



A new species of *Neominois* from northeastern Mexico (Lepidoptera: Nymphalidae: Satyrinae)

ANDREW D. WARREN^{1,2}, GEORGE T. AUSTIN¹, JORGE E. LLORENTE-BOUSQUETS²,
ARMANDO LUIS-MARTÍNEZ² & ISABEL VARGAS-FERNÁNDEZ²

¹McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, P.O. Box 112710, Gainesville, Florida 32611. E-mail: hesperioidea@yahoo.com

²Museo de Zoología, “Alfonso L. Herrera”, Departamento de Biología Evolutiva, Facultad de Ciencias, Universidad Nacional Autónoma de México, Apdo. Postal 70-399, México 04510 D.F., México

Abstract

A new species from northeastern Mexico, *Neominois carmen* (Lepidoptera: Nymphalidae: Satyrinae), is described, illustrated, and compared with its only known congener, *N. ridingsii*. The species is distinguished from the latter by its orange coloration and shape of and pattern on the wings as well as by differences in the genitalia of both sexes.

Key words: butterflies, Coahuila, Maderas del Carmen, pine-oak woodland, *Piptochaetium*, satyr

Resumen

Se describe, ilustra y compara una especie nueva del noreste de México, *Neominois carmen* (Nymphalidae: Satyrinae), con el único miembro cogenérico conocido, *N. ridingsii*. Se distingue de esta última por su coloración naranja y el patrón alar, como también por diferencias en los genitales de ambos sexos.

Palabras clave: bosque de pino-encino, Coahuila, Maderas del Carmen, mariposas, *Piptochaetium*, satírido

Introduction

Neominois Scudder, 1875, proposed for *Satyrus ridingsii* W. H. Edwards, has long been considered a monotypic genus-level taxon (e.g., Scudder 1875, Avinoff & Sweadner, 1951, Austin 1986, Opler & Warren 2002). *Neominois ridingsii* was revised by Austin (1986), who recognized five subspecies. Its distribution extends from southern Alberta, Saskatchewan, and Manitoba, Canada, south to Guadalupe and Catron counties, New Mexico, and west to the central Sierra Nevada of California and central Oregon (Austin 1986, Toliver *et al.* 1994, Warren 2005). Geographic variation in *N. ridingsii* includes subtle differences in coloration and wing pattern elements, but none of the described subspecies differ dramatically from nominotypical *N. ridingsii* (type locality: Loveland, [Larimer Co.], Colorado) (e.g., Scott 1998). Populations of *Neominois* flying in late summer have been named (Scott 1998), but their taxonomic status is uncertain (e.g., Opler 1999; see Opler & Warren 2002).

Neominois was first reported from Mexico by de la Maza *et al.* (1989), who listed *Neominois ridingsii* in their checklist of Mexican butterfly taxa, without further details. However, those authors apparently had not examined specimens of *Neominois* from Mexico, since the listing of *N. ridingsii* was followed by “(RC)”,

indicating that the record required confirmation. A subsequent report of *N. ridingsii* from Oaxaca, Mexico, by Luis *et al.* (2004) is erroneous. Recent fieldwork in Coahuila, Mexico, has indeed confirmed the presence of the genus in that country (also see Kobelkowsky 2003), but of a striking undescribed species.

Materials and methods

Neominois was first discovered in the Maderas del Carmen, Coahuila, Mexico, in 2005 by Bonnie Reynolds McKinney and Jonás Delgadillo Villalobos, the Coordinator and Assistant Coordinator (respectively) of Wildlife for the CEMEX-Proyecto El Carmen, a conservation initiative currently managing over 400,000 acres in the Maderas. Subsequently, a collaboration was formed in 2007 between researchers at and associated with the “Alfonso L. Herrera” Zoology Museum at Mexico’s National Autonomous University (Mexico City) and the Proyecto El Carmen, in order to obtain a series of specimens for study and formal description. In addition, specimens of *Neominois* from various public and private collections were examined, including the holdings of the McGuire Center for Lepidoptera and Biodiversity (Gainesville, Florida), which includes the majority of specimens examined by Austin (1986), as well as specimens in the private collection of ADW.

The subuncus of the male genitalia as used here (after *e.g.*, de Lesse 1951a, Peña & Lamas 2005) refers to the structure elsewhere termed the brachia (*e.g.*, Higgins 1975, Coutsis 1984, Goulson 1993) or gnathos (*e.g.*, Avinoff & Sweadner 1951).

Results

Neominois carmen A. Warren, Austin, Llorente, Luis & Vargas, NEW SPECIES

(Figs. 1a–h, 3a–d, 4a–b, 5a–b)

Description. Male (Figs. 1a–d, 3a–b (right)): mean forewing length = 22.3 mm (range 20.0–23.6 mm, $n=27$); forewing costa slightly curved, apex rounded, termen straight to CuA_2 , then rounded to nearly straight anal margin; termen of hindwing convex; venation as illustrated for genus (Holland 1916, Miller 1968); dorsum of both wings pale tan; forewing with medial and submedial area orange-tan; base and costa and outer margins heavily overscaled with brown; medial area may be lightly overscaled with brown; veins brown; submargin with elongate pale tan macules divided by brown veins in R_5-M_1 , M_1-M_2 , anterior 2/3 M_2-M_3 , posterior 2/3 M_3-CuA_1 , and CuA_1-CuA_2 , shorter and more quadrate macule (may be divided horizontally by thin brown line) in CuA_2-2A , all macules indistinctly outlined with brown, space between macules in M_2-M_3 and M_3-CuA_1 brown as outer margin; large and white-pupiled black ocellus within submarginal macules in M_1-M_2 and CuA_1-CuA_2 , supernumerary ocelli with or without white pupils often within submarginal macule in M_3-CuA_1 (in R_5-M_1 on one specimen); terminal line dark brown; fringes brown. Hindwing heavily overscaled with brown extending distad to submarginal macules, may be less dense distad in discal cell and bases of M_1-M_2 , M_2-M_3 , and M_3-CuA_1 , these regions may have slight tinge of orange; marginal area overscaled with brown, most dense apically; elongate submarginal macules contrastingly tan forming continuous band divided or not by brown veins from vein R_s to $2A$ and variably into $2A-3A$ without overscaling except lightly cephalad, distal margin of macules sharply angled cephalad, more rounded caudad, distinctly margined distad by dark brown; distal portion of submarginal macule in CuA_1-CuA_2 usually with black white-pupiled or not ocellus; terminal line dark brown; fringes brown.

Ventral forewing variably pale orange-tan proximad, becoming pale gray along costa and outer margin; gray-brown striations in base of discal cell and in its anterior 1/3 to 1/2 to its end, striations finer apically along costal and outer margins and in space between macules in M_2-M_3 and M_3-CuA_1 ; submarginal macules

pale tan, all indistinctly outlined with brown, ocelli repeated from dorsum, but smaller; terminal line vaguely darker than ground color. Ventral hindwing pale tan; entire surface except submarginal area finely striated with gray-brown, may be denser in median area and especially proximad of submarginal macules; submarginal macules lightly overscaled or not, outlined distad with dark gray-brown, no ocellus; terminal line vaguely darker than ground color.

Dorsal head, thorax, and abdomen pale gray-brown; head white behind eyes; long tan scales on abdomen cephalad; eyes reddish; antennae gray above, whitish on venter with vague and thin black at segments, nudum pale reddish tan; palpi pale gray; ventral thorax and abdomen pale gray.

Genitalia (Fig. 4a–b): uncus in lateral view relatively broad, decurved slightly to a pointed and slightly hooked caudal end, tapering in dorsal view; tegumen broad in both lateral and dorsal views; appendix angularis prominent; subuncus thin, curved dorsad, tapering to sharply pointed caudal end; combined ventral arm of tegumen and dorsal arm of saccus thin, slightly sinuate; anterior arm of saccus broad in both lateral and ventral views, variable in length, often slightly curved to right in ventral view; valva tapering caudad to blunt caudal end, upcurved, variable fine serrations on dorsal and ventral edges caudad; aedeagus long (1/5X length of valva), thin, nearly straight; vesica with lightly sclerotized leaf-shaped cornutus.

