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### The New Zealand planthopper genus *Semo* White (Hemiptera: Cixiidae): Taxonomic review, geographical distribution, and biology

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## The New Zealand planthopper genus *Semo* White (Hemiptera: Cixiidae): taxonomic review, geographical distribution, and biology

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**Abstract** The alpha-taxonomy of the New Zealand planthopper genus *Semo* White (Hemiptera: Cixiidae) is reviewed. *Semo clypeatus* is redescribed and three new species (*S. transinsularis*, *S. westlandiae*, and *S. southlandiae*) are described. A key to species is provided as well as information on geographical distribution and biology.

**Keywords** Hemiptera; Cixiidae; *Semo*; taxonomy; distribution; biology; new species

### INTRODUCTION

Nine genera and 18 species of Cixiidae are known from New Zealand (Wise 1977; Larivière 1997a, b).

The genus *Semo* is endemic to New Zealand—as is also true of at least 75% of the described cixiid fauna. The Cixiidae are among the more plesiomorphic families of Fulgoroidea. There is as yet no rigorous treatment of their classification. Criteria defining supraspecific taxa are still insufficiently elaborated, and phylogenetic (or even cladistic) analyses are practically nonexistent for this family.

Traditionally, the family is recognised to be divided into three subfamilies (Bothriocerinae, Borystheninae, and Cixiinae). Two tribes of Cixiinae have so far been recorded from New Zealand: the Pentastirini, represented by *Oliarus* Stål, and the Cixiini, represented by all other described genera, including *Semo*. In a tentative cladogram of the family Emeljanov (1997) suggested that *Semo* could be placed in a separate tribe, the Semonini, together with the mainly Oriental genera *Kuvera* and *Betacixius*, on the basis of having a swollen postclypeus. Emeljanov made it clear, however, that his attempt to distinguish the tribes of Cixiidae was made on precarious basis; he did not intend to propose a formal classification.

Furthermore, the monophyly of the Cixiini remains highly doubtful and has not been tested cladistically. Therefore, in the absence of such information, or of a recent revision of the higher classification of the Cixiinae, we are adopting the traditional placement of *Semo* within the Cixiini.

*Semo* has until now been recognised to be monotypic. White (1879) described *Semo clypeatus* apparently from four specimens. A male lectotype, designated by Deitz (Deitz & Helmore 1979), is located in the F.B. White collection, Perth Museum and Art Gallery, Scotland.

Myers (1924) extended the description of *Semo clypeatus* on the basis of 25 males and 35 females from localities on the North Island (“Mount Egmont, Tararua Ranges”) and on the South Island (“Mount Arthur, Arthur’s Pass, Wakatipu”). Our examination of material in New Zealand collections revealed four species grouped under the name *Semo clypeatus* and matching collection details published by Myers (1924).

Species of *Semo* inhabit montane to subalpine shrublands, grasslands, herbfields, and bogs on the South Island and on the North Island south of the Taupo line—a biogeographic feature referring to a band across the central North Island at approximately 39°–39°30’S (Gibbs 1989).

Precise data on the ecology and life history of *Semo* species are lacking. What little information is

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available suggests that they are univoltine, and winter is passed as eggs or nymphs, probably subterraneously close to the roots of host plants, which could be species of *Hebe* (Scrophulariaceae) or *Dracophyllum* (Epacridaceae).

This paper presents part of the results from current investigations on New Zealand Cixiidae, which aim to present a faunistic survey of species occurring in this region. Here, we review the alpha-taxonomy of *Semo*. The type species, *Semo clypeatus* White, is redescribed, and three new species are described. A key to species is provided as well as information on geographical distribution and biology.

## MATERIALS AND METHODS

The material used for this study was provided by the Auckland Institute and War Memorial Museum, Auckland (AMNZ); B.H. Patrick private collection, Dunedin (BPNZ); Canterbury Museum, Christchurch (CMNZ); Lincoln University, Lincoln (LUNZ); Museum of New Zealand Te Papa Tongarewa, Wellington (MONZ); New Zealand Arthropod Collection, Landcare Research, Auckland (NZAC); and University of Canterbury, Christchurch (UCNZ).

For locality records, area codes of Crosby et al. (1976) are listed from north to south and west to east. Area codes used in this paper are as follows. **North Island:** AK, Auckland; BP, Bay of Plenty; CL, Coromandel; HB, Hawkes Bay; ND, Northland; RI, Rangitikei; TO, Taupo; TK, Taranaki; WI, Wanganui; WN, Wellington; WO, Waikato. **South Island:** BR, Buller; CO, Central Otago; FD, Fiordland; MK, Mackenzie; MB, Marlborough; MC, Mid Canterbury; NC, North Canterbury; NN, Nelson; OL, Otago Lakes; SD, Marlborough Sounds; SL, Southland; WD, Westland. The latitude and longitude co-ordinates of collection localities are given in Table 1.

