abita Springs, St. Tammany Parish, Louisiana.

because, like other authors, I had not determined where it belongs. This has not changed because it would require comprehensive revisionary study of the neotropical Ennominae to determine the phylogenetic relationships of *Nematocampa.*

Key to Species of *Nematocampa* of the United States and Canada

1. Male with hindtibia enlarged and inner preapical spur curiously modified, long, clavate (Figs. 24–26); ground color of wings whitish or yellow; wing length generally more than 10 mm; widely distributed 2
– Male with hindtibia not enlarged and preapical spurs unmodified (Fig. 27); ground color of wings orange brown to yellowish; moths small, wing length less than 10 mm; southeastern United States ..... *baggettaria*
2. Females with ground color white or nearly so; males with clavate hindtibial spur (Figs. 24, 25) longer than first tarsal segment, conspicuously swollen to 3–4 times thickness of other preapical spur; transcontinental, widespread ..... *resistaria*
– Females with ground color yellow (a few Oregon females of *resistaria* with yellow



FIGS. 28–33. Male genitalia. **28,** *N. resistaria,* McMinnville, Oregon. **29,** Aedeagus of same specimen. **30,** *N. baggettaria,* Jefferson Co., Florida. **31,** Aedeagus of same specimen. **32,** *N. brehmeata,* Anderson Springs, Lake Co., California. **33,** Aedeagus of same specimen.

ground color will key here); males with clavate hindtibial spur (Fig. 26) swollen only to twice thickness of other preapical spur; California ..... *brehmeata*

Nematocampa resistaria (Herrich-Schäffer), revised status
(Figs. 1–13, 24, 25, 28, 29, 34)

Phalaena limbata Haworth, 1809, Lepidoptera Brittanica, Pt. 2:346. (Publication dates for the four parts of the Lepidoptera Britannica were established by Griffin, 1932). **HOMONYM**

NOTE: *Phalaena limbata* Haworth is a junior primary homonym of *Phalaena limbata* Linnaeus, 1767, Systema Naturae, ed. 12, p. 873, which is the European species now known as *Evergestis limbata* (L.) (Crambidae). According to the International Code of Zoological Nomenclature (1985, Art. 59a), "a species-group name that is a junior primary homonym must be permanently rejected." It is unlikely that the name *limbata* could be conserved because it has not been in continuous use for the past 50 years. Some authors have used the name *filamentaria* Guenée for this species.

Macaria limbata, Stephens 1829(2):155. Wood 1839, 1854:116, pl. 26, fig. 748n.

Ania limbata, Stephens [1831]:322. Hulst 1896:373. Dyar 1902 [1903]:338.

Nematocampa limbata, Barnes and McDunnough 1917:121. McDunnough 1938:169. Ferguson 1983:98.

Type locality: England ("Angliae rarissime"). Presumed to be a false type locality.

Microgonia resistaria Herrich-Schäffer, 1855, Sammlung Aussereuropäischer Schmetterlinge, p. 41, pl. [65], fig. 368.

Nematocampa resistaria, Walker 1860:147.

Type locality: not given.

Microgonia vestitaria Herrich-Schäffer, 1855, ibidem, pp. 63, 82, pl. [65], fig. 368.

Type locality: Brasil (considered to be an error; see below).

NOTE: Herrich-Schäffer proposed different species names, *resistaria* and *vestitaria,* on different pages of the same work in reference to the same figure. The names were published simultaneously, but *resistaria* has page priority. This synonymy was recognized by Guenée (1857, pt. 9:121), who applied the name *resistaria* and listed *vestitaria* as a junior synonym. Walker (1860:147) did likewise, but Guenée qualifies as the first reviser. Packard (1876:471) synonymized both under *N. filamentaria* Guenée but attributed *resistaria* to Walker, 1860, overlooking Herrich-Schäffer's prior publication. Although Guenée (1857), oblivious in this instance to the principle of priority, used the older name *resistaria* for what he thought was a South American variety of his new North American species, *N. filamentaria,* both Walker (1860) and Packard (1876) considered *resistaria* to be the North American species. The names *resistaria* and *vestitaria* of Herrich-Schäffer, *filamentaria* Guenée, and *limbata* Haworth continued to be treated as synonyms by most subsequent authors.

Although the only type locality mentioned by Herrich-Schäffer is Brasil (for *vestitaria*), his figure 368 clearly represents a male of the widespread North American species. I found no neotropical species or specimen that agrees with the figure and consider the locality to be an error. A similar error may be seen in figures 373 and 374 on the same plate (pl. [65]). The type locality for *Gnophos armataria* Herrich-Schäffer is given as Venezuela, although the specimens depicted are of the North American species treated in more recent literature as *Priocycla* or *Cepphis armataria* (Herrich-Schäffer).