Female (Figs. 1e–h, 3c–d (left)): mean forewing length = 26.2 mm (range 24.7–27.6 mm, n=7); wings broader and more rounded than on male, costa gradually curved, more so than on male, apex rounded, termen convex, curving evenly to straight anal margin, termen of hindwing strongly convex; venation similar to male; dorsum of both wings tawny-orange; forewing with base overscaled with gray-brown, diminishing in intensity distad; costal margin gray-brown exhibiting vague darker striations on basal half; outer margin overscaled with gray-brown cephalad of vein CuA_1 or CuA_2 ; submargin with pale and elongate ochreous-orange macules (paler cephalad) divided by brown veins in R_4 - R_5 (may be absent), R_5 - M_1 , M_1 - M_2 , anterior 2/3 M_2 - M_3 , posterior 1/2 to 2/3 M_3 - CuA_1 , and CuA_1 - CuA_2 , shorter and more quadrate macule in CuA_2 -2A, all macules individually finely outlined with brown, most prominent on distal edges, space between macules in M_2 - M_3 and M_3 - CuA_1 overscaled with gray-brown; large and white-pupiled oval black ocellus within submarginal macules in M_1 - M_2 and CuA_1 - CuA_2 ; terminal line prominent, dark gray-brown extending thinly along full length of anal margin; fringes pale gray-brown. Hindwing overscaled extensively with pale gray-brown extending distad to submarginal macules, least dense distad in discal cell and bases of M_1 - M_2 , M_2 - M_3 , and M_3 - CuA_1 ; marginal area overscaled with pale gray-brown, most densely adjacent to submarginal macules; elongate submarginal macules pale ochreous-orange as on forewing forming continuous band divided by brown veins from vein R_s to 2A and vaguely into 2A-3A, distal margin of macules sharply angled cephalad, more rounded caudad; inner margin of macules variably shaped; band outlined narrowly with brown both proximad and distad; distal portion of submarginal macule in CuA_1 - CuA_2 with or without black white-pupiled or not ocellus; terminal line prominent, dark gray-brown; fringes pale gray-brown.

Ventral forewing tawny-orange, becoming pale gray along costal and outer margins; gray-brown striations in base of discal cell and in its anterior 1/3 to its end, along costal margin becoming finer apically, along outer margin, and in space between macules in M_2 - M_3 and M_3 - CuA_1 ; submarginal macules as on dorsum, those in R_5 - M_1 , M_1 - M_2 , and M_2 - M_3 tan or with slight tinge of orange; macules all indistinctly outlined with brown; ocelli repeated from dorsum but smaller, terminal line distinct, brown. Ventral hindwing pale gray to pale tan with indistinct tinges of orange especially submarginally; entire surface striated by pale gray-brown densest as outline of often otherwise nearly indistinguishable submarginal macules; no ocellus; terminal line distinct, brown.

Dorsal head, thorax, and abdomen brown to gray-brown; head with white behind eye; long pale tan scales cephalad on abdomen; eyes reddish; antennae, palpi, and ventral thorax and abdomen as on male.

Genitalia (Fig. 5a–b): sterigma broad in ventral view (width about 2X length); largely lightly sclerotized or membranous; lamella antevaginalis with well-sclerotized central lobe, variably notched on caudal edge,

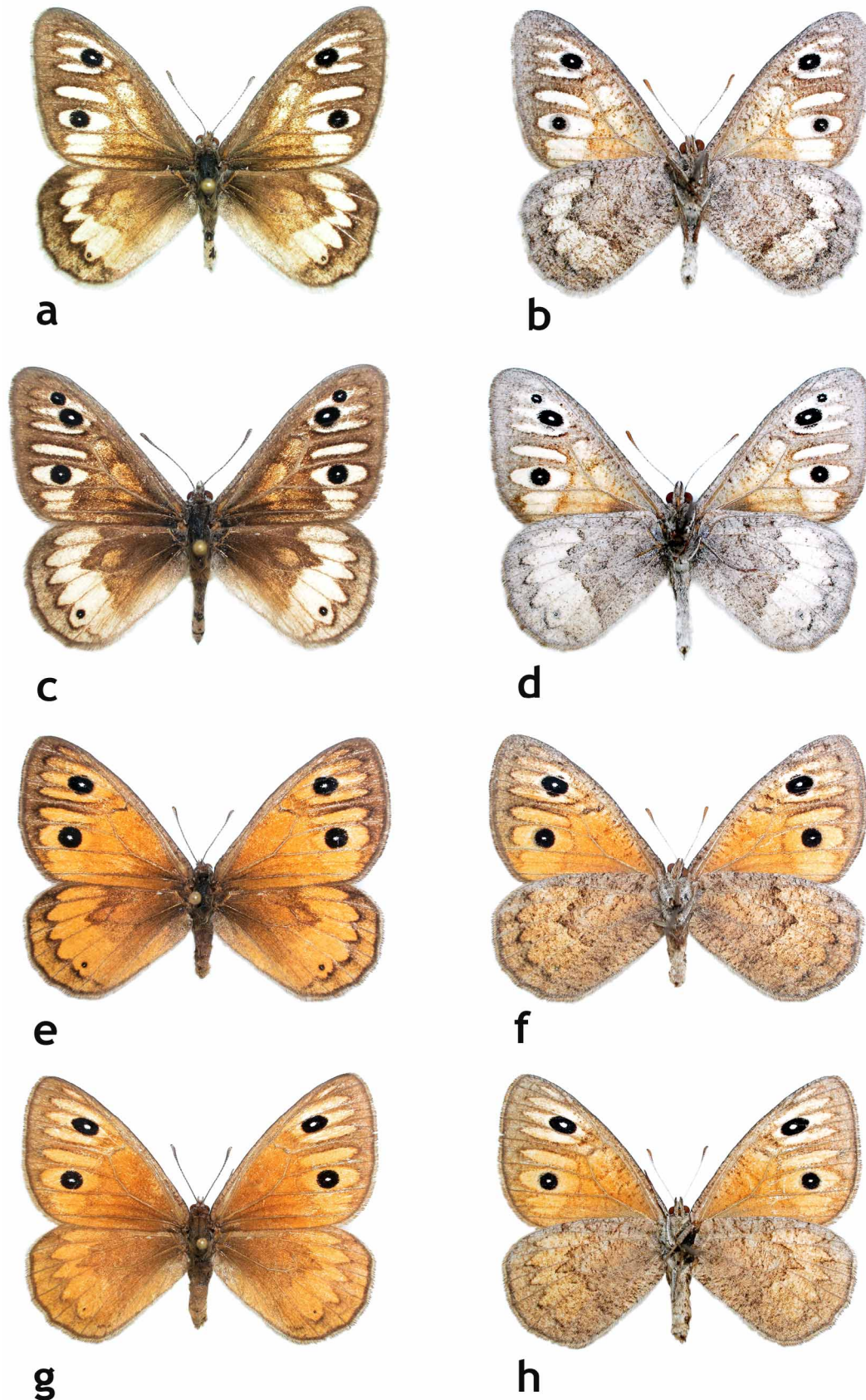


FIGURE 1. Types of *Neominois carmen*. Holotype male, dorsal (a) and ventral (b), from Mexico: Coahuila: Mpio. Acuña: Maderas del Carmen: Los Cojos Ridge, 7000-7400', 18-VI-2007. Paratype male, dorsal (c) and ventral (d), from same locality and date as holotype. Allotype female, dorsal (e) and ventral (f), from same locality and date as holotype. Paratype female, dorsal (g) and ventral (h), from same locality and date as holotype.