Biological notes are based on an analysis of specimen label data. The native plants associated with *Semo* species are listed in Table 2, along with their family placement.

The status, depositories, and full label data of all primary type specimens seen (and a summary of label information for secondary type specimens) are cited for each species. In the list of label data different labels are separated by a solidus (/) and different lines on a label by a semicolon; all other punctuation is as it appears on the label.

## Taxonomically relevant characters

Detailed investigations of the external morphology, including the tymbal organ and the female abdomen, revealed very few characters that could be useful in species diagnosis. Species of *Semo* are morphologically quite similar, and intraspecific variation is high in most characters, e.g., forewing venation, shape and proportion of structures of the head and thorax.

The characters presented in the taxonomic descriptions are subsets of the totality of characters studied, and represent the most important differences between—or variation amongst—closely related taxa.

The morphological terminology adopted here generally follows O'Brien & Wilson (1985) and recent taxonomic revisions on Cixiidae (e.g., Van Stalle 1991). Diagnoses are based on adults. Descriptive measurements and counts were taken in the following manner: *vertex length* measured from tip of basal emargination to apex of vertex; *vertex width* taken at level of tip of basal emargination; *forewing length* taken from base to apex; *forewing width* measured at tip of clavus; *body length* measured from apex of head to tip of forewing, cited as a range with mean in parentheses.

## Species concept

The species concept used here is biological, inferred from morphological characters (especially male genitalia) hypothesized to constitute barriers to interbreeding and hence to gene flow between the different species. This assumption is corroborated where possible by geographic and biological information, but is not tested by genetic or ethological investigations. That would require the evidence of reproductive (genetic) continuity or isolation among natural populations, documented from continuity or discontinuity in characters of external morphology and genital structures provided by the study of population samples.

As generally observed in Fulgoroidea, the characters most important for discriminating *Semo* species are the male genital structures, particularly the aedeagus. In *Semo* most external characters (e.g., forewing colour or venation, head or thorax morphology) are found to vary within species, or the range of their variation overlaps with that of closely related species, and for the most part similarities or differences in external morphology are not congruent with the study of genitalia. Accurate species identification in *Semo* is virtually impossible without an examination of genital structures. Thus, females can

be identified only by association with male specimens, facilitated by the fact that different *Semo* species are largely allopatric.

### Dissection of male genitalia

Male genitalia were dissected as follows. Pinned specimens were warmed for 5–6 minutes in hot acetic alcohol, a mixture of 70% absolute ethanol and

30% commercial white vinegar. Each specimen was transferred to a watch glass half-filled with acetic alcohol, and the pygofer was pulled away from the body using fine forceps and a microscalpel (needle tip from 1.0 ml disposable hypodermic syringe). The pygofer was returned to hot acetic alcohol for 3–4 minutes, then transferred to another watch glass also containing acetic alcohol. The anal tube, genital

**Table 1** Geographical co-ordinates of main collection localities. Co-ordinates should be read as 00°00'S/000°00'E. Two-letter area codes follow Crosby et al. (1976).