Nematocampa filamentaria Guenée, 1857, Hist. Nat. des Insectes, Species Général des Lépidoptères 9:121; pl. 5, fig. 1; pl. 2, fig. 3 (larva). Packard 1876:471, pl. 11, fig. 46; pl. 13, figs. 8, 8a. Capps 1943:147. Forbes 1948:110. Ferguson 1954:321.

Type locality: Canada, by present lectotype designation.

NOTE: This species was described from one male and three female specimens from "Amérique septentrionale." The male and one female are in the United States National Museum (USNM); but the location of the second female, the syntype illustrated by Guenée (1857:pl. 5, fig. 1), has not been determined. Although this syntype appears to belong to the genus *Nematocampa,* it does not agree with any known species.

Ordinarily, one would choose the illustrated syntype as the lectotype, but because the source and identity of the specimen shown by Guenée are in doubt, I hereby designate as lectotype the male in the USNM, which bears the word "Canada" on a small, round label, as well as the usual Guenée and Oberthür labels and a Guenée type label. Although the right wings and abdomen are lost, the specimen clearly represents *resistaria*; all the more so because it is from a region where only that species is known to occur. The specimen reached the USNM with other Guenée types through the Oberthür and Barnes collections.

Nematocampa expunctaria Grote, 1872, Canad. Entomol. 4:101. Capps 1943:147. Ferguson 1983:98. **REVISED SYNONYMY**

Nematocampa limbata form *expunctaria*, McDunnough 1938:169.

Type locality: Alabama. [Holotype in Academy of Natural Sciences of Philadelphia.]

Ania limbaria var. *chagnoni* Swett, 1913, Canad. Entomol. 45:76.

Type locality: Isle Ste. Therese, St. Johns Co., Quebec. [Holotype in Museum of Comparative Zoology, Harvard University (MCZ).]

NOTE: The name was based on one male of a melanic form of *N. resistaria*.

Nematocampa limbata orfordensis Cassino and Swett, 1922, The Lepidopterist 3:156. McDunnough 1938:169. Ferguson 1983:98. **REVISED SYNONYMY**

Type locality: Port Orford, Oregon. [Holotype male in MCZ.]

Eugonobapta brunneolineata Hulst, 1900, J. New York Entomol. Soc. 11:218. **REVISED SYNONYMY**

Ellopia brunneolineata, McDunnough 1938: 171

Nematocampa brunneolineata, Ferguson 1983:98 (as synonym of *expunctaria*)

Type locality: Hastings, Florida. [Holotype in American Museum of Natural History, New York.]

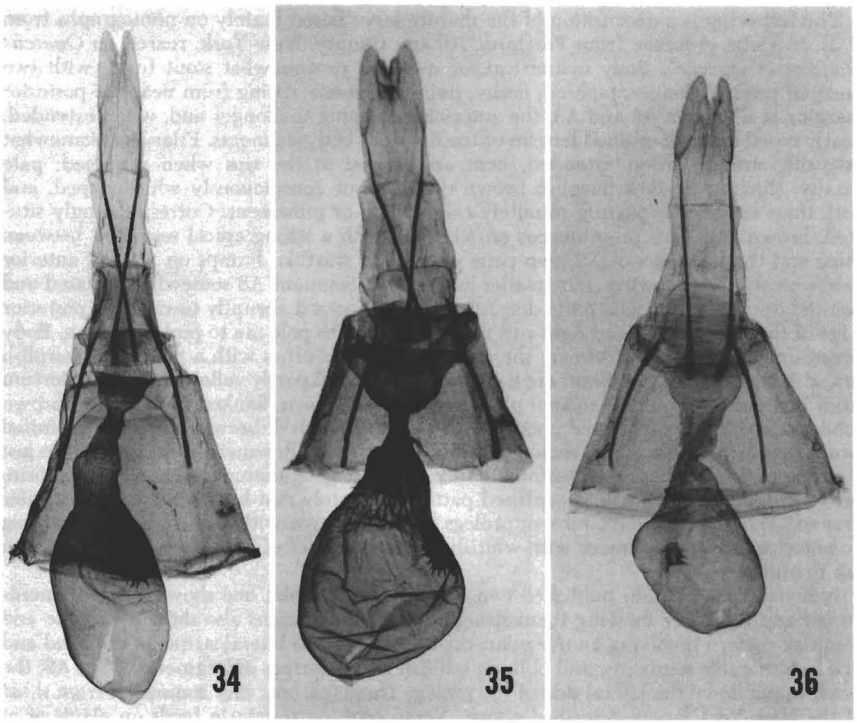
Diagnosis. This widespread nearctic species is distinguished by the pale whitish ground color of nearly all females (with rare exceptions) as compared to the more yellowish males; the swollen male hindtibia and the large size of the modified male hindtibial spur (Figs. 24, 25), which is swollen to three times the thickness of the other spurs; the combination of long, nearly straight prongs on the bifurcate juxta and the large coremata of the male genitalia (Fig. 28); and the combination of large, spiny signum but otherwise unsclerotized bursa copulatrix in the female genitalia (Fig. 34).

