

## A New Subspecies of *Habrodais poodiae* Brown (Lepidoptera: Lycaenidae: Theclini) from Baja California, Mexico, Representing the Southernmost Distribution of the Nearctic *Habrodais*

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**Yu-Feng Hsu (2005)** A new subspecies of *Habrodais poodiae* Brown (Lepidoptera: Lycaenidae: Theclini) from Baja California, Mexico, representing the southernmost distribution of the Nearctic *Habrodais*. *Zoological Studies* 44(1): 26-33. *Habrodais poodiae* Brown is one of only 3 species of the Theclini that occur in North America, and it is the only member of the tribe that is endemic to Mexico. *Habrodais poodiae* was described from Sierra de Juárez in Baja California Norte, the northeastern part of which represents the southern extension of the Californian Phytogeographic Province. Additional populations of *H. poodiae* occur in Sierra San Pedro Mártir, disjunct from and far to the south of the type locality. These populations are phenotypically distinct from those of the type locality, and are described herein as a new subspecies, *H. poodiae browni*. This new subspecies represents the southernmost limit of the Nearctic *Habrodais*. The fact that *H. poodiae* consists of 2 differentiated, geographically separated, and highly restricted subspecies reveals it is likely derived from post-glacial refugia of its sister species, *H. grunus*, which has a much-wider and more-northerly distribution. <http://www.sinica.edu.tw/zool/zoolstud/44.1/26.pdf>

**Key words:** *Quercus chrysolepis*, Canyon oak, Californian Province, Post-glacial withdrawal.

The "hairstreaks" in the tribe Theclini are distributed predominantly in Asia, especially in the transitional zone between the eastern Palaearctic and northern Oriental realms, where over 100 species have been documented (Koiwaya 1999). The tribe is poorly represented in the Nearctic and western Palaearctic realms, with only 3 species in each region. However, both regions support peculiar endemic genera. *Laeosopis* Rambur and *Quercusia* Verity are found only in the latter, *Hypaurotis* Scudder and *Habrodais* Scudder only in the former. These genera are monobasic except *Habrodais*, which is a genus of the Californian Province which ranges from southern Washington, southwestern Idaho, and Oregon, throughout the montane zone of California, south to Baja California, Mexico; it also is found in central Arizona (Pyle 1981, Scott 1986, Brown et al.

1992). It is intriguing that although *H. grunus* (Boisduval) inhabits much of the range of the genus and is fairly uniform in appearance (Garth and Tilden 1986), a distinct species, *H. poodiae* Brown and Faulkner, inhabits northern Baja California, Mexico (Brown and Faulkner 1982), representing the southern end of the range of *Habrodais*. *Habrodais poodiae* occurs in cismon-tane oak woodlands in the higher elevations of the Sierra de Juárez, where it is intimately associated with canyon oak, *Quercus chrysolepis* Liebmann (Fagaceae) (Brown and Faulkner 1982). A population of *H. poodiae* is also found in the Sierra San Pedro Mártir, more than 120 km to the south of the type locality (Brown and Faulkner 1984, Brown et al. 1992), and that population is phenotypically distinct from the nominotypical *H. poodiae* (Brown and Faulkner 1984, Brown et al. 1992). A

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comparison of series of specimens from both localities showed that differences among specimens from the 2 areas are consistent. Biogeographical implications of the new subspecies are discussed.