Ahukawakawa Swamp, TK, 3915/17403	Mount Cook National Park, MK, 4337/17010
Alex Knob, WD, 4326/17009	Mount Dewar, BR, 4205/17132
Aniwaniwa Falls, GB, 3844/17711	Mount Domett, NN, 4104/17219
Arthur's Pass, NC, 4257/17134	Mount Egmont/Taranaki, TK, 3919/17404
Balloon Hut, NN, 4110/17241	Mount Grono, Secretary Island, FD, 4518/16656
Berwick State Forest, DN, 4559/17000	Mount Hedgehope, SL, 4606/16843
Blue Mountains, SL, 4554/16923	Mount Isobel, MB, 4229/17251
Buckland Peaks, BR, 4153/17138	Mount Priestly, BR, 4204/17132
Cass, MC, 4302/17145	Mount Robert, BR, 4150/17249
Castle Rocks Valley, WD, 4327/17009	Mount Ruapehu, TO, 3916/17534
Chancellor Shelf, WD, 4330/17006	Mount Sewell, BR, 4224/17121
Cheviot Hills, Takitimu Range, SL, 4538/16745	Mount Tuhua, WD, 4249/17111
Cobb Reservoir, NN, 4107/17240	Murchison Mountains, FD, 4515/16732
Codfish Island, Stewart Island, 4646/16734	Nelson Lakes National Park, BR, 4156/17241
Connors Creek, MB, 4200/17254	Ohakune, TO, 3925/17525
Cupola Basin, BR, 4159/17245	Owaka, SL, 4627/16940
Darran Mountains, FD, 4439/16801	Paparoa Range, BR, 4205/17133
Davis Flat, OL, 4408/16919	Plateau Creek, OL, 4411/16816
Denniston, NN, 4145/17148	Point Burn, Main Flat, FD, 4518/16739
Dundas Hut/Ridge, Tararua Range, WN, 4043/17526	Porters Pass, MC, 4318/17145
Ellis River, NN, 4118 87242	Pouakai [Range], TK, 3914/17402
Fletcher Creek, BR, 4159/17150	Pouakai Hump, TK, 3914/17402
Flora Track, NN, 4110/17242	Pouakai Trig, TK, 3914/17401
Fox Glacier, WD, 4328/17001	Punakaiki, BR, 4207/17120
Franz Josef, WD, 4325/17010	Route Burn, OL, 4444/16815
Gertrude Valley, FD, 4445/16801	Rainbow State Forest, MB, 4155/17258
Haast Pass, WD, 4406/16921	Ruahine Range, RI, 4004/17603
Hochstetter State Forest, BR, 4224/17135	Secretary Island, FD, 4515/16654
Holly Hut, Mount Egmont, TK, 3916/17403	Shuteye Camp, Ruahine Range, RI, 3947/17610
Homer Saddle/Tunnel, FD, 4445/16758	Slopedown Hill, Mokoreta No. 2, SL, 4622/16904
Kapuni Valley, Mount Egmont, TK 3920/17407	Stony River, Mount Egmont, TK, 3916/17358
Key Summit, OL, 4450/16808	Takahe Valley, FD, 4517/16740
Klondyke Corner, NC, 4301/17135	Taranaki Falls, Mount Ruapehu, TO, 3911/17533
Lake Orbell, FD, 4517/16740	Tararua Range, Logan E Basin, WN, 4043/17528
Lake Rototoi, BR, 4149/17250	Tatangi Peak, Pouakai, TK, 3914/17401
Lake Sylvester, NN, 4106/17238	Tin Range, Stewart Island, 4705/16745
Lake Waikaremoana, GB, 3846/17705	Tongariro National Park, TO, 3913/17536
Lewis Pass, BR, 4223/17224	Tower Peak, SL, 4539/16748
Liverpool Bivouac, OL, 4426/16840	Waitahuna Hill, DN, 4555/16955
Lochnagar Ridge, BR, 4204/17133	Waterfall Stream, MB, 4225/17244
McKenzie Burn, FD, 4517/16725	Westland National Park, WD, 4332/17005
Meggat Burn, DN, 4557/17000	Whakapapa, Mt Ruapehu, TO, 3912/17532
Mount Anglem, Stewart Island, 4644/16755	Wilmot Pass, Manapouri, FD, 4531/16711
Mount Arthur Range, NN, 4113/17241	Wolfe Flat, Lake Manapouri, FD, 4532/16717
Mount Aspiring NP, OL, 4431/16830	

styles and aedeagus were detached and extracted from the pygofer in this solution again, using fine forceps and a microscalpel. Dissected genitalia were subsequently stored in genitalia vials containing glycerine and remounted on the pin below the relevant specimens.

### Taxonomic arrangement

Further study of Australasian Cixiidae is needed before phylogenetic relationships can be hypothesised, hence taxa are treated alphabetically in this paper.

### KEY TO SPECIES OF *SEMO*, BASED ON MALES

1. Aedeagus (in ventral view, Fig. 17) with 2 short (approx. 0.4–0.5x aedeagal length), thick, arched spinose processes of subequal length arising near base of flagellum. .... *S. southlandiae*, sp. nov.  
*Distribution* (Fig. 23): *central eastern and southeastern South Island.*
- Aedeagus (in ventral view, Fig. 14–16) with 2 longer (approx. 0.6–0.7x aedeagal length), thinner, sinuate spinose processes of unequal length arising near base of flagellum. .... 2
2. Aedeagus (in ventral view, Fig. 14) with right spinose process distinctly shorter than left one; both processes with apices directed outwards..... *S. clypeatus* White  
*Distribution* (Fig. 23): *central North Island and northern South Island.*
- Aedeagus (in ventral view, Fig. 15–16) with right spinose process longer than left one; both processes directed dextrad, or apex of right process nearly hook-shaped. .... 3
3. Aedeagus (in ventral view, Fig. 16) with apex of right spinose process sinuate, almost hook-shaped. Apex of left genital style (Fig. 12) broad, with outer edge oblique, rectilinear. ... *S. westlandiae*, sp. nov.  
*Distribution* (Fig. 23): *South Island west coast, western Stewart Island, and eastern Southland.*
- Aedeagus (in ventral view, Fig. 15) with apices of both spinose processes directed dextrad, i.e., apex of right process not sinuate, hook-shaped. Apex of left genital style (Fig. 11) narrower with outer edge arcuate..... *S. transinsularis*, sp. nov.  
*Distribution* (Fig. 23): *southernmost North Island, south of the Central Plateau, and northernmost South Island, mostly in the west.*