Further description. Both sexes with scales of front, antennae, palpi, and body light brown, legs and vertex somewhat paler.

Male (Figs. 1–13): Outer margin of forewing variable from rounded to angulate, hindwing usually rounded; ground color pale to deep yellow, with brown or purplish-brown markings well developed (Fig. 2) to obsolescent (Fig. 6) and geographically variable. Hindtibia much enlarged, apparently containing a large hair pencil that seems never to be fully extruded in museum specimens; hindtibia also with curiously modified, clavate, inner preapical spur twice as long as, and distally widened to at least three times as wide as outer preapical spur; modified spur longer than metatarsus. **Female** (Figs. 8–13): Outer margins of both wings angulate, that of forewing quite strongly so and concave between terminus of M_3 and apex. Ground color whitish or cream colored, with reddish-brown markings much less variable geographically than those of male (variation discussed below).

Undersides of both sexes paler and and with markings less distinct than above. The reticulate nature of the wing pattern is more emphasized in females than in males because the longitudinal veins are more strongly outlined. Length of forewing: ♂♂, 10–14 mm; ♀♀, 12–14 mm (reared specimens may be smaller).

Male genitalia (Figs. 28, 29). Similar to those of *N. brehmeata* but with saccular lobe of valve more narrowed distally, prong of bifurcate juxta nearly straight and somewhat divergent, not incurved as in *brehmeata*, and with gnathos more produced distally; differ



FIGS. 34–36. Female genitalia. **34,** *N. resistaria,* Okefenokee Swamp, Georgia. **35,** *N. brehmeata,* Anderson Springs, Lake Co., California. **36,** *N. baggettaria,* no locality (old specimen without data in U.S. National Museum).

obviously from those of *N. baggettaria* in having large coremata, a longer, slightly curved saccular (ventral) lobe on valve, and prongs on bifurcate juxta that are shorter than juxtal neck or base from which they arise.

Female genitalia (Fig. 34). Characterized by combination of large stellate signum, about three times wider than narrowest constriction of ductus bursae and often larger than that of *brehmeata* (specimen illustrated is an exception); an ovoid corpus bursae, twice as long as wide and with little sclerotization of its surface; and an ostial funnel whose widest dimension is considerably less than width of seventh segment at that point. By comparison, *N. brehmeata* (Fig. 35) has a wider ostial funnel, nearly as wide as the segment; more sclerotization on corpus bursae between signum and ductus bursae; and smaller signum only twice as wide as ductus bursae. *Nematocampa baggettaria* (Fig. 36) has an almost globular corpus bursae, and small, differently shaped signum hardly wider than narrowest constriction of ductus bursae.

Early stages. The peculiar larva of *N. resistaria,* which has been given the common name of "the filament bearer," was described and illustrated many times (e.g., Guenée 1857:pl. 2, fig. 3; Packard 1876:pl. 13, fig. 8; Peterson 1948:L56F; Furniss & Carolin 1977: fig. 122; Stehr 1987:504, fig. 26.281; Ives & Wong 1988:20, fig. G, p. 142, fig. E). Guenée's illustration was copied from a John Abbot drawing, probably of a specimen from Georgia; Packard's was a drawing of a larva from Salem, Mass.; Furniss and Carolin's was from the western U.S.; and Ives and Wong's were from the prairie provinces of Canada. These illustrations show considerable variation. Mosher (1917:41–43, fig. 2E, H) concentrated mainly on the pupa and illustrated it, but she also briefly described the larva.