## MATERIALS AND METHODS

Samples of *Habrodais* were examined from the following localities: *H. grunus* (3 ♂♂, 7 ♀♀, Contra Costa Co., CA, USA; 5 ♂♂, 6 ♀♀, San Diego Co., CA; 2 ♂♂, 3 ♀♀, Monterey Co., CA; 1 ♂, 3 ♀♀, Butte Co., CA; and 2 ♂♂, Ventura Co., CA), *H. poodiae* (10 ♂♂, 9 ♀♀, Sierra de Juárez, Baja California Norte, Mexico and 12 ♂♂, 8 ♀♀, Sierra San Pedro Mártir, Baja California Norte, Mexico). Dissection of the genitalia follows the protocol of Hsu and Liu (2002). Terminology follows Nijhout (1991) for wing patterns and Klots (1970) for genitalia. Abbreviations of measurements are as follows: FL, forewing length; AL, antennal length. Types of the new taxon are deposited in the following institutions and collections: BMNH, The Natural History Museum, London; CAS, California Academy of Sciences, San Francisco, CA, USA; IOZ, Institute of Zoology, Chinese Academy of Sciences, Beijing; NTNU, National Taiwan Normal University, Taipei, Taiwan; NMNS, National Museum of Natural Sciences, Taichung, Taiwan; and TFC, Tomoo Fujioka Collection, Tokyo, Japan.

## SYSTEMATIC ACCOUNT

### *Habrodais poodiae browni*, subsp. nov.

(Figs. 1-2, 7-8, 13-18)

**Holotype** ♂: Mexico: Baja California Norte: Sierra San Pedro Mártir, 31 km E of Rancho Melling, 2200~2400 m, 17~18 July 1994, associated with *Quercus chrysolepis* (CAS).

**Paratypes**: 10 ♂♂, 7 ♀♀, same data as holotype (BMNH, CAS, IOZ, NMNS, NTNU, and TFC); 1 ♂, 1 ♀, Mexico: Baja California Norte: Sierra San Pedro Mártir, 28 km E of Rancho Melling, 1850 m, 18 July 1994, associated with *Quercus chrysolepis* (NTNU).

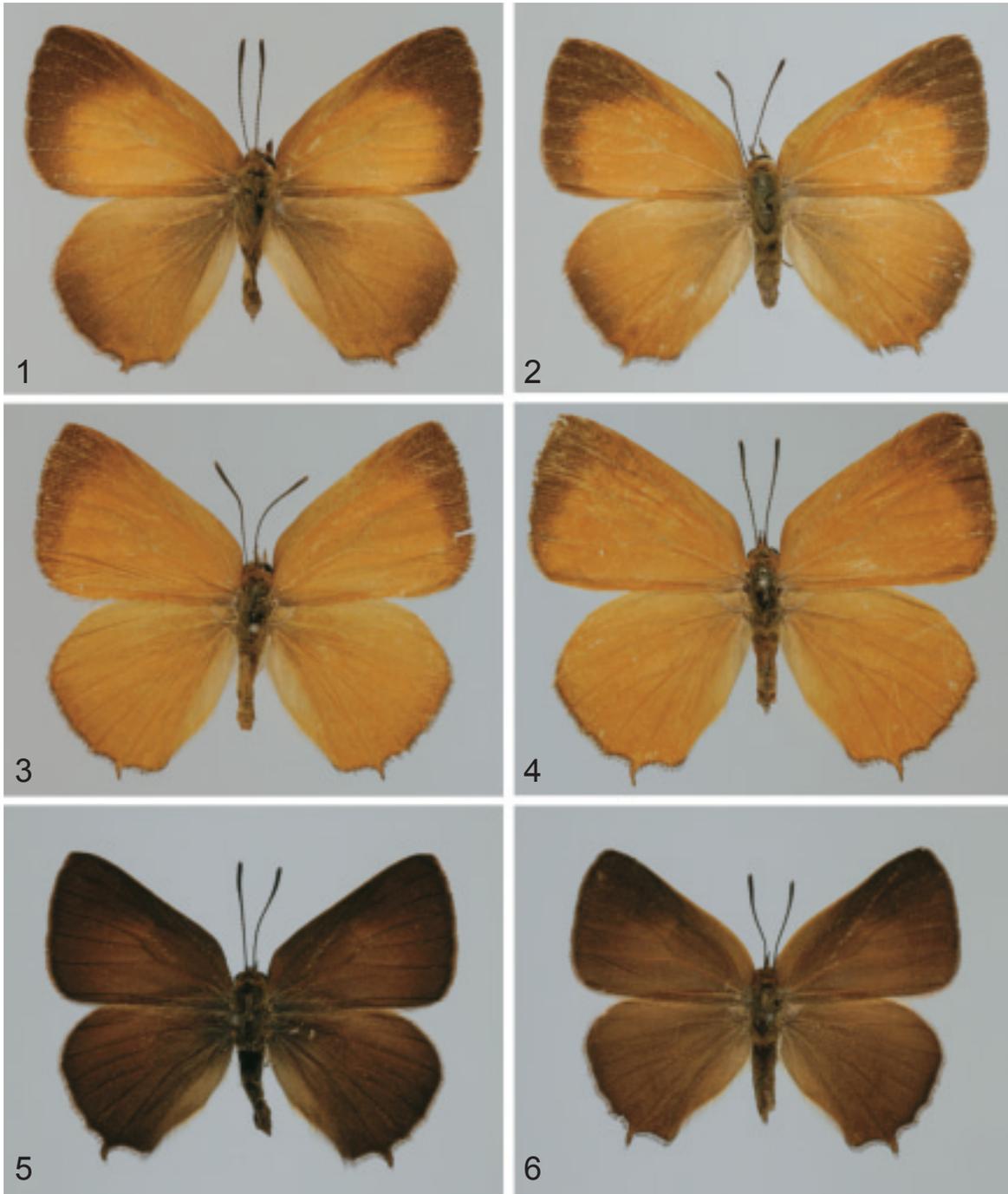
**Diagnosis**: The new subspecies is similar to the nominotypical subspecies (Figs. 3, 4, 8, 9), but distinguishable by the following characters: 1) the ground color of the upper sides of the wing of *H. p. browni* is dull orangish yellow (Figs. 1, 2), in contrast to the bright orange of *H. p. poodiae* (Figs. 3,