**Table 2** Native plants associated with *Semo* species.

<i>Cassinia</i> sp.	Asteraceae
<i>C. vauvilliersii</i> (Homb. et Jacq.) Hook. f.	Asteraceae
<i>Chionochloa</i> sp.	Poaceae
<i>Coprosma propinqua</i> A. Cunn.	Rubiaceae
<i>Dracophyllum</i> sp.	Epacridaceae
<i>D. longifolium</i> (J.R. et G. Forst.) R. Br.	Epacridaceae
<i>Hebe</i> sp.	Scrophulariaceae
<i>H. stricta</i> (Benth.) L. B. Moore	Scrophulariaceae
<i>H. rakaiensis</i> (J.B. Armst.) Ckn.	Scrophulariaceae
<i>Nothofagus</i> sp.	Fagaceae
<i>N. fusca</i> (Hook. f.) Oersted	Fagaceae
<i>Olearia</i> sp.	Asteraceae
<i>O. ilicifolia</i> Hook. f.	Asteraceae
<i>O. lacunosa</i> Hook. f.	Asteraceae
<i>Senecio eleagnifolius</i> Hook. f.	Asteraceae
<i>Uncinia</i> sp.	Cyperaceae

## TAXONOMIC REVIEW

### Genus *Semo* White

*Semo* White, 1879: 217. Type species *Semo clypeatus* White, 1879: 217, by original designation and monotypy.

**DESCRIPTION. Adults** (Fig. 8). Rather small (3–6 mm), yellowish-brown to dark brown, stubby cixiids; head, pronotum, and mesonotum with paler margins and carinae; forewings whitish yellow or infumate, often opaque, with a dark spot at tip of apical cells and irregular, often coalescing patterns of brown spots across midportion and apex.

**Head** (Fig. 1, 2, 9) narrower than pronotum in dorsal view. Vertex 0.3–0.6x as long as wide; transverse subapical keel arcuate, connected or not to anterior margin by 2 narrow ridges (often obsolete); anterior margin resembling a flattened M, sometimes evanescent; lateral margins usually not—or sometimes barely—more elevated along basal compartment than along remainder of vertex; basal compartment slightly depressed, with or without a narrow, evanescent median keel; basal emargination widely U-shaped, squarish at middle. Frons slightly swollen; median carina absent or evanescent (reduced to a rather flat elevation) and thickened near midlength; outer carinae slightly concave at middle; frontoclypeal suture strongly arcuate, sometimes squarish at middle; median ocellus present. Postclypeus swollen (more so in males), without a visible median carina. Rostrum surpassing hind coxae.

**Thorax** (Fig. 1). Pronotum shortest in middle; a pair of curved postocular carinae, 1 on either side of middle, subparallel to hind margin. Mesonotum with 3 longitudinal carinae, the median one sometimes evanescent. Forewings (Fig. 4) 2.5–3.5x longer than broad; venation and markings as in Fig. 22; veins—including costal margin—smooth, lacking visible setiferous granules (or granules obsolete), often contrastingly more calloused and paler than surrounding area; 7–9 apical cells; stigma well developed, usually pale. Tegula concolorous with pronotum. Hind wings fully developed. Hind tibiae (Fig. 3) bearing 3 immovable lateral spines (all 3 equidistant in basal half, or 1 or 2 basally plus 1 or 2 more apically), and sometimes a feeble extra spine between the 2 basalmost ones; tarsomeres I and II with an apical row of 7 teeth.

**Abdomen. Male genitalia.** Externally visible portions similar throughout the genus. Anal tube (Fig. 6), pygofer (Fig. 5), and genital styles (Fig. 10–13) as illustrated. Aedeagus (Fig. 14–17, ventral view) with 2 spinose processes arising near base of

flagellum; flagellum about as long as aedeagus, acuminate, unarmed, directed basad. **Female genitalia.** Similar throughout the genus. Pregenital sternite small; ovipositor (Fig. 7) with 3 pairs of valvulae longer than sclerotised part of anal tube. Anal tube in dorsal view similar in shape to that of male.

**Remarks.** Until now the main combination of characters used to diagnose *Semo* from other New Zealand genera has been the frons lacking a median carina and the swollen postclypeus (see Deitz & Helmore 1979). These characters are, however, much more variable than was previously recognised. Most females studied lack a median carina on the frons, but some have a slight flat elevation that is thickened near its middle as is the case for most males. In both sexes the postclypeus varies from convex and slightly swollen to strongly swollen, and the postclypeus is on average more swollen in males than in females.