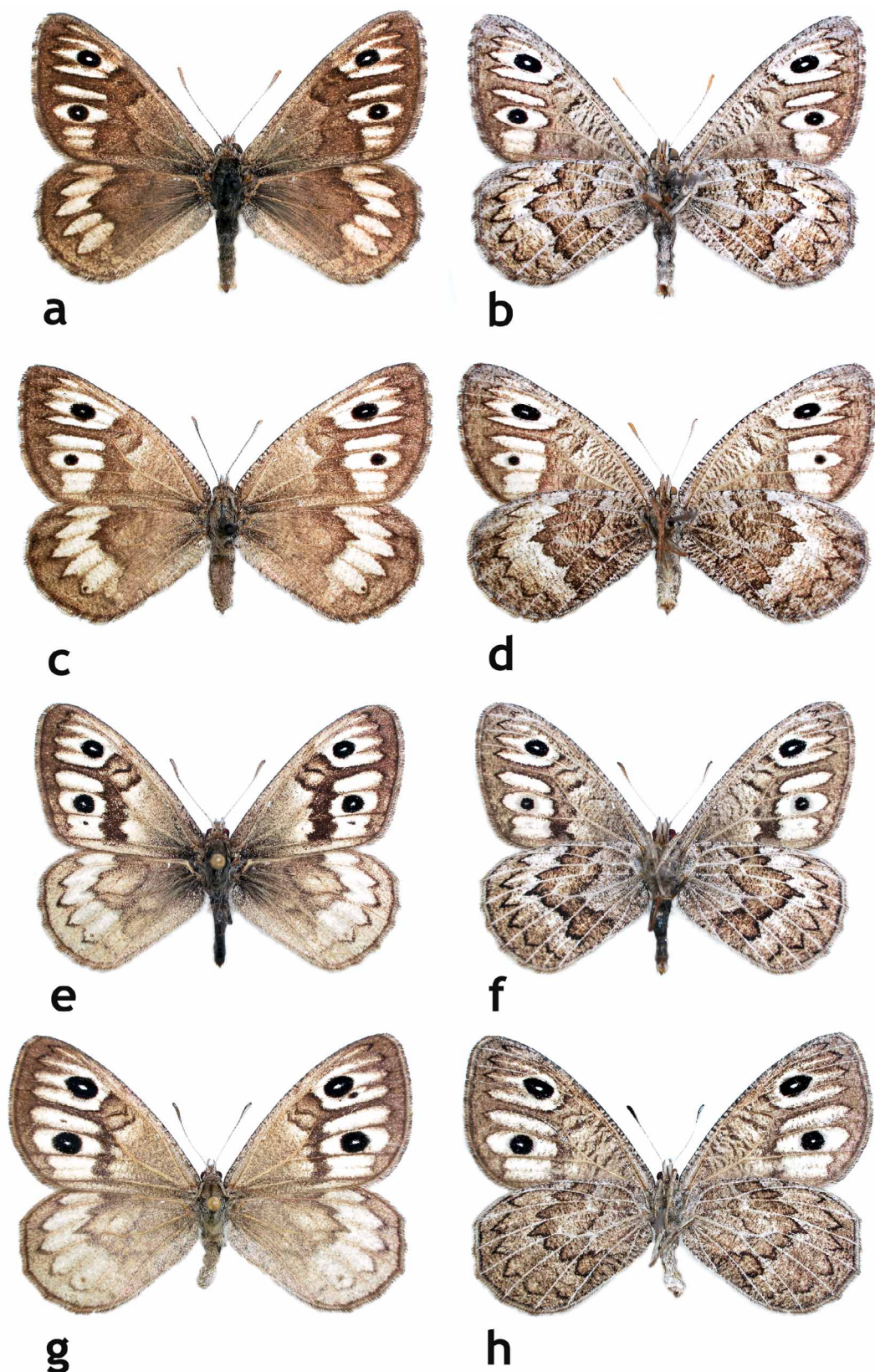


FIGURE 2. Extremes of variation seen in *Neominois ridingsii* from the western United States. Populations from the western Great Plains region, including the nominotypical race, male dorsal (**a**) and ventral (**b**) [Colorado: Arapahoe Co.: Piney Creek area on Smoky Hill Rd., 8-VI-1993], female dorsal (**c**) and ventral (**d**) [Colorado: Arapahoe Co.: Piney Creek area on Smoky Hill Rd., 6-VI-1992], are darker than those further west, such as those from central Oregon, male dorsal (**e**) and ventral (**f**), female dorsal (**g**) and ventral (**h**) [both from Oregon: Deschutes Co.: Millican, 0.0-0.5 mi S Hwy. 20 on rd. to Pine Mtn. Observatory, 4400', 30-VI-2005].