The following is a description of the mature larva based mainly on photographs from T. L. McCabe of larvae from Pinebush, Albany County, New York, reared on *Quercus ilicifolia* (Fagaceae). Body cylindrical, of medium to somewhat stout form, with two unequal pairs of slender, tapered, fleshy, dorsal filaments arising from near the posterior margins of segments A2 and A3, the anterior pair being the longer and, when extended, nearly equal to the combined lengths of the first four body segments. Filaments somewhat extensile, straight when extended, bent and curled at the tips when retracted; pale basally, shading to dark purplish brown distally, but conspicuously white tipped, and with their surfaces appearing minutely tuberculate or pubescent. Correspondingly situated, brown, knoblike prominences on A1, each with a strong apical seta, and between these and the filaments of A2, two pairs of smaller, wartlike humps on A2, the anterior pair whitish, the following pair smaller and brown. Segment A8 somewhat elevated and pointed dorsally, after which the dorsum slopes downward abruptly toward the posterior edge of the anal plate. Head light rust red, marbled with pale tan to pinkish brown. Body variegated light and dark brown, the pale ground color often with a pinkish or purplish tint, although thoracic segments are dark brown and A1–2 partly yellowish brown. Dorsum from first pair of filaments to anal plate mostly dark brown, flanked by a gray to brown subdorsal stripe. Superimposed upon this are two or three dark-brown, oblique, abdominal bands that arise in the dorsal region and incline gradually downward and forward to just above lateral fold where they terminate in vague, elongate, diamond-shaped or fusiform, brown patches. Venter with a confused pattern of mainly rust-brown shading on a paler ground. Thoracic legs dark brown; prolegs mottled brown with whitish anterior edging on anterior proleg continuous with whitish posterior border of anal plate in one larva but not the other.

Ives and Wong (1988) published two colored photographs, one showing the filaments curled and the other showing them straight. Their illustrations also show a variable and complex pattern involving an irregular, continuous whitish lateral stripe on the head and first two thoracic segments, and oblique whitish lateral stripes on segments A6 to A8, the last running down the lateral side of the proleg. These features vary somewhat from those of the New York larvae described above. *Nematocampa resistaria* feeds on plants of at least 20 families. Prentice et al. (1963:489) listed the following as hosts (number of collections in parentheses): *Pseudotsuga menziesii* (Mirb.) Franco. (242); *Tsuga heterophylla* (Rafn.) Sarg. (220); *Abies balsamea* (L.) Miller (Pinaceae) (66); *Salix* spp. (Salicaceae) (20); *Picea glauca* (Moench) Voss (Pinaceae) (18); *Betula papyrifera* Marsh. (Betulaceae) (14); *Larix laricina* (DuRoi) K. Koch (Pinaceae) (12); *Thuja plicata* D. Don (Cupressaceae) (12); *Picea engelmannii* Parry (Pinaceae) (11); *Ulmus americana* L. (Ulmaceae) (8); *Larix occidentalis* Nutt. (6); *Pinus monticola* Dougl. (Pinaceae) (5); *Fraxinus americana* L. (Oleaceae) (5); and *Acer rubrum* L. (Aceraceae) (5); *Tilia americana* L. (Tiliaceae) (4); *Abies lasiocarpa* (Hook.) Nutt. (Pinaceae) (3); *Ostrya virginiana* (Mill.) K. Koch (Betulaceae) (2); *Acer negundo* L. (Aceraceae) (2); *Abies grandis* (Dougl. Lind.) (Pinaceae) (2); and *Alnus rubra* Bong. (Betulaceae) (2); Prentice et al. list 10 other host plants with only one collection for each, but only two additional plant families are represented, Rosaceae (*Prunus virginiana* L.) and Fagaceae (*Quercus macrocarpa* Michx.). The above records probably are biased in a way that reflects more thorough sampling of economically important trees and little attention to shrubs.

The compilation of host information by Tietz (1972) gives references to 25 food plants, of which the following are plants of genera not included above: *Aesculus hippocastanum* L. (Hippocastanaceae); *Carya* sp. (Juglandaceae); *Castanea dentata* (Marsh.) Borkh. (Fagaceae); *Corylus* sp. (Betulaceae); *Crataegus* sp.; *Pyrus ioensis* (Wood) Bailey; *Pyrus malus* L.; *Rosa* sp.; *Rubus allegheniensis* Porter; *Rubus idaeus* L. var. *strigosus* (Michx.) Maxim.; *Fragaria chiloensis* (L.) (all Rosaceae); *Humulus lupulus* L. (Moraceae); *Ribes americanum* Mill.; *Ribes lacustre* (Pers.) Poir.; *Ribes sativum* Syme (Saxifragaceae); *Robinia Pseudo-Acacia* L. (Fabaceae); and *Sedum* sp. (Crassulaceae). It was also reared from *Abies lasiocarpa* (Hook.) Nutt. (Pinaceae) at Bonner, Montana (U.S. Forest Service); *Liquidambar styraciflua* L. (Hamamelidaceae) (Kimball, 1965:186); *Myrica cerifera* L. (Myricaceae) (by D. Baggett, in USNM); *Myrica gale* L. (USNM); "sweet fern" [*Myrica asplenifolia* L.] (Mosher, 1917:43); *Quercus ilicifolia* Wangenh. (Fagaceae) (T. L. McCabe