4); 2) brown scaling is prominent along the termen of the upper sides of the hindwing in *H. p. browni* (Figs. 1, 2) but absent or weakly present in *H. p. poodiae* (Figs. 3, 4); 3) a flush of gray scaling is present on the upper sides of the hindwing in *H. p. browni* (Figs. 1, 2), whereas it is absent from *H. p. poodiae* (Figs. 3, 4); 4) the 'g'-element on the underside of the hindwing is greatly reduced in *H. p. browni* (Figs. 7, 8) but prominent in *H. p. poodiae* (Figs. 9, 10); and 5) the ampulla of *H. p. browni* (Fig. 16) is broader at the base and shorter compared to that of *H. p. poodiae* (see Brown and Faulkner 1982). *Habrodais poodiae browni* is also phenotypically similar to *H. grunus*, but in the latter the ground color of the upper side of the wing is much darker (Figs. 5, 6) and the 'g'-element of the underside of the hindwing is more prominent (Figs. 11, 12).

**Description**: **Male** (Figs. 1, 7): FL 12.6~15.0 mm (mean  $13.77 \pm 0.80$  mm,  $n = 11$ ); AL 6.7~7.6 mm (mean  $7.14 \pm 0.33$  mm,  $n = 10$ ). **Head**: Frons covered by appressed white scaling overlaid with a medial patch of brown mixed with yellow hairs and scales; vertex covered by appressed brown scaling with brown bristle-like scales from chaetosemata, with a sheet of orange scales posteriad; a narrow white rim surrounding eye; eye semi-oval, covered with prominent gray setae mesially; labial palpus porrect, with 3rd segment pointed downwards and much shorter than 2nd segment, covered with white scaling laterally, white mixed with orange ventrally, and with a patch of brown dorsally, scales on venter long, slender, and hair-like; maxillary palpus reduced, not visible; proboscis unscaled, pale buff; antenna smoothly scaled, naked at terminal end of nudum and along inner surface distad where short trichoid sensillae are present. A pair of white dots at base of most flagellomeres, attenuating toward nudum. **Thorax**: Gray tinged with orange scaling dorsad, white ventrad; tegulae elongate, covered by gray hairs tinged with orange; legs slender, femur and tibia covered with white scales, tinged with orange distally, tarsomeres overlaid with extensive glossy dark-brown scaling. Fore tarsus aborted, fused. **Forewing**: Termen and costa slightly concave, dorsum nearly straight. Ground color of upper side dull orangish yellow, with extensive dark-brown scaling distad along termen and around apex on forewing. Ground color of underside ochre. Discal spot faint, forming narrow yellow bar edged with brown. Distal band of central symmetry system represented by tilted, uneven, narrow white line edged with brown proximally, sub-parallel to ter-