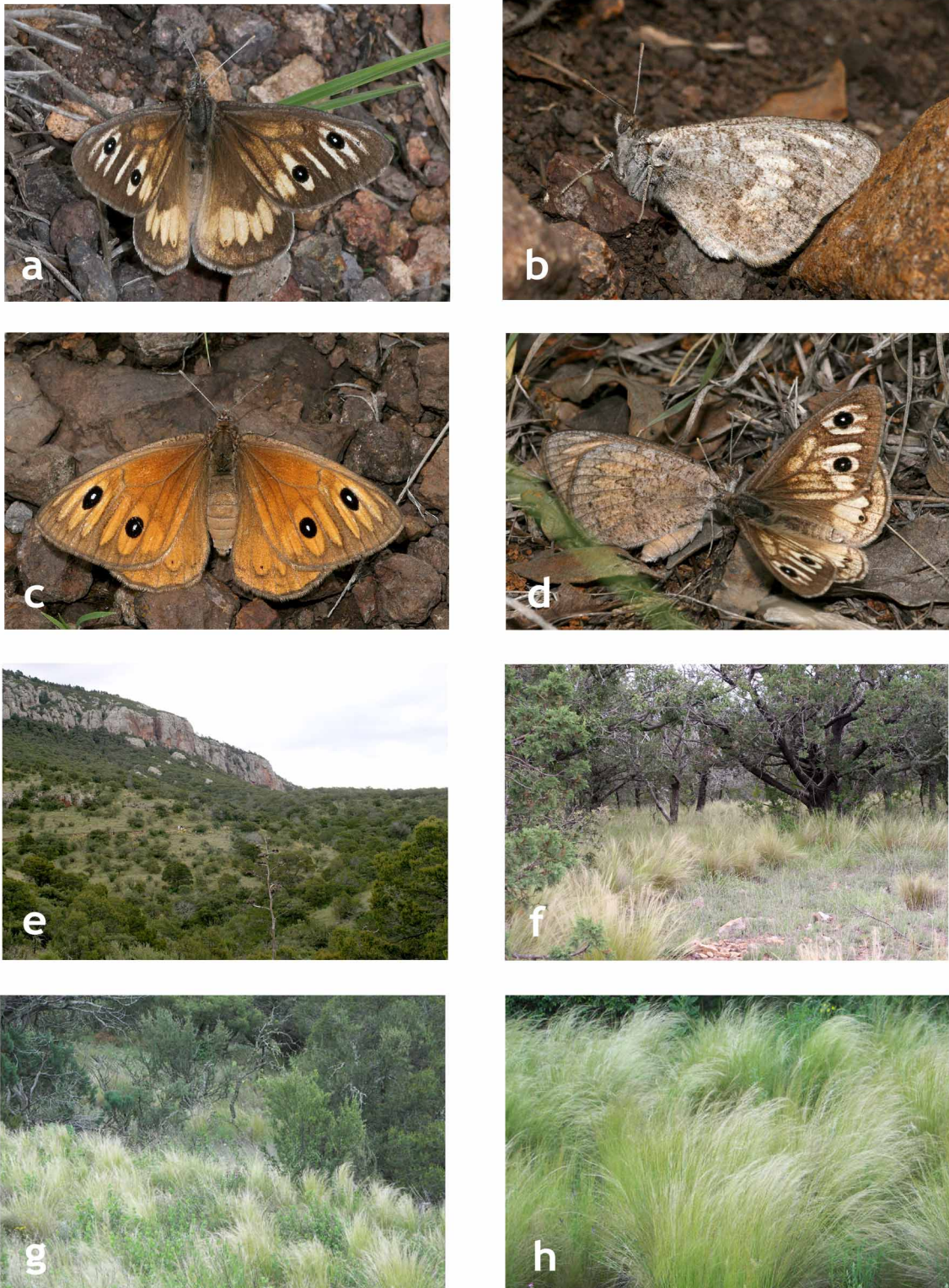


FIGURE 3. Live adults and habitats of *Neominois carmen*. (a) Dorsal and (b) ventral view of male; (c) dorsal and (d) ventral view of female (same individual as Figs. 1g-h), with male at right; habitat (e) from a distance, and (f) close up, showing *Piptochaetium pringlei*, a grass that probably serves as a larval foodplant; all from Mexico: Coahuila: Mpio. Acuña: Maderas del Carmen: Los Cojos Ridge, 7000-7400', 18-VI-2007, by Jim P. Brock; (g) and (h) show additional views of *Piptochaetium pringlei* in the Maderas del Carmen, by Bonnie McKinney.

(which is vertical in lateral view); antrum long, broad, lightly sclerotized, strongly folded on ventral surface; ductus bursae broad, membranous, expanding at junction with globular corpus bursae; no signa.

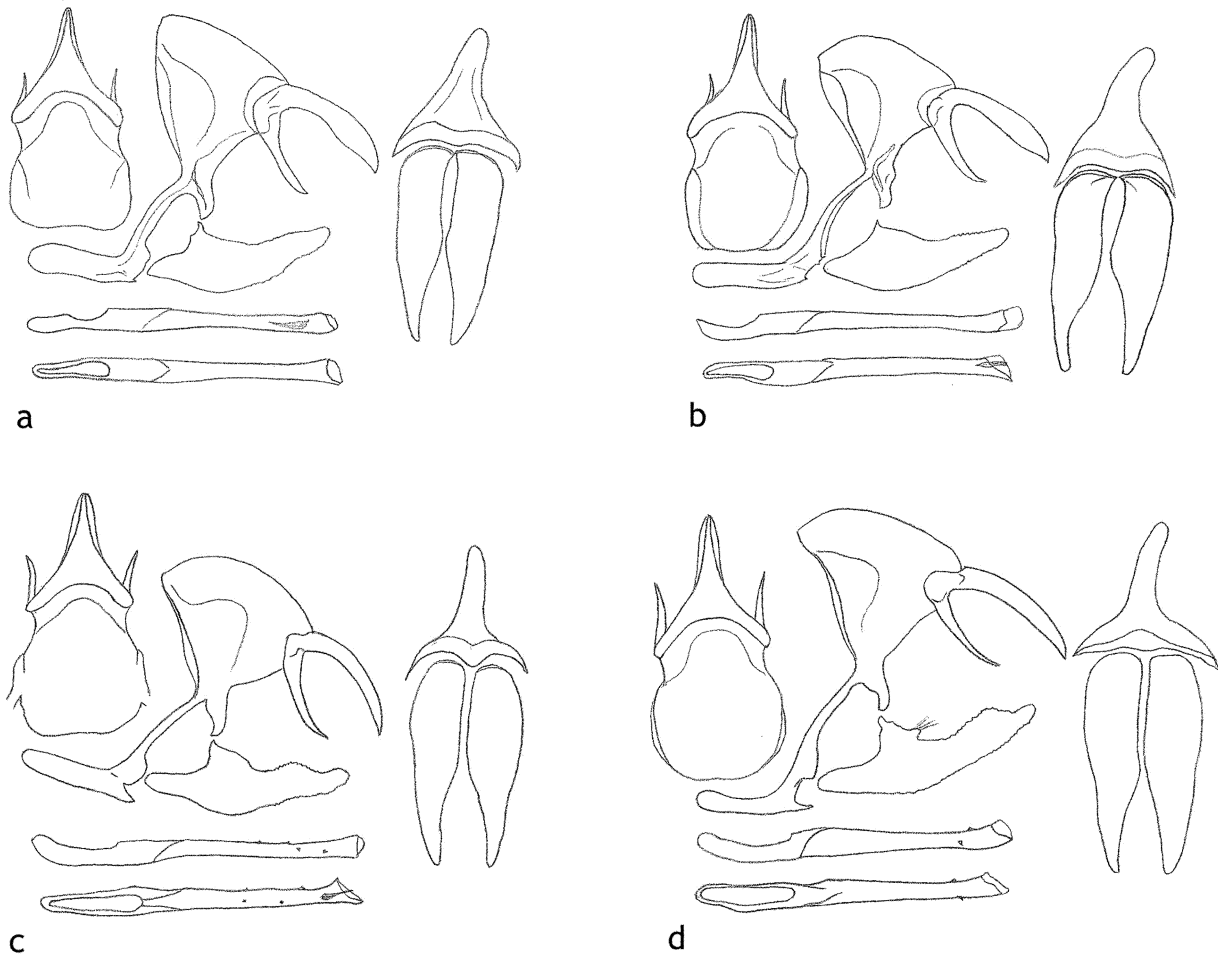


FIGURE 4. Male genitalia of *Neominois*. **a)** *N. carmen*—MEXICO: Coahuila; Maderas del Carmen (ADW #08-21); **b)** *N. carmen*—MEXICO: Coahuila; Maderas del Carmen (ADW #08-19); **c)** *N. ridingsii*—CANADA: Saskatchewan (GTA #11579); **d)** *N. ridingsii*—USA: Nevada; Elko County (GTA #11576).

Types. Holotype male (Figs. 1a–b) with the following labels: / MEXICO: COAHUILA: / Mpio. Acuña: Maderas / del Carmen. Los Cohos [sic = Cojos] / Ridge. 7000–7400' / N28°56'21.5" W 102° / 36'01.8". 18-VI-2007 / Jim P. Brock /, to which is attached a red, printed label - / HOLOTYPE / *Neominois carmen* / A. Warren, Austin, Llorente, Luis & Vargas /. Allotype female (Figs. 1e–f) with the following labels: / MX, Coahuila, / Maderas del Carmen, / Los Cohos [sic = Cojos] Ridge, / 7000–7400' / N28 51' 21.5" / W102 36' 01.8" / 18 June 2007 / leg. Jim P. Brock /, to which is attached a red, printed label - / ALLOTYPE / *Neominois carmen* / A. Warren, Austin, Llorente, Luis & Vargas /. Paratypes: same locality, date, and collector as holotype, 18 males, 8 females; MEXICO: COAHUILA: Mpio. Acuña: Maderas del Carmen: Vista Hermosa, 16-VI-2005, Bonnie Reynolds McKinney & Jonás Delgadillo Villalobos (1 male); MEXICO: COAHUILA: Mpio. Acuña: Maderas del Carmen: Casa Negro, 30-VI-2005, Bonnie Reynolds McKinney & Jonás Delgadillo Villalobos (1 male); MEXICO: COAHUILA: Mpio. Acuña: Maderas del Carmen, 2279m, UTM 733798 x 3203239, 6-VI-2007, Bonnie Reynolds McKinney & Jonás Delgadillo Villalobos (7 males); MEXICO: COAHUILA: Mpio. Acuña: Maderas del Carmen, 2238m, UTM 733510 x 3203060, 6-VI-2007 (1 male); MEXICO: COAHUILA: Mpio. Acuña: Maderas del Carmen, 2176m, UTM 733388 x 3202774, 17-VI-2007, Bonnie Reynolds McKinney & Jonás Delgadillo Villalobos (1 male, 1 female); MEXICO: NUEVO LEÓN: 9 km E San Roberto, 1850m., 23-VII-2006, D. C. Robacker (1 female); MEXICO: NUEVO LEÓN: San Roberto, 6500', 14-22-VII-2007, D. C. Robacker (1 male, 1 female). The holotype, allotype and most paratypes

are deposited at the Museo de Zoología “Alfonso L. Herrera”, Facultad de Ciencias, Universidad Nacional Autónoma de México, México D.F., México; a pair of paratypes are at the McGuire Center for Lepidoptera and Biodiversity, and an additional pair temporarily remains with ADW.