pers. comm.); *Vaccinium arboreum* Marsh. (Ericaceae) (T. S. Dickel pers. comm.); *Ceanothus velutinus* (Rhamnaceae) in Idaho (U.S. Forest Service); *Amelanchier* and *Crataegus* spp. (Rosaceae) (L. R. Rupert; pers. comm. reported by the author, 1954:321); cherry (USNM); and *Gleditsia triacanthos* L. (Fabaceae) (reared by the author).

Distribution. *Nematocampa resistaria* occurs across southern Canada from Nova Scotia to Vancouver Island, B.C., southward at least to Hernando Co., Florida, Mississippi, southern Louisiana, Harris, Jackson, Colorado, and Blanco counties, Texas, and in the West at least to Morgan Co., Colorado, Sanpete and Wasatch counties, Utah, and Josephine Co., Oregon. In mountainous or semi-arid regions it is a species of low elevations and riparian habitats. It is replaced in California by *N. brehmeata*.

Flight period. The species is single brooded in Canada and most of the northern U.S., flying mainly in July and August. It becomes double brooded in the middle states, emerging in May and again in late July (e.g., in Maryland), but it seems to be no more than double brooded in the South. Thirty specimens in the USNM from South Carolina, Georgia, northern Florida, and Texas were all collected in April and May. In Louisiana and Mississippi it was collected in April, May, June, and July, based on many records from year-round light-trapping (V. A. Brou and B. Mather collections). The flight period in the Northwest is also mainly in July and August, rarely in June, but with a few September and early October records for western Oregon.

Geographical variation. *Nematocampa resistaria* has two main geographical variants that were named as species or subspecies: *N. expunctaria* (=*brunneolineata*) in the Southeast, and subspecies *orfordensis* in the Pacific Northwest. Grote (1872, 1882), Capps (1943:147), and the present author (1983:98) regarded *expunctaria* as a distinct species in which the wing pattern of the male is reduced to little more than the antemedial and postmedial lines (Figs. 6, 7). Females remain unchanged. Capps, knowing only the type of *expunctaria*, further described what he thought were differences in the genitalia. A reevaluation of more and better material now indicates that *expunctaria* is the same species as *resistaria*, at best a weak subspecies occupying a narrow coastal zone from South Carolina to northern Florida and westward through southern Louisiana to Texas. Intermediate forms of every degree may be found. Where the range of the species continues westward into eastern Texas, the moths revert to the more normal, well-marked form of *resistaria*. The differences in genitalia mentioned by Capps prove to be of no consequence when more than one specimen is examined.

The form described as *orfordensis* is localized and possibly related to the cool maritime climate of coastal Oregon, Washington, and Vancouver Island. It is as large as *N. brehmeata* (wing length: ♂♂, 13–14 mm; ♀♀, 15–16 mm) and sometimes, like that species, a deep shade of yellow. A size gradient is apparent between populations of the coastal region and the interior, those from eastern Oregon and Washington hardly differing from eastern specimens. Again, it is a poorly defined subspecies. However, one unusual feature of *orfordensis* is the occasional occurrence of yellow females colored like males (Fig. 12). Three of these in the USNM were collected near Elsie, Clatsop Co., Oregon on 5, 6 September 1963, 1968, and 1969. It is not a seasonal form because normal females with whitish ground color were collected with them. These are the only yellow females of *N. resistaria* that I have seen, although *N. brehmeata* always has yellow females.

Material examined. 244 adults, 7 genitalia slides.

Nematocampa brehmeata (Grossbeck)
(Figs. 14–18, 26, 32, 33, 35)

Ania brehmeata Grossbeck, 1907, Trans. Amer. Entomol. Soc. 33:343.
Nematocampa brehmeata, Barnes and McDunnough 1917:121. McDunnough 1938:169. Ferguson 1983:98.
Type locality: Cazadero, Sonoma County, California. [Holotype in AMNH.]