men. Proximal band of central symmetry system obsolete. Submarginal band and 'g'-element obsolete. Fringe white mixed with brown. *Hindwing*: Contour of wing fairly circular; a tail-like projection at distal end of  $Cu_2$ . Ground color of upper side dull orangish yellow, dark-brown scaling

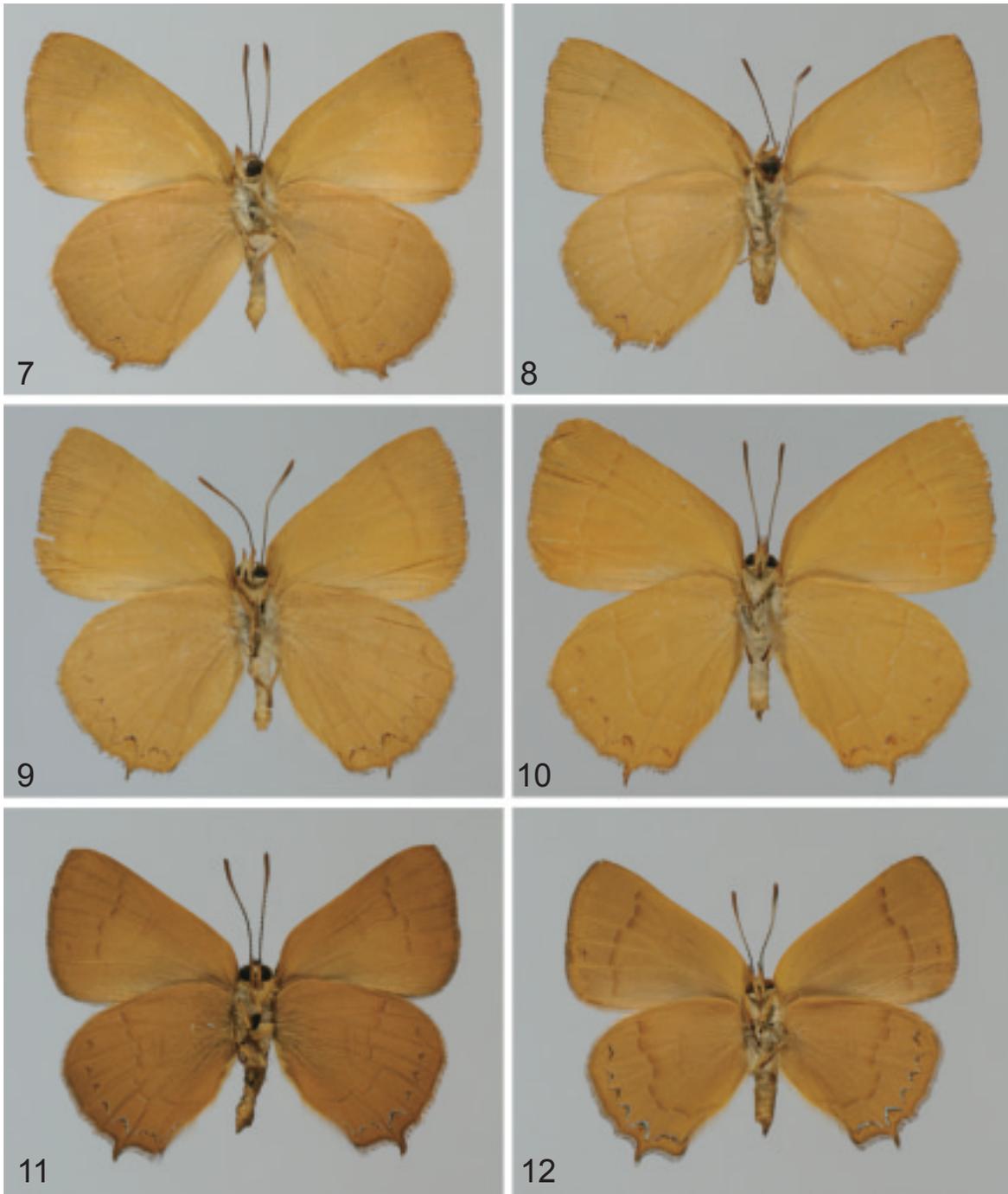
along termen. A flush of diffused, gray scaling basad. Ground color of underside ocher. Discal spot faint, forming narrow yellow bar edged with brown. Distal band of central symmetry system represented as uneven, narrow white line edged with brown proximally, nearly straight from dorsum