Type locality. MEXICO: COAHUILA: Mpio. Acuña: Maderas del Carmen: Los Cojos Ridge, 7000–7400' (2134–2256 m), 28°56'21.5"N 102°36'01.8"W (Fig. 3e–f). Los Cojos Ridge is a high igneous ridge managed by CEMEX-Proyecto El Carmen.

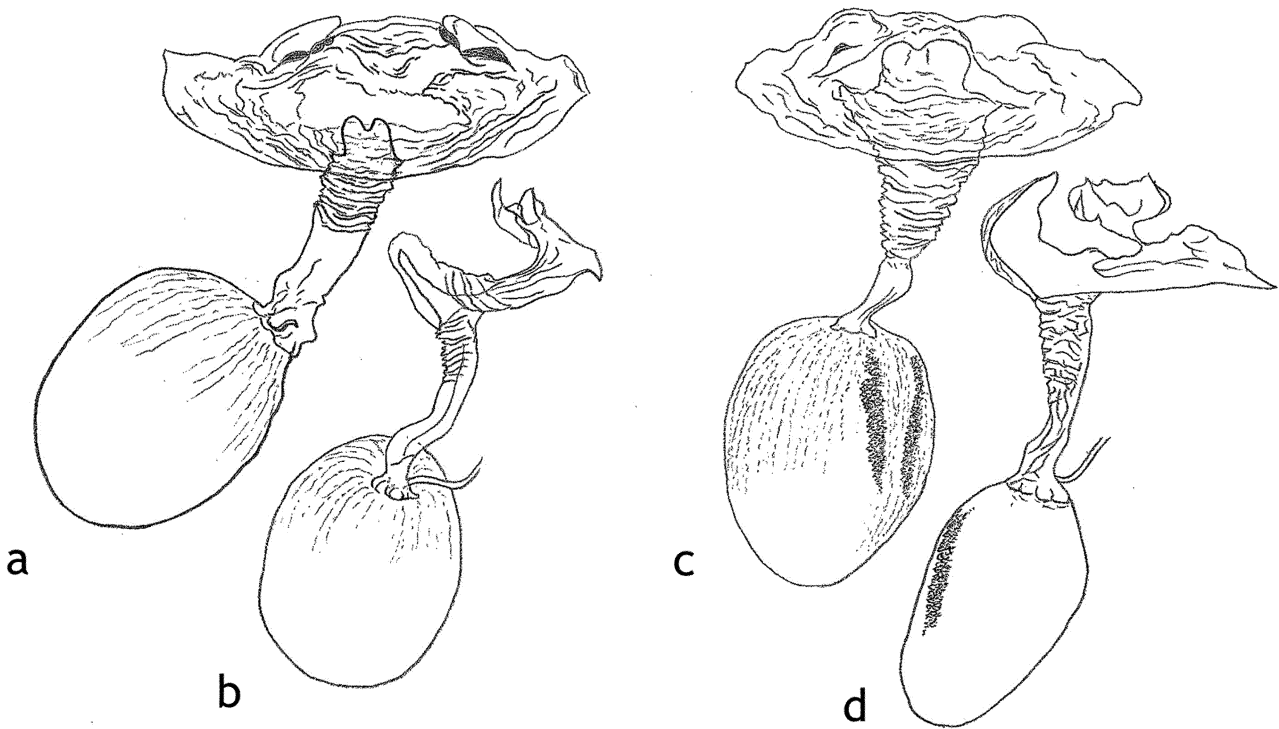


FIGURE 5. Female genitalia of *Neominois*. **a)** *N. carmen*—MEXICO: Coahuila; Maderas del Carmen (GTA #14022), ventral view; **b)** same, lateral view **c)** *N. ridingsii*—USA: Nevada; Esmeralda County (GTA #11598), ventral view; **d)** same, lateral view.

Distribution and phenology. The type series of *Neominois carmen* suggests that the species occupies a rather extensive range in northeastern Mexico, at least from the Maderas del Carmen in northwestern Coahuila, to the area west of Linares in southern Nuevo León; these areas are separated by about 480 km. It is probable that *N. carmen* inhabits regions between northern Coahuila and southern Nuevo León, and perhaps even in southwestern Texas, although its overall range remains to be elucidated. Dates of capture of the type specimens indicate a single generation annually, from early June to late July.

Habitat. The Sierra Maderas del Carmen, a sky island with elevations from 600 to 2700 m encircled by low elevational Chihuahuan Desert, represents the major forested portion of the Sierra del Carmen. Its location in northwestern Coahuila, Mexico, is adjacent to the Big Bend region of southern Texas and only 60 km south of Big Bend National Park. The region encompasses a series of biotic associations from desert scrub at lower elevations to mesic montane forest, including *Pseudotsuga* Carr. and *Abies* P. Mill., at the higher elevations (Jiménez-G & Zuñiga-R 1991). The climate is temperate with average monthly temperatures ranging from 10C in winter to 32C in summer. Annual rainfall varies from negligible at low elevations to perhaps as much as 60 cm at higher elevations, principally from mid-summer to early autumn.

The part of Los Cojos Ridge in the Maderas del Carmen where *N. carmen* is most abundant is comprised of open areas along a dirt road at the beginning of the pine-oak woodland habitat (Fig. 3e–f). This area is dominated by the following plants: *Quercus mohriana* Buckl. ex Rydb. (Fagaceae), *Pinus cembroides* Zucc

(Pinaceae), *Juniperus deppeana* Steud. (Cupressaceae), *Muhlenbergia emersleyi* Vasey, *Piptochaetium pringlei* (Beal) Parodi (both Poaceae), *Lepidium montanum* Nutt. (Brassicaceae), *Nolina erumpens* (Torr.) S. Wats., *Agave* spp. (both Agavaceae), and *Opuntia polyacantha* var. *polyacantha* Haw. (Cataceae). Other sites in the Maderas del Carmen inhabited by *N. carmen* include Casa Negro (UTM 734154 x 3203755), 2470m, and Vista Hermosa (UTM 731220 x 3198759), 1398m. The former site, Casa Negro, is at a slightly higher elevation than Los Cojos Ridge, and is dominated by *Quercus* spp. (Fagaceae), *Juniperus monosperma* (Engelm.) Sarg., *Juniperus flaccida* Schldtl. (both Cupressaceae), *Pinus cembroides*, *Muhlenbergia emersleyi*, and *Panicum hallii* var. *hallii* Vasey (latter two Poaceae). The latter site, however, is significantly lower in elevation, at the beginning of the transition zone from low desert to foothill grasslands; Vista Hermosa is dominated by *Yucca* sp., *Dasyllirion leiophyllum* Engelm. ex Trel., *Agave lechuguilla* Torr. (all Agavaceae), *Opuntia engelmannii* Salm-Dyck ex Engelm. (Cataceae), *Bouteloua curtipendula* (Michx.) Torr. var. *caespitosa* Gould & Kapadic (Poaceae), and *Viguiera stenoloba* Blake (Asteraceae). The habitat for *N. carmen* east of San Roberto, Nuevo León, is dominated by “Pinyon pine, Juniper, cactus and grasses” (David Robacker, pers. comm. 2006).