Diagnosis. This is a Californian species in which both sexes are yellow, showing somewhat of a reversal of the sexual dimorphism of *resistaria*

because the females are often a deeper yellow than the males. The dark markings of the outer third of both wings in males are more broken up by encroachments of pale ground color and in females are lacking entirely. These yellow females, without dark submarginal markings, are very different in appearance from most females of *resistaria*. Diagnostic differences in the hindtibial spurs were noted in the key. In the male genitalia, the prongs of the bifurcate juxta are incurved distally, not straight. This species occurs in northern and central California west of the Sierra Nevada. It appears to be the only species of *Nematocampa* in that area, although *resistaria* occurs in nearby Oregon.

Further description. Body, head, antennae, and legs similar to those of *resistaria* except that modified hindtibial spur of male is more slender, distally swollen to not more than twice thickness of the other preapical spur, and slightly shorter than metatarsus. Wing shape and pattern similar to those of *resistaria* except that the dark, purplish-brown shading in outer third of wings in males tends to appear reduced, narrowed, or otherwise broken up, usually faded, and further reduced or lost on the hindwing. Dark shading of outer third of wings lost entirely in the four females examined. Ground color varies from light yellow to intense orange yellow in both sexes, but males are mostly light (9 of 11), and females may more often be deep yellow (2 of 4). Length of forewing: ♂♂, 12–14 mm; ♀♀, 13–14 mm.

Male genitalia (Figs. 32, 33). Differ from those of *resistaria* in slightly wider saccular lobe of valve; shorter coremata, only about half as long; narrower overall shape of juxta, with its two bowed prongs diverging basally but curving toward each other distally; and two free sclerites laterad of base of juxtal prongs thicker, and also bowed, not straight like those of *resistaria*.

Female genitalia (Fig. 35). Ostial funnel very large, almost as wide across opening as width of seventh segment at that point; about twice as large as ostial funnel of *resistaria*. Bursa copulatrix quite heavily sclerotized in zone between signum and ductus bursae; integument in this area pleated or rugose in both species, but not sclerotized in *resistaria*. Ovipositor wider and less elongated than that of *resistaria*, the lobes (papillae anales) being shorter than ostial funnel is wide (longer than width of funnel in *resistaria*).

Early stages. Unknown.

Distribution. I saw specimens from the following localities in California: Santa Cruz, Santa Cruz Co.; Los Gatos, Santa Clara Co.; Lucas Valley, Marin Co.; San Antonio Creek, Sonoma Co.; Napa, Napa Co.; Lucerne and Anderson Springs, Cobb. Mt., Lake Co.; Michigan Bluff, Placer Co.; Nelson Creek and Mohawk, Plumas Co.; Laytonville, Mendocino Co.; Oroville, Butte Co.; Hat Creek, Shasta Co.; Mt. Shasta (city), Siskiyou Co., and Gasquet, Del Norte Co. I collected three males of this species in a riparian habitat on the outskirts of the town of Mt. Shasta, on the road to Lake Shasta. The site was in a moist stream bottom with abundant willows, dogwood, and alder, mixed conifers nearby, and a pond fringed with *Typha* marsh.

Flight period. 20 June–27 August.

Geographical variation. Compared to those from elsewhere, three males from Mt. Shasta are smaller (wing length: 12–13 mm), slightly paler yellow, and with all dark markings intensified, although specimens from Shasta and Del Norte counties are the usual orange-yellow and more nearly normal in size and markings. The Mt. Shasta specimens could be mistaken for *N. resistaria*, but in pattern and structure they are *brehmeata*.

Material examined. Thirty-five adults, 5 genitalia slides.

Remarks. The distinction between *N. brehmeata* and *resistaria* may not always be as clear as I have indicated, because a few specimens that appear intermediate have been taken near the contact zone. Two males from Mt. Shasta (Fig. 14) almost have the markings of *resistaria*, and the male from McMinnville, Oregon, whose genitalia are shown in Fig.