**Figs. 1-6.** Upper side of *Habrodais* species. (1) *Habrodais poodiae browni*, subsp. nov., holotype ♂; (2) *H. poodiae browni*, subsp. nov., paratype ♀; (3) *H. poodiae poodiae* ♂; (4) *H. poodiae poodiae* ♀; (5) *H. grunus* ♂; (6) *H. grunus* ♀.

to  $Cu_1$ , bent inwards in cell  $Cu_1$ , forming an arc. Proximal band of central symmetry system obsolete. Submarginal band and 'g'-element as defined by Nijhout (1991) nearly obsolete, except for faint lunules consisting of a few brown and metallic pale blue scales near tornal area. Male

genitalia (Figs. 13-17): Ring-shaped sclerites of 9+10 segments with width approximately 0.86x height, posterior end forming triangular extension laterally; uncus forming flattened, triangular protrusion with blunt caudal end; saccus weakly represented, wart-like; brachium simple, hook-shaped;



**Figs. 7-12.** Underside of *Habrodais* species. (7) *Habrodais poodiae browni*, subsp. nov., holotype ♂; (8) *H. poodiae browni*, subsp. nov., paratype ♀; (9) *H. poodiae poodiae* ♂; (10) *H. poodiae poodiae* ♀; (11) *H. grunus* ♂; (12) *H. grunus* ♀.

socii digitate, setose. Valva broad, harpe weakly developed, represented as slightly stretched rim; ampulla forming prominent, flattened, setose extension attenuating to blunt end. Phallus stout, slightly upcurved posteriorly, with caudal end forming trumpet-like opening; length of aedeagus approximately 1.1x that of phallobase, cornuti absent. Juxta broad, pincer-shaped, forming 2 lateral, elongate arms extending dorsally.

*Female* (Figs. 2, 8): FL 13.7~15.2 mm (mean  $14.43 \pm 0.49$  mm,  $n = 7$ ); AL 6.5~6.8 mm (mean  $6.68 \pm 0.15$  mm,  $n = 6$ ). Body and wing patterns as described for male except brown scaling on upper sides of wing paler and fore tarsus segmented, not aborted. *Genitalia* (Fig. 18): Papillae anales weakly sclerotized, setose, boot-shaped. Apophyses posteriores slender, elongate, slightly flattened at base. Sterigma forming 2 prominent sclerotized pieces that combine to form a shovel-like structure with its base surrounding ostium bursae; a pair of elongate, needle-like processes arising near ostium bursae. Ductus bursae sclerotized caudally into cup-like sclerite, with junction of duc-

tus seminalis midway from sclerite to corpus bursae. Ductus bursae swollen anteriorly into distal bulb. No signum on corpus bursae.