***Semo clypeatus* White** Fig. 1–10, 14, 18, 22, 23.

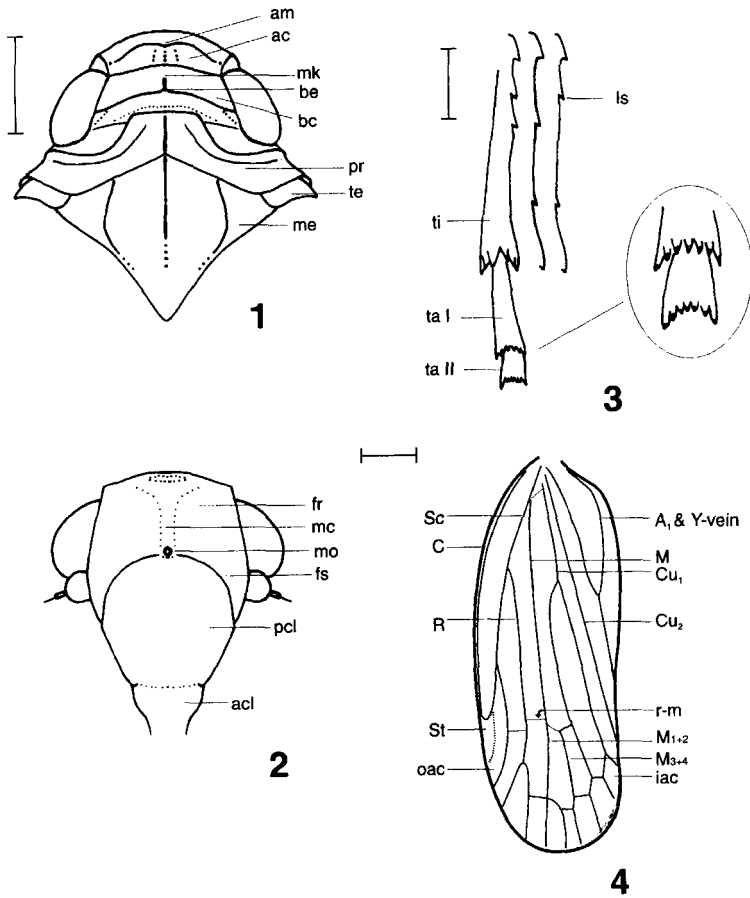
*Semo clypeatus* White, 1879: 217.

**TYPE MATERIAL.** Lectotype (not seen) designated by Deitz in Deitz & Helmore (1979): “A male specimen (total length 4.2 mm, width 1.7 mm; figs 23, 25, 31, 32) in the F.B. White collection, Perth Museum and Art Gallery, Scotland.” It bears the labels: “N.Z.; H / LARGE CABINET; CASE 32 / BUCHANAN WHITE COLL<sup>n</sup>; PERTH MUSEUM; 1979.3.77 / *Semo clypeatus* / LECTOTYPE ♂; *Semo*; clypeatus; F.B. White; desig. LL Deitz 1979.”

**DESCRIPTION. Adults** (Fig. 8) yellowish brown dorsally; forewings completely infumate or opaque whitish, with an irregular band of brown spots across midportion and a few scattered pale patches distally.

**Head.** Vertex yellowish brown with yellowish-ivory margins and carinae, and 3 dark spots (sometimes coalescent) on anterior compartment. Frons (Fig. 9) uniformly yellowish or brownish, or with scattered dark spots; outer carinae often pale yellow; median ocellus visible, yellowish. Postclypeus yellowish brown, in some specimens much darker along outer carinae.

**Thorax.** Pronotum yellowish brown, often with pale outline. Mesonotum yellowish brown, usually darker medially. Thoracic sterna yellowish brown, always paler than ventral sternites. Forewing venation as in Fig. 18 and 22, sometimes with dark spots along Y-vein and other longitudinal veins; the latter yellowish brown, sometimes calloused, pale yellow or whitish; Sc+R usually forked slightly basad of Cu, more rarely at same level as Cu; r-m usually located



**Fig. 1–4** *Semo clypeatus*, external morphology: (1) head, pronotum, and mesonotum, dorsal view (ac—apical compartment of vertex; am—anterior margin of vertex; bc—basal compartment of vertex; be—basal emargination of vertex; me—mesonotum; mk—median keel; pr—pronotum; te—tegula); (2) head, frontal view (acl—anteclypeus; fr—frons; fs—frontoclypeal suture; mc—median carina; mo—median ocellus; pcl—postclypeus); (3) left hind leg, ventral view (ls—lateral spines; ta I—tarsomere I; ta II—tarsomere II; ti—tibia); (4) left forewing (A1—first anal vein and Y-vein; C—costa; Cu—cubital vein; iac—inner apical cell; M—median vein; oac—outer apical cell; r-m—crossvein between R and M veins; R—radial vein; Sc—subcosta; St—stigma). Scale lines = 0.5 mm.

at same level as  $M_{3+4}$ ; 8–9 apical cells. Legs yellowish brown to dark brown, often with base and apex of femora paler.

**Abdomen.** Ventral sternites yellowish brown to dark brown, in some individuals black. **Male genitalia.** Anal tube as in Fig. 6. Left genital style as in Fig. 10. Aedeagus (in ventral view, Fig. 14) with 2 long (approx. 0.6–0.7x aedeagal length), thick spinose processes subapically near base of flagellum—right process slightly shorter than left, their apices curved outwards; flagellum nearly as long as aedeagus, directed basad.