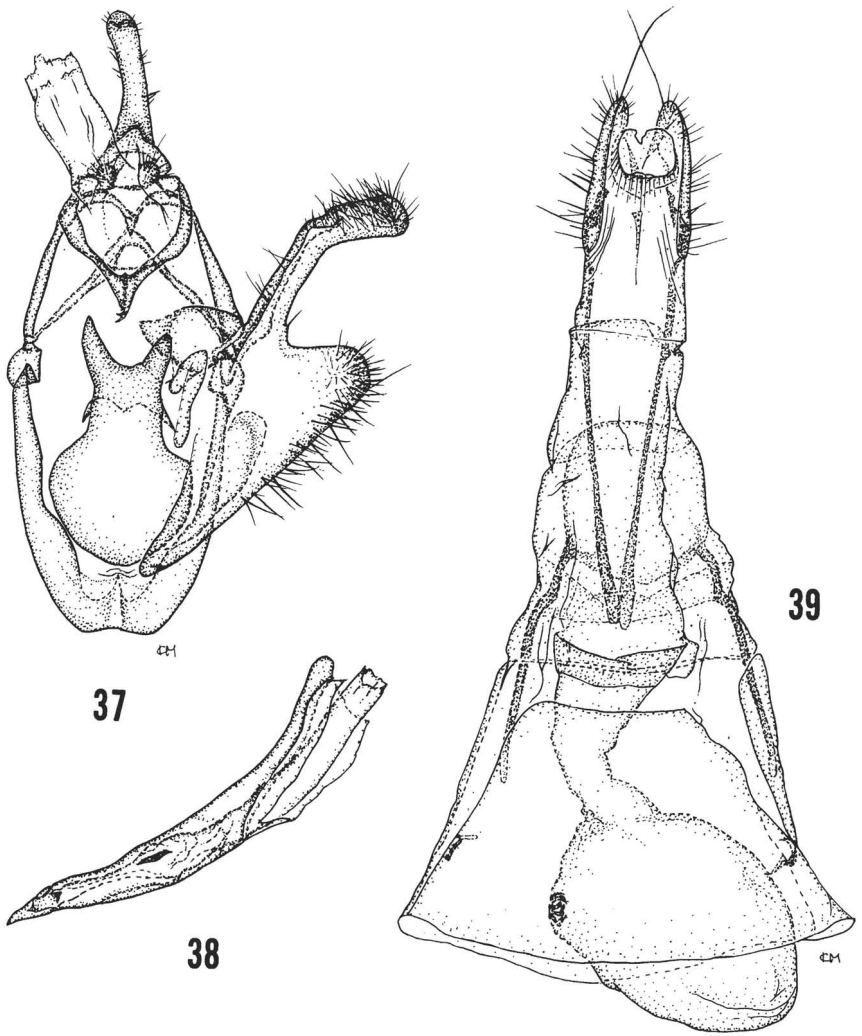
28, resembles a deep-yellow male of *brehmeata*, although its juxta is clearly that of *resistaria*. Also, the only truly yellow females of *resistaria* (Fig. 12) are from Oregon, but they are otherwise consistent with *resistaria*, not *brehmeata*.

Nematocampa baggettaria Ferguson, n. sp.
(Figs. 19–23, 27, 30, 31, 36, 37–39)

Diagnosis. This is the smallest and most distinct of the nearctic species, with the wing margins rounded, not angulate, wings mostly orange brown but with dark, purplish-brown shading in most of the outer third in females. The pattern is simplified, with two regular lines on the forewing, one on the hindwing, and almost no reticulation of lighter areas in either sex. It is the only species of *Nematocampa* in the U.S. without a swollen, clavate, hindtibial spur. The species is known from northern Florida and the central Gulf Coast region, and there is one record from Lumberton, North Carolina.

Further description. Head, antennae, and legs similar to those of *resistaria* except that the male hindtibia is not swollen and does not bear a specialized, large, clavate spur; all spurs are small and normal. Front in both sexes light yellowish brown, variably sprinkled with bright red-brown scales or with a diffuse red-brown border on each side. **Male** (Figs. 19–21): outer margin of wings rounded like those of southern *resistaria* or more so, and with apex less acute; wings almost uniformly ochreous orange brown, or variably tinged with purplish in outer third; forewing with antemedial a thin, dark, regular, convex line; postmedial line similar, curved subparallel to outer margin or nearly straight; hindwing with slightly curved postmedial line bisecting wing nearly in middle; small, rounded, dark discal dot on each wing; fringes dusky; wings faintly dusted with a few dark scales but without reticulation or any sign of a median band in median space. Underside darker, with markings reduced, although postmedial of hindwing may be closely preceded for most of its length by a faint, thinner, subparallel line. Spring brood (April) specimens with tendency to be slightly larger and paler than summer (June–August) specimens. Length of forewing: holotype, 8 mm; other ♂♂, 7–8 mm. **Female** (Figs. 22, 23): Apex of forewing somewhat produced but with outer margins rounded like those of male, unlike females of other species. Ochreous orange-brown ground color of wings dusted with reddish-brown scales that outline veins of median space in some specimens, giving a suggestion of reticulate pattern seen in pale wing areas of other species. Forewing with antemedial line thicker than that of male and purplish; postmedial line curved or nearly straight, blackish, commonly indented at cubital fold; postmedial of hindwing slightly curved to nearly straight, bisecting wing near middle. Discal spots small but prominent. Outer third of both wings dark purplish brown except for orange-yellow patch toward apex of forewing and variable indications of same color in form of a diffuse, mesial, transverse band in outer third of hindwing; fringes concolorous. Underside similarly marked but with lines thickened and diffuse, and all paler areas more or less suffused with gray or purplish brown. Little seasonal variation apparent. Length of forewing: 7–9 mm.