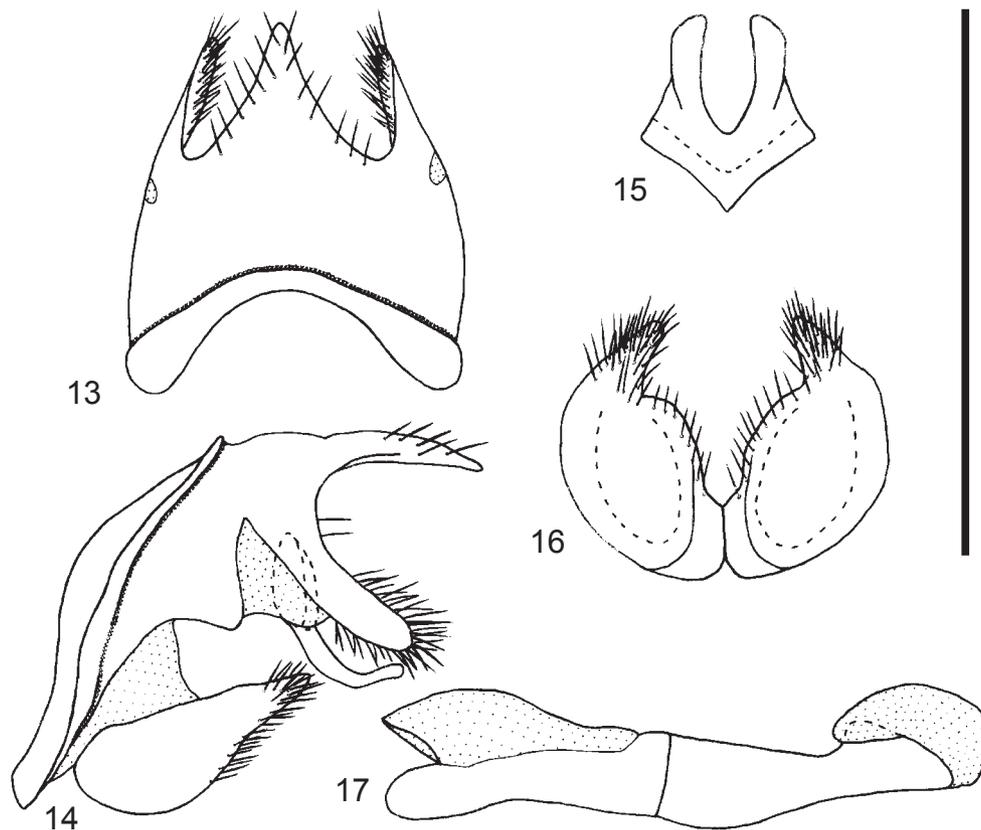
*Geographical range*: Restricted to higher elevations of the Sierra San Pedro Mártir, Baja California, Mexico.

*Larval host association*: Canyon oak, *Quercus chrysolepis* (Fagaceae) (Brown et al. 1992).

*Etymology*: The new subspecies is named after Dr. John W. Brown, who discovered and described *H. poodiae*.