Biogeography. Various authors have discussed biogeographic attributes of taxa occurring in the Sierra del Carmen (e.g., Miller 1955, Encina & Villareal 2002), as well as diverse aspects of their ecology and bioconservation (e.g., Ceballos *et al.* 1998, Hellgren *et al.* 2005, McCormack *et al.* 2005, Villalobos *et al.* 2005, Bhagabati & Horvath 2006, Poulus *et al.* 2007). Studies based on birds (Miller 1955) and oaks (Encina & Villareal 2002) have reached similar conclusions regarding biogeographic affinities of the faunal elements. While the Sierra del Carmen can be considered an extreme northern geological or biogeographical province of the Sierra Madre Oriental (Villaseñor & Téllez-Valdés 2004), mesic habitats above 1500m represent a relictual, southern distributional limit for a number of nearctic taxa (including two mammals *Sorex milleri* Jackson (Soricidae) and *Ammospermophilus interpres* (Merriam) (Sciuridae), and subspecies of another mammal *Erethizon dorsatum* L. (Erethizontidae) and a butterfly *Limenitis weidemeyerii* W. H. Edwards (Nymphalidae)), and have strong faunal affinities to various Trans-Pecos ranges in western Texas (Miller 1955, Encina & Villareal 2002) and higher ranges in northern Coahuila (e.g., Sierra de la Madera, Sierra Cruces).

A number of endemic or quasiendemic animals are known from the Sierra del Carmen, including the mammal *Scalopus montanus* Baker (Talpidae), subspecies of two additional mammals, *Odocoileus virginianus* Zimmermann (Cervidae) and *Tamias dorsalis* Baird (Sciuridae), and two snakes *Natrix erythrogaster* (Forster in Bossu) and *Coluber constrictor* L. (both Colubridae) (Kobelkowsky 2003). Encina & Villareal (2002) noted the Sierra del Carmen to be the most diverse region for *Quercus* in Coahuila, with 16 of 30 species known from the state. Thus, the Sierra del Carmen can be considered a biological island, a component of the “sierras coahuilenses,” which has served various taxa as a relictual distributional outpost.

While the butterfly genera *Neominois* and *Gyrocheilus* have been cited as relictual elements of the fauna of the Sierra del Carmen (Kobelkowsky 2003), both genera are also distributed far to the southeast in the northwestern Sierra Madre Oriental (data on northeastern Mexican *Gyrocheilus* will be presented in a subsequent study). The Lepidoptera of the entire region between the known distributional limits of *Neominois carmen* has been poorly studied, and more endemic taxa could well be found here with continued fieldwork and collections (especially between April and October).

Larval foodplant. Adults of *Neominois carmen* were found in openings dominated by *Piptochaetium pringlei* (Fig. 3f–h) at both Los Cojos Ridge and Casa Negro. While no oviposition events were witnessed, the close association of adults with this particular grass on Los Cojos Ridge strongly suggests that it is the local larval foodplant. No *Piptochaetium* was encountered at Vista Hermosa. *Neominois* was seen only once at this latter locale, indicating a possible stray from higher elevations, but if it breeds in the area around Vista Hermosa, it is possible that the species may use the locally common *Bouteloua* as a larval foodplant. The early stages are unknown.

Etymology. *Neominois carmen* is named for the Maderas del Carmen of northwestern Coahuila. This

species has been known by the common name Joboni Satyr (see Warren et al. 2008), after Jonás A. Delgadillo Villalobos and Bonnie Reynolds McKinney, who collected part of the type series.

Diagnosis and discussion

Morphology. *Neominois carmen* immediately stands out from *N. ridingsii* by its tawny-orange dorsal coloration, especially of females. *Neominois ridingsii* (Figs. 2a–h) are predominately whitish gray to warm yellowish gray and marked with various shades of brown or gray-brown. The orange coloration of *N. carmen*, obvious on freshly-emerged individuals, becomes faded so that some older males appear much like *N. ridingsii*. Additionally, *N. ridingsii* exhibits a prominently shaded medial area on the dorsal forewing and more extensive and bolder striations, especially on the venter, including across the entire discal cell and medially on the ventral forewing. The ventral hindwing of *N. ridingsii*, and often the ventral forewing, usually has the medial area well-defined by dense striations. *Neominois ridingsii* further have the distal (and often proximal) margins of the submedial macules on both wings more sharply pointed than *N. carmen*, have fringes that are usually checkered with brown at the ends of the veins, and have a more persistent continuation of the submarginal band cephalad on the forewing into the base of cell R_4 - R_5 . The wings of *N. ridingsii* are proportionately more elongate and less angular than are those of *N. carmen*. The venation of the two species is similar, but the discal cells of both wings on *N. carmen* are broader and longer than on *N. ridingsii*. In size, males of *N. carmen* are comparable with populations of *N. ridingsii* occurring in the southern Rocky Mountains and Intermountain region of the western United States (Austin 1986); females average larger than female *N. ridingsii* from those same populations.

Male genitalia of *Neominois* (Fig. 4a–d), first (but poorly) illustrated by Skinner (1922) and subsequently by Avinoff & Sweadner (1951) and de Lesse (1951a), have a massive tegumen; a decurved uncus about the length of the tegumen; a thinner, shorter, upcurved, and sharply pointed subuncus; a short and slightly sinuate combined ventral arm of the tegumen and dorsal arm of the saccus; a stout anterior arm of the saccus; an upcurved valva that narrows caudad to a blunt caudal end with variable serration on both its dorsal and ventral edges caudad; and a long (about 1.5X length of the valva) and thin aedeagus. Within the two species of *Neominois*, male genitalia exhibit intraspecific variation (also noted by Scott 1998), especially in the orientation (ventral view) and length of the anterior arm of the saccus and details of the valva. The latter on both species varies in its width, its curvature, and in the extent and strength of the caudal serrations. Intraspecific variability in the genitalia (especially of males), at times particularly so, has been documented for a variety of satyrines (e.g., Elwes & Edwards 1893, Lorkovic 1957, Craw 1978, Coutsis 1984, Goulson 1993, Pycrz *et al.* 1999). Nonetheless, the male genitalia show consistent differences between the species of *Neominois* (Fig. 4a–d). These most notably include a broader (lateral view) uncus on *N. carmen* compared with *N. ridingsii*, the absence of the expanded aspect of the dorsal margin of the valva near its caudal end as present on *N. ridingsii*, this clearly indicated on previously illustrated valvae (Skinner 1922, Avinoff & Sweadner 1951, de Lesse 1951a), and the absence on *N. carmen* of the small thorn-like projections on the aedeagus of *N. ridingsii* (Fig. 4c–d, see also de Lesse 1951a).

Female genitalia of *Neominois* (Fig. 5a–d), figured previously by de Lesse (1951a), have a very broad sterigma (breadth about 2X its length), a variably bilobed lamella antevaginalis, a distinctive broad and long accordion-shaped membranous antrum, a short, membranous ductus bursae, and a globular membranous corpus bursae. As for genitalia of males, female genitalia of *N. carmen* exhibit differences from those of *N. ridingsii* (Fig. 5a–d). These include a narrower and more vertical central lobe of the lamella antevaginalis (broader and curved caudad on *N. ridingsii*), a shorter and narrower folded portion of the antrum, and the absence of signa (prominent as parallel bands on *N. ridingsii*). Variation of signa has been considered taxonomically significant at the generic level (e.g., Holloway 1974, Parsons 1986), but in *Neominois* the presence or absence of signa is a diagnostic species-level character.

Behavior and Ecology. *Neominois carmen* appears to be largely associated with habitats where *Piptochaetium*, the probable larval foodplant, is a prominent component of the flora. This is a tall grass (Fig. 3f–h), up to a meter in height, that grows in tight clumps, often separated by small patches of bare ground. It is on these small patches of ground where adults of *N. carmen* prefer to bask. As with *N. ridingsii* in Colorado and Nevada (Scott 1973; ADW, GTA pers. obs.), adults of *N. carmen* bask with wings open (about 130–180 degrees, Figs. 3a, c) early in the day under cool conditions, but perch with closed wings (often leaving essentially no shadow on the ground) when hotter. Adults are mostly sedentary, and were observed in flight most often only once flushed by the observer's approach.