Male genitalia (Figs. 30, 31, 37, 38). Similar in general form to those of *N. resistaria* and *brehmeata* but with two conspicuous differences. Long, hairy coremata that arise near bases of saccular lobes in other species all but absent (vestiges remain), and prongs of bifurcate juxta are short in *baggettaria*. Prongs shorter than paired, longitudinally parallel sclerites lying off to each side of "neck" of juxta, whereas in *resistaria* prongs are much longer than these sclerites. Overall, genitalia smaller and more delicate, saccular lobe less produced, and vesica of aedeagus with smaller cornutus. Two specimens are illustrated to show variation. The prongs of the bifurcate juxta are asymmetrical in Fig.



FIGS. 37–39. Genitalia of *N. baggettaria*. **37,** ♂, Abita Springs, Louisiana. **38,** Aedeagus of same specimen. **39,** ♀, Abita Springs, Louisiana.

37, which is probably not normal; and the aedeagus of the other specimen (Fig. 31) has a knoblike process on its proximal end, also abnormal.

Female genitalia (Figs. 36, 39). Main difference in female is in signum, which is small and of the simpler, two-pointed type found in some neotropical species. Signa of *resistaria* and *brehmeata* differ in being large, round or ovate disks bearing small surface points and fringed marginally with many more sclerotized points, which form a dentate margin on the signum that is widest toward its anterior end. Two specimens are illustrated, with the bursa copulatrix differently oriented.

Types. Holotype: ♂, Torreya State Park, Liberty Co., Florida, H. D. Baggett; in U.S. National Museum of Natural History. Paratypes (19): Torreya State Park, Liberty Co.,

Florida, 17 July 1982 (1 ♂), H. D. Baggett; same locality and date (1 ♀), W. L. Adair; same locality, 4 July 1986, (1 ♂, 1 ♀); 27 June 1981 (1 ♂); 17 Aug. 1982 (1 ♀); 4 Sept. 1983 (1 ♀), H. D. Baggett. Eight mi N of Sumatra, Apalachicola Natl. Forest, Liberty Co., Florida, 10 May 1990 (1 ♀), 2 June 1990 (1 ♂), H. D. Baggett. Goose Pasture, Jefferson Co., Florida, 27 May 1989 (1 ♂), H. D. Baggett. Manatee Springs State Park, Levy Co., Florida, 16 July 1982 (1 ♀), H. D. Baggett. Cedar Key, Levy Co. (Hardwood Swamp, CR-347, 5.4 mi N Jct. SR-24), Florida, 27 June 1987 (1 ♀), T. M. and L. Neal. 4.2 mi NE of Abita Springs, St. Tammany Parish, Louisiana, 25 Apr. 1984 (1 ♂), 7 May 1983 (1 ♂), 14 May 1984 (1 ♀), 25 May 1984 (1 ♀), 23 June 1983 (1 ♀), 16 July 1983 (1 ♂), 29 Sept. 1983 (1 ♂), V. A. Brou. Lumberton, North Carolina (on Interstate 95, at light), 21 Aug. 1987 (1 ♀), R. Gilmore. Paratypes deposited in U.S. National Museum, the Florida State Collection at Gainesville, and in the private collections of H. D. Baggett, V. A. Brou, and others.

Early stages. Unknown.

Distribution. Seen only from the Apalachicola National Forest and Torreya State Park, Liberty Co., Goose Pasture, Jefferson Co., and Manatee Springs and Cedar Key, Levy Co., Florida; Abita Springs, St. Tammany Parish, Louisiana; and Lumberton [Robeson Co.], North Carolina.

Flight period. Collected every month from April to September.

Material examined. Twenty-six specimens.

Remarks. This species is named for H. D. (Dave) Baggett of Palatka, Florida, who first brought it to my attention and who collected about half of the specimens seen.

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