## DISCUSSION

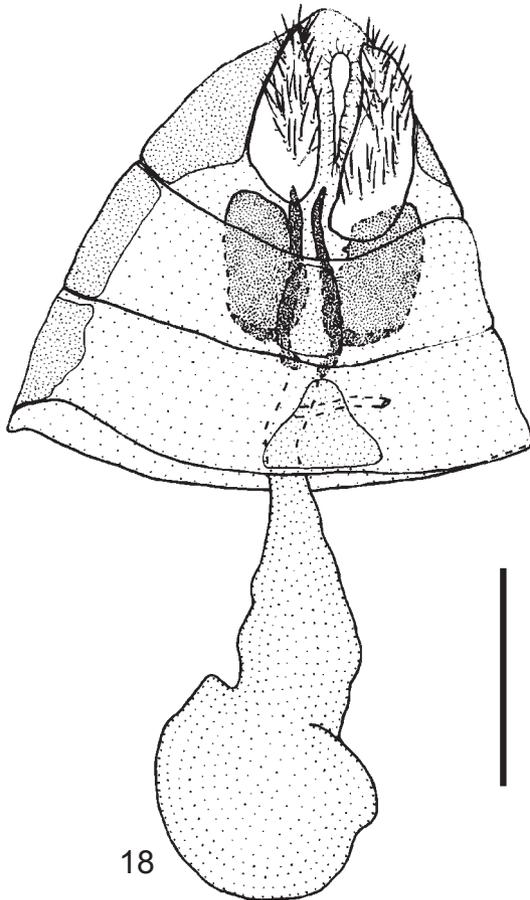
Truxal (1960) suggested that most phytophagous insects in Baja California exhibit a certain degree of host specificity, which consequently limits their natural geographic distributions to regions which contain their required host plants. Brown (1987) further stated that most butterflies in Baja California are relatively host specific, and the distribution of host plants is likely the single great-



**Figs. 13-17.** Male genitalia of *Habrodais poodiae browni*, subsp. nov. (based on genitalia dissection of YFH 1305). (13) Dorsal view of the 9th +10th abdominal segments; (14) lateral view of the 9th+10th abdominal segments; (15) caudal view of the juxta; (16) caudal view of the valvae; (17). lateral view of the phallus. Scale bar = 1 mm.

est factor determining their distributions. Brown et al. (1992) reviewed the phytogeographic regions of Baja California and concluded that butterfly distributions conform well to the previously defined phytogeographic provinces. They inferred 2 general tracks in an analysis of the origin of the butterfly fauna of the peninsula, with the 1st associated with the Californian Phytogeographic Province, represented by butterfly species of Nearctic origin; and the 2nd associated with the Cape Region Phytogeographical Province, represented by Neotropical species. As *H. poodiae* occurs only at higher elevations of the montane zone in northern Baja California and is closely related to the more-northern *H. grunus* (Brown et al. 1992), this species is clearly Nearctic in origin. It seems plausible to assume that the tribe Theclini sensu Eliot (1973) originated in eastern Asia, where over 100 species in about 30 genera (Koiwaya 1999) occur. Shirôzu and Yamamoto (1956) considered *Iratsume* Sibatani and Ito, a Hamamelidaceae-

associated, phenotypically distinct genus, as the most closely related group to *Habrodais*. Other putatively closely related genera to *Habrodais* include *Japonica* Tutt, *Cordelia* Shirôzu and Yamamoto, *Gonerilia* Shirôzu and Yamamoto, *Thecla* Fabricius, and *Shirozua* Sibatani and Ito, all of which possess wing ground colors and patterns similar to those of *Habrodais*. All these genera occur in the Palaearctic and northern Oriental realms but none cross the Himalayas (Koiwaya 1999), suggesting that *Habrodais* may have derived from a previous expansion of the Theclini to North America via Beringia. Linsley (1963) pointed out that the flora of East Asia had a prominent to dominant place in the Pacific coastal region as recent as the late Oligocene, and many genera of plants, including *Habrodais*' hosts *Castanopsis* and *Lithocarpus*, "clearly are relicts of the Arcto-Tertiary Geoflora that formerly linked the areas." Similar affinities are demonstrated by a few groups of cerambycids and were termed the



**Fig. 18.** Ventral view of the female genitalia of *Habrodais poodiae browni*, subsp. nov. (based on genitalia dissection of YFH 1347). Scale bar = 1 mm.