Throughout the Great Plains of southern Canada (Alberta and Saskatchewan), south through eastern parts of Montana, Wyoming, Colorado and New Mexico, *Neominois ridingsii* is frequently found in close association with *Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths (Poaceae), a documented larval foodplant (Scott 1973, 1992). Areas where *N. ridingsii* occur within this broad distribution are often windblown and/or periodically grazed, so that average height of the *Bouteloua* during the adult flight season is 2–8 cm. Thus, at first glance, *N. ridingsii* and *N. carmen* appear to have very different general ecological preferences. However, *N. ridingsii* uses a variety of grasses other than *B. gracilis* as larval foodplants (Scott 1992), and, at the western edge of its distribution, is very closely associated with *Hesperostipa comata* (Trin. & Rupr.) Barkworth (Poaceae) everywhere it occurs in Nevada (Austin 1986, GTA pers. obs. 1981–2003) and in the flatlands of Crook and Deschutes counties, Oregon (ADW pers. obs. 2005). The suspected principal foodplant of *N. carmen* in the Maderas del Carmen, *Piptochaetium*, is a member of the Stipeae and most closely related to *Hesperostipa* (Cialdella & Giussani 2002).

Phylogenetic placement of *Neominois* and discussion of Old World relatives. *Neominois*, included by Miller (1968) in a “*Satyrus*-series” of his tribe Satyrini (see also de Lesse 1951a, 1951b), is embedded within the Holarctic subtribe Satyrina (e.g., Peña *et al.* 2006). Besides *Satyrus* Latreille (type species *Papilio actaea* Esper), *Satyrus ridingsii* has also been included within *Hipparchia* Fabricius (type species, *Papilio hermione* Linnaeus, a junior synonym of *Papilio fagi* Scopoli), *Eumenis* Hübner (type species *Papilio autonoe* Esper; now synonymized with *Hipparchia*, but see Miller & Brown 1981), and *Chionobas* Boisduval (type species *Papilio aello* Hübner, now synonymized with *Oeneis* Hübner) (see synonymy for *Satyrus ridingsii* in Austin 1986). Elwes & Edwards (1893) thought that *Satyrus ridingsii* was “perhaps best treated as an aberrant *Oeneis*”, based on its closer resemblance to that genus than to *Satyrus*. Hemming (1935) considered *Neominois* an unnecessary genus and inseparable from *Eumenis*. Miller (1968) maintained that *Neominois* was “most nearly related to the Asian *Karanasa*” Moore (see also Avinoff & Sweadner 1951). Some *Karanasa* are superficially strikingly similar to *Neominois* (see figures in Avinoff & Sweadner 1951), but their genitalia differ. Niculescu (1980) subsumed all genera of Miller's (1968) “*Satyrus*-series” in the genus *Satyrus*. Although several authors had placed *S. ridingsii* in *Hipparchia* (apparently beginning with Kirby 1871; see Austin 1986), Scott (1998) formally placed *Neominois* within *Hipparchia*.

Genitalia of both sexes of *Neominois*, however, exhibit several notable differences from those of *Hipparchia* (compare figures herein with those of de Lesse 1951a, Higgins 1975, Kudrna 1977, Oehmig 1983, Coutsis 1984, Korshunov 1991) and other related species (Avinoff & Sweadner 1951, de Lesse 1951a). *Neominois* lack the Jullian organ of a number of *Hipparchia* (de Lesse 1951a, Higgins 1975). *Neominois* further have no patches of androconial scales, often also present on *Karanasa* (Avinoff & Sweadner 1951), have an elongate and cylindrical antennal club expanding from the shaft (abrupt, oval, and spatulate on *Hipparchia*), and a proportional difference in the lengths of the legs (Miller 1968). Although Scott (1998) noted similarity in the larvae of *Neominois* and *Hipparchia* (e.g., compare Edwards 1897 with Oehmig 1983), their eggs are different (Edwards 1897, Comstock 1927, Oehmig 1983, García-Barros & Martín 1991, 1995).

The latest phylogeny of satyrines (Peña *et al.* 2006), based on combined molecular data, placed *Neominois* in a terminal clade within the Satyrina, in a sister relationship with *Oeneis*. These two genera, in turn, are sister to *Karanasa*. Peña *et al.* (2006) gave the following topology for the Satyrina: ((*Berberia* + *Hipparchia*)

+ ((*Satyrus* + (*Charaza* + *Pseudocharaza*)) + ((*Arethusana* + *Brintesia*) + (*Karanasa* + (*Neominois* + *Oeneis*))))). These results most closely corroborate the views of Elwes & Edwards (1893), who believed *Neominois* to be closely related to or synonymous with *Oeneis*. However, the existence of *N. carmen* further reinforces the genus-level status of *Neominois*, since most of the autapomorphic characters that separated *N. ridingsii* from related genera can now be viewed as synapomorphies that define *Neominois*.

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Literature cited

- Austin, G.T. (1986) A review of the satyrine genus *Neominois*, with descriptions of three new subspecies. *Bulletin of the Allyn Museum*, 107, 1–27.
- Avinoff, A. & Sweadner, W.R. (1951) The *Karanasa* Butterflies. A Study in Evolution. *Annals of the Carnegie Museum*, 32(1), iii, 1–251.
- Bhagabati, N.K. & Horvath, E.G. (2006) Mexican jay social group size varies with habitat in northeastern Mexico. *Journal of Field Ornithology*, 77, 104–110.
- Ceballos, G., Rodríguez, P. & Medellín, R.A. (1998) Assessing conservation priorities in megadiverse Mexico: mammalian diversity, endemism, and endangerment. *Ecological Applications*, 8, 8–17.
- Cialdella, A.M. & Giussani, L.M. (2002) Phylogenetic relationships of the genus *Piptochaetium* (Poaceae, Pooideae, Stipeae): evidence from morphological data. *Annals of the Missouri Botanical Garden*, 89, 305–336.
- Comstock, J.A. (1927) *Butterflies of California*. Published by author, Los Angeles, 334 pp., 63 plates.
- Coutsis, J.G. (1984) Description of the female genitalia of *Hipparchia fagi* Scopoli, *Hipparchia semele* Linnaeus (Satyridae) and their related taxa. *The Journal of Research on the Lepidoptera*, 22, 161–203.
- Craw, R.C. (1978) Revision of genus *Argyrophenga* (Lepidoptera: Satyridae). *New Zealand Journal of Zoology*, 5, 751–768.
- de Lesse, H. (1951a) Révision de l'ancien genre *Satyrus* (s.l.). *Annales de la Société entomologique de France*, 121, 77–101.
- de Lesse, H. (1951b) Divisions génériques et subgénériques des anciens genres *Satyrus* et *Eumenis* (sensu lato). *Revue française de Lépidoptérologie*, 13, 39–42.
- Edwards, W.H. (1897) *The Butterflies of North America. Third Series*. Houghton, Mifflin & Co., Boston, 420 pp., 51 plates.
- Elwes, H.J. & Edwards, J. (1893) A revision of the genus *Oeneis*. *Transactions of the Entomological Society of London*, 1893, 457–481.
- Encina, J.A. & Villareal, J.A. (2002) Distribución y aspectos ecológicos del género *Quercus* (Fagaceae) en el estado de Coahuila, México. *Polibotánica*, 13, 1–23.
- García-Barros, E. & Martín, J. (1991) Immature stages of *Hipparchia* Fabricius and the systematics of the '*Satyrus* series' (Lepidoptera: Nymphalidae: Satyrinae). *Systematic Entomology*, 16, 407–426.
- García-Barros, E. & Martín, J. (1995) The eggs of European satyrine butterflies (Nymphalidae): external morphology and its use in systematics. *Biological Journal of the Linnean Society*, 115, 73–115.
- Goulson, D. (1993) Variation in the genitalia of the butterfly *Maniola jurtina* (Lepidoptera: Satyrinae). *Zoological Jour-*