Body length of males ( $n = 10$ ) 3.64–4.72 (4.32) mm, of females ( $n = 10$ ), 4.92–5.38 (5.14) mm. Other characters as in generic description.

**GEOGRAPHICAL DISTRIBUTION** (Fig. 23). Central North Island and northern South Island.

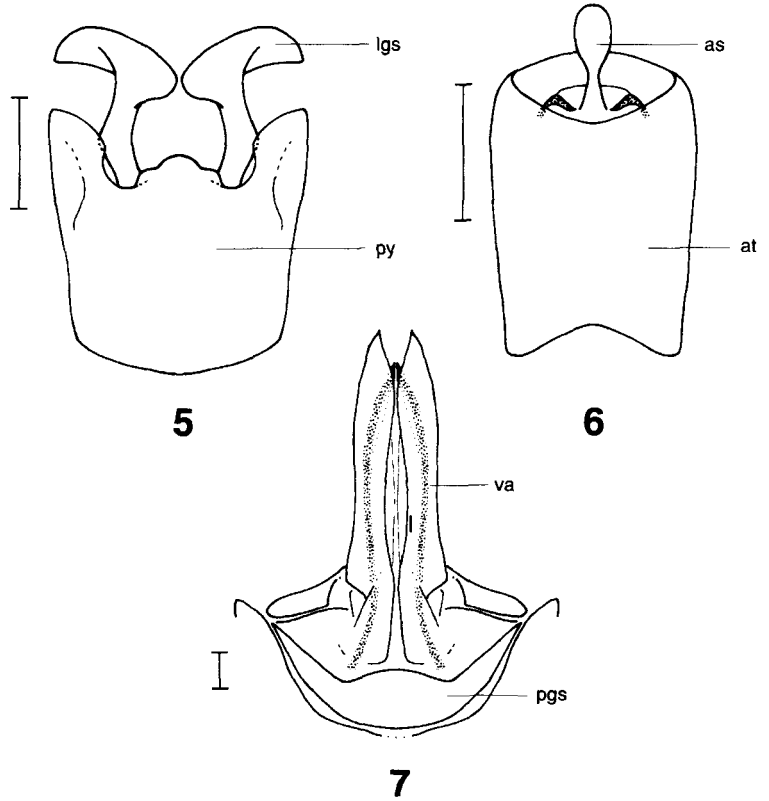
**CHOROLOGICAL AFFINITIES.** This species co-occurs with *S. transinsularis* sp. nov. on Mt Ruapehu (North Island central volcanic plateau), where the two

appear to be separated altitudinally; *S. clypeatus* is apparently restricted to above 1000 m. *S. clypeatus*, *S. transinsularis* sp. nov. and *S. westlandiae* sp. nov. are all found in the Northwest Nelson area (NN), but there is no record of their having been collected in the exact same locality.

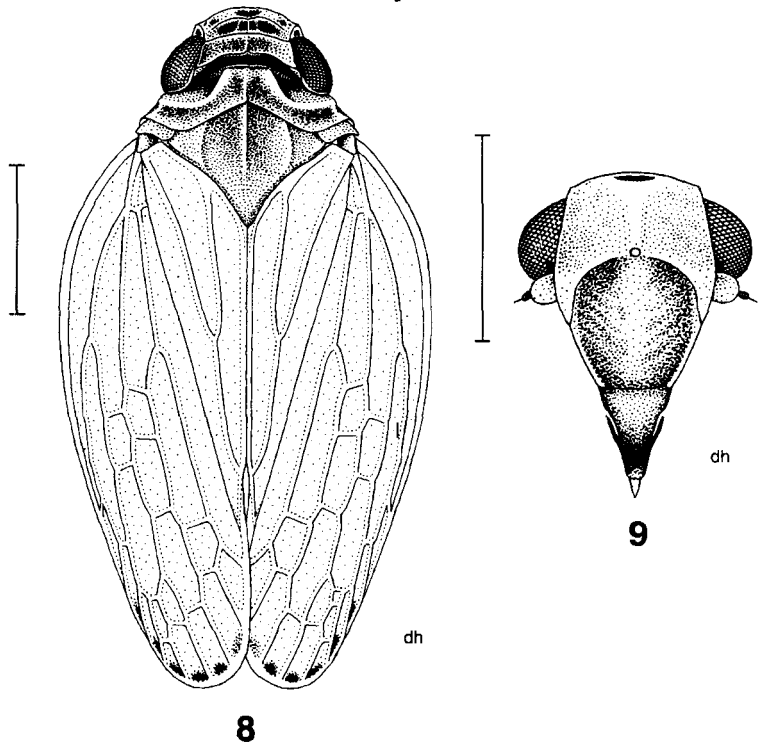
**MATERIAL EXAMINED.** A total of 99 males and 66 females (non-type specimens), from the following localities:

**North Island**, along the Taupo-line. **TK.** Mt Egmont: Holly Hut (NZAC); Kapuni Valley (NZAC); South Flank (NZAC); Stony River (NZAC). Pouakai Range (NZAC): Ahukawakawa Swamp (NZAC); Pouakai Hump (NZAC); Pouakai Trig (NZAC); SE (NZAC); Tatangi Peak (NZAC). **TO.** Tongariro NP, Mt Ruapehu: Taranaki Falls (NZAC); Whakapapa (NZAC). **GB.** Urewera National Park: Aniwaniwa Falls (NZAC); Lake Waikaremoana (NZAC). **South Island.** **NN.** Cobb Reservoir (NZAC). Lake Sylvester, Cobb Valley

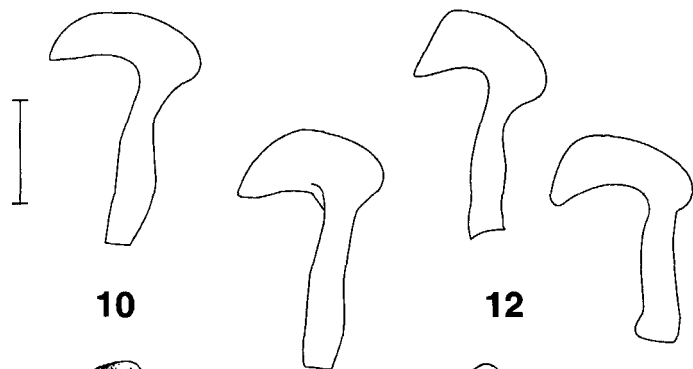
**Fig. 5–7** *Semo clypeatus*: (5) male pygofer, ventral view (lgs—left genital style; py—pygofer); (6) male anal tube, dorsal view (as—anal style; at—anal tube); (7) female ovipositor, ventral view (pgs—pregenital sternite; va—valvulae). Scale lines = 0.25 mm.



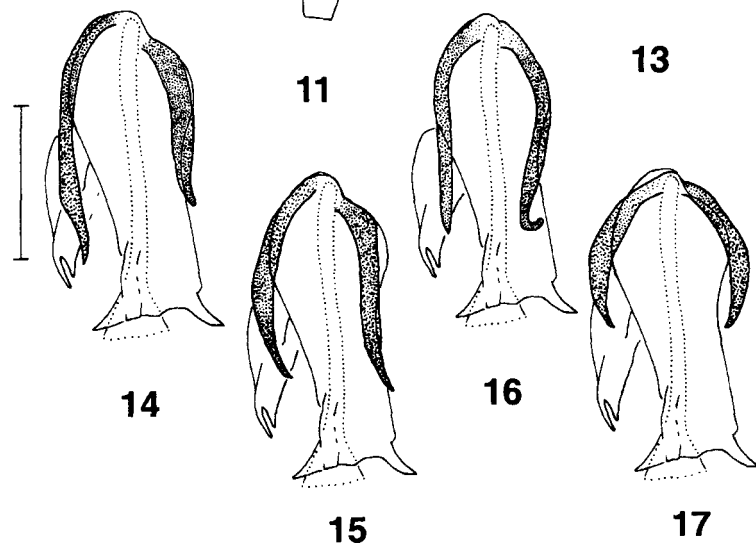
**Fig. 8,9** *Semo clypeatus*: (8) habitus, female; (9) head, frontal view. Scale lines = 1.0 mm.







**Fig. 10–13** Left genital style of male, ventral view: (10) *Semo clypeatus*; (11) *S. transinsularis*; (12) *S. westlandiae*; (13) *S. southlandiae*.



**Fig. 14–17** Aedeagus, ventral view: (14) *Semo clypeatus*; (15) *S. transinsularis*; (16) *S. westlandiae*; (17) *S. southlandiae* sp. nov. Scale lines = 0.25 mm.

(NZAC). **MB.** Mount Isobel Track (UCNZ); Waterfall Stream (UCNZ). Connors Creek (LUNZ). **BR.** Nelson Lakes National Park: Cupola Basin (LUNZ); Lake Rotoiti (LUNZ, NZAC). Lewis Pass (NZAC). Mt Robert (NZAC). Punakaiki (LUNZ). **NC.** Arthurs Pass National Park: Arthurs Pass, summit (LUNZ); Klondyke Corner (LUNZ). **MC.** Cass (UCNZ): Middle Bush (UCNZ).

**BIOLOGY.** Montane to subalpine shrublands and grasslands, often in the vicinity of streams. Found on the following plants: *Hebe stricta* (teneral and fully mature adults); *Cassinia vauvilliersii*, *Coprosma-Olearia* associations, *Dracophyllum longifolium*, *Hebe-Uncinia* associations, *Nothofagus fusca*, *Senecio eleagnifolius*, tussocks and mat plants (fully mature adults). Teneral found from November to January, but mostly in November. Fully mature adults collected from November to end of February, but in highest numbers in November and January.

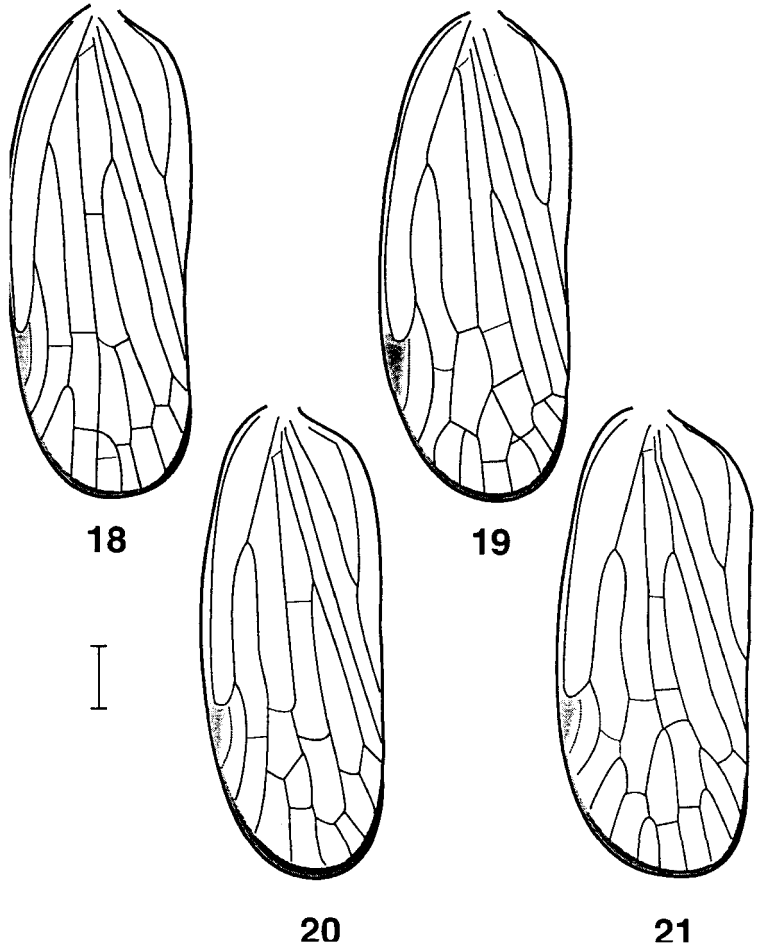
***Semo southlandiae*, sp. nov.** Fig. 13, 17, 21, 23.

**TYPE MATERIAL.** **Holotype:** Male (NZAC) labeled “NEW ZEALAND SL; Tower Peak 1000 m; Takitimu Range; 30 Jan 1976; L.L. Deitz / sweeping bog / HOLOTYPE; *Semo; southlandiae* sp. nov.; Larivière & Hoch, 1998 (red).” Note: male genitalia dissected, stored underneath specimen in genitalia vial containing glycerol. **Allotype:** Female (NZAC) labeled “as holotype / ALLOTYPE; *Semo; southlandiae* sp. nov.; Larivière & Hoch, 1998 (red).” **Paratypes** (NZAC, LUNZ): 4 males and 5 females, same data as primary types, bearing blue paratype labels.

**DESCRIPTION.** **Adult** dark brown dorsally with blackish head and mesonotum; forewings opaque, pale yellowish or whitish brown, often mottled with dark brown.

**Head.** Vertex brown to almost black with yellowish ivory margins and carinae; anterior compartment solid brown or black. Frons yellowish or brown,

**Fig. 18–21** Venation of left forewing: (18) *Semo clypeatus*; (19) *S. transinsularis*; (20) *S. westlandiae*; (21) *S. southlandiae*. Scale line = 0.5 mm.



mottled with dark brown, or uniformly dark brown to black; outer carinae often pale yellow; median ocellus visible, yellowish or whitish. Postclypeus yellowish brown to almost black.

**Thorax.** Pronotum brown to black, usually with thick, pale outline. Mesonotum blackish. Thoracic sterna yellowish brown, always paler than ventral sternites. Forewings venation as in Fig. 21, sometimes with dark spots along Y-vein and other longitudinal veins; veins yellowish brown, sometimes calloused, pale yellow; Sc+R forked at same level as Cu, sometimes slightly basad of Cu; r-m located basad of  $M_{3+4}$ ; 8–9 apical cells. Legs yellowish brown to almost black, often with base and apex of femora pale.

**Abdomen.** Ventral sternites dark brown to black.

**Male genitalia.** Left genital style as in Fig. 13. Aedeagus (in ventral view, Fig. 17) with 2 short (approx. 0.4–0.5x aedeagal length), thick, arched