**Fig. 19.** Known distribution of *Habrodais poodiae*. Circles denote *H. p. poodiae* and triangles *H. p. browni*. (modified from Brown and Faulkner 1984; data resource: Brown and Faulkner 1984 and NTNU specimens)

Vancouveran-Palearctic relationships by Linsley (1963). Thus *Habrodais*, as well as the only other Nearctic Theclini genus, *Hypaurotis*, may be considered Tertiary relicts. Gould and Moran (1981) suggested that there was a considerable southward movement during Pleistocene glacial periods of both plants and animals now considered elements of the Californian Province. With the retreat of the glaciers, Nearctic species returned northward; however many left behind isolated outposts in higher elevations. This scenario seems to apply to *H. poodiae*, as this species occupies the southernmost range of the genus, and is represented by 2 disjunct montane subspecies in the Sierra de Juárez and Sierra San Pedro Mártir, the 2 highest mountain ranges in Baja California, both within the Californian Phytogeographic Province. These 2 montane areas are separated by lower elevations supporting chaparral vegetation and lacking montane oaks. Truxal (1960) was impressed by the coincident disjunctive distributions of insects and their host plants inhabiting the higher elevations of the Californian Province in Baja California, and he coined the term Vancouveran Province for the higher regions of Sierra de Juárez and Sierra San Pedro Mártir. *Habrodais poodiae* thus may be regarded as a species endemic to Truxal's Vancouveran Province. In contrast to the much wider distribution of its sister species, *H. grunus* (Scott 1986), *H. poodiae* has a highly restricted distribution. Similar patterns of distribution are seen in many butterflies in both Asia and North America. For instance, *Lycaena ferrisi* Johnson and Balogh (Lycaenidae) occurs in a small area in the White Mountains of eastern Arizona. There is no doubt it is closely related to *L. rubidus* (Behr) (Johnson and Balogh 1977), which has a very broad distribution to the north, disjunct from the range of *L. ferrisi* (Scott 1986, Tilden and Smith 1986). Some authors (e.g., Scott 1986) consider *L. ferrisi* a subspecies of *L. rubidus*; however, *L. ferrisi* is phenotypically distinct from *L. rubidus* and is considered a species endemic to Arizona by others (e.g., Johnson and Balogh 1977, Miller and Brown 1981 1983, Tilden and Smith 1986). The recent discovery of a new species of *Teratozephyrus* (Lycaenidae) in Taiwan, which is phenotypically distinct from its putative sister species, *T. nuwai* Koiwaya, of the Asiatic continent (Hsu and Lu 2005, in press) is a similar case. Brown et al. (1992) pointed out that although *H. poodiae* is spatially separated from the nearest population of *H. grunus* by only about 60 km, it has probably long been temporally isolated. The pres-

ence of *H. poodiae* at the periphery of the range of *Habrodais* agrees with the phenomenon that peripheral isolates are more likely to diverge, as discussed by Mayr (1970). The fact that populations of *H. poodiae* from 2 disjunct areas differ phenotypically further demonstrates that small, isolated populations are liable to diverge, and the 2 distributional areas of this hairstreak may function as ecological islands for this species. Another intriguing issue is that both subspecies of *H. poodiae* are associated with *Q. chrysolepis*, the host plant utilized by the nominotypical *H. grunus*. *Habrodais g. herri* Field, which has a paler wing color and occupies the northern part of the range of *H. grunus*, appears to be restricted to *Castanopsis chrysophylla* (Douglas ex Hook.) Hjelmqvist (Fagaceae) (Miller 1995) as its larval host, whereas populations inhabiting coastal northern California utilize *Lithocarpus densiflorus* (Hook. and Arn.) Rehder (Fagaceae) (Tokunaga 2000). It appears that the ground color of *H. grunus* is paler northwards (Garth and Tilden 1986); the same trend is seen in *H. poodiae*, for which the southern *H. p. browni* is darker than the northern nominotypical subspecies.

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