- nal of the Linnean Society*, 107, 65–71.
- Hellgren, E.C., Onorato, D.P. & Skiles, J.R. (2005) Dynamics of a black bear population within a desert metapopulation. *Biological Conservation*, 122, 131–140.
- Hemming, F. (1935) Notes on seventeen genera of Rhopalocera. *Stylops*, 4, 1–3.
- Higgins, L.G. (1975) *The Classification of European Butterflies*. Collins, London, 320 pp.
- Holland, W. J. (1916) *The Butterfly Book. A Popular Guide to a Knowledge of the Butterflies of North America*. Doubleday, Page & Company, 382 pp., 48 plates.
- Holloway, J.D. (1974) The endemic Satyridae (Lepidoptera: Rhopalocera) of New Caledonia. *Journal of Entomology*, 43, 89–101.
- Jiménez-Guzmán, A. & Zuñiga-Ramos, M.A. (1991) Caracterización biológica de Sierra del Carmen, Coahuila, México. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología*, 62, 373–382.
- Kirby, W.F. (1871) *A Synonymic Catalogue of Diurnal Lepidoptera*. John van Voorst, London, 690 pp.
- Kobelkowsky, R.S. (2003) Maderas del Carmen Área de Protección de Flora y Fauna. In: <http://www.conanp.gob.mx/anp/maderas.php>. 2008/03/04 3:21 (accessed 4 March 2008).
- Korshunov, Y.P. (1991) Review of the species of *Hipparchia* of the USSR. *Entomological Review*, 70(4), 136–140 (translated from Redkiye gel'minty, kleshchni i nasekomyye. *Nauka, Novosibirsk*, pp. 69–75, 1990).
- Kudrna, O. (1977) *A Revision of the Genus Hipparchia Fabricius*. Classey, Faringdon, 300 pp.
- Lorkovic, Z. (1957) Die Speciationsstufen in der *Erebia tyndarus*-Gruppe. *Biološki glasnik*, 10, 61–110.
- Luis, A.M., Llorente, J.B., Warren, A.D. & Vargas, I.F. (2004) Lepidópteros: papilionoideos y hesperioideos. In: García, A. J. M., M. J. Ordóñez & M. S. Briones (Eds.), *Biodiversidad de Oaxaca*. Instituto de Biología, UNAM, Fondo Oaxaqueño para la Conservación de la Naturaleza, and World Wildlife Fund, México, pp. 335–355.
- Maza, R.G. de la, Maza, J. de la & White, A. (1989) La fauna de mariposas de México. Parte I. Papilionoidea (Lepidoptera: Rhopalocera). *Revista de la Sociedad Mexicana de Lepidopterología*, 12(2), 39–98.
- McCormack, J.E., Castañeda G., Milá, B. & Heredia, F. (2005) Slate-throated redstarts (*Myioborus miniatus*) breeding in Maderas del Carmen, Coahuila, Mexico. *The Southwestern Naturalist*, 50, 501–503.
- Miller A.H. (1955) The avifauna of the Sierra del Carmen of Coahuila, Mexico. *The Condor*, 57, 154–178.
- Miller, L.D. (1968) The higher classification, phylogeny and zoogeography of the Satyridae (Lepidoptera). *Memoirs of the American Entomological Society*, 24, 1–174.
- Miller, L.D. & Brown, F.M. (1981) A catalogue/checklist of the butterflies of America north of Mexico. *Memoir. The Lepidopterists' Society*, 2, 1–280.
- Niculescu, E.V. (1980) Problèmes de systématique dans la famille des Satyridae. *Nouvelle Revue de Entomologie*, 10, 301–311.
- Oehmig, S. (1983) *Hipparchia azorina* (Strecker, 1899) (Satyridae) biology, ecology and distribution on the Azores Islands. *The Journal of Research on the Lepidoptera*, 20, 136–160.
- Opler, P.A. (1999) *A Field Guide to Western Butterflies*. Houghton Mifflin Co., Boston, 540 pp., 44 pls.
- Opler, P.A. & Warren, A.D. (2002) *Butterflies of North America. 2. Scientific Names List for Butterfly Species of North America, North of Mexico*. Contributions of the C. P. Gillette Museum of Arthropod Diversity, Colorado State University, 79 pp.
- Parsons, M.J. (1986) A new genus and twenty-six new species of butterflies (Lepidoptera: Hesperiiidae, Lycaenidae, Nymphalidae) from Papua New Guinea and Irian Jaya. *Tyô to Ga*, 37, 103–177.
- Peña, C. & Lamas, G. (2005) Revision of the butterfly genus *Forsterinaria* Gray, 1973 (Lepidoptera: Nymphalidae, Satyrinae). *Revista peruana de Biología*, 12, 5–48.
- Peña, C., Wahlberg, N., Weingartner, E., Kodandaramaiah, U., Nylin, S., Freitas, A.V.L & Brower, A.V.Z. (2006) Higher level phylogeny of satyrine butterflies (Lepidoptera: Nymphalidae) based on DNA sequence data. *Molecular Phylogenetics and Evolution*, 40, 29–49.
- Poulus, H. M., Goodale, U. M. & Berlyn, G. P. (2007) Drought response of two Mexican oak species, *Quercus laceyi* and *Q. sideroxyla* (Fagaceae), in relation to elevational position. *American Journal of Botany*, 94, 809–818.
- Pyrz, T.W., Willmott, K.R. & Hall, J.P.W. (1999) Contribution to the knowledge of Ecuadorian Pronophilini. Part III. Three new species and five new subspecies of *Lymanopoda* (Lepidoptera: Nymphalidae: Satyrinae). *Genus*, 10, 497–522.
- Scott, J.A. (1973) Convergence of population biology and adult behaviour in two sympatric butterflies, *Neominois ridingsii* (Papilionoidea: Nymphalidae) and *Amblyscirtes simius* (Hesperioidea: Hesperiiidae). *Journal of Animal Ecology*, 42, 663–672.
- Scott, J.A. (1992) Hostplant records for butterflies and skippers (mostly from Colorado) 1959–1991, with new life histories and notes on oviposition, immatures, and ecology. *Papilio (new series)*, 6, 1–171.
- Scott, J.A. (1998) New western North American butterflies. *Papilio (new series)*, 11, 1–12.
- Scudder, S.H. (1875) Synonymic list of the butterflies of North America, north of Mexico. Part 1, Nymphales. *Bulletin of the Buffalo Society of Natural Sciences*, 2(4), 233–269.
- Skinner, H. (1922) The identity of *Neominois ridingsii* and *N. dionysus* (Lepidoptera, Satyridae). *Entomological News*,

33, 74–75.

- Toliver, M.E., Holland, R. & Cary, S.J. (1994) *Distribution of Butterflies in New Mexico (Lepidoptera: Hesperioidea and Papilionoidea)*, Second Edition. Published by authors, Albuquerque, New Mexico, 393 pp.
- Villalobos, J.A.D., McKinney, B.R., Heredia Pineda, F. & Gilbert Isern, S. (2005) Nest record of *Sorex milleri* from Maderas del Carmen, México. *The Southwestern Naturalist*, 50, 94–95.
- Villaseñor, J.L. & Téllez-Valdés, O. (2004) Distribución potencial de las especies del género *Jefea* (Asteraceae) en México. *Anales del Instituto de Biología. Universidad Nacional Autónoma de México* (Serie Botánica), 75, 205–220.
- Warren, A.D. (2005) *Lepidoptera of North America 6. Butterflies of Oregon. Their Taxonomy, Distribution, and Biology*. Contributions of the C. P. Gillette Museum of Arthropod Diversity, Colorado State University, 408 pp.
- Warren, A.D., Llorente-Bousquets, J.E., Luis-Martínez, A. & Vargas-Fernández, I. (2008) Interactive Listing of Mexican Butterflies. <http://www.mariposasmexicanas.com/> (accessed 21 February 2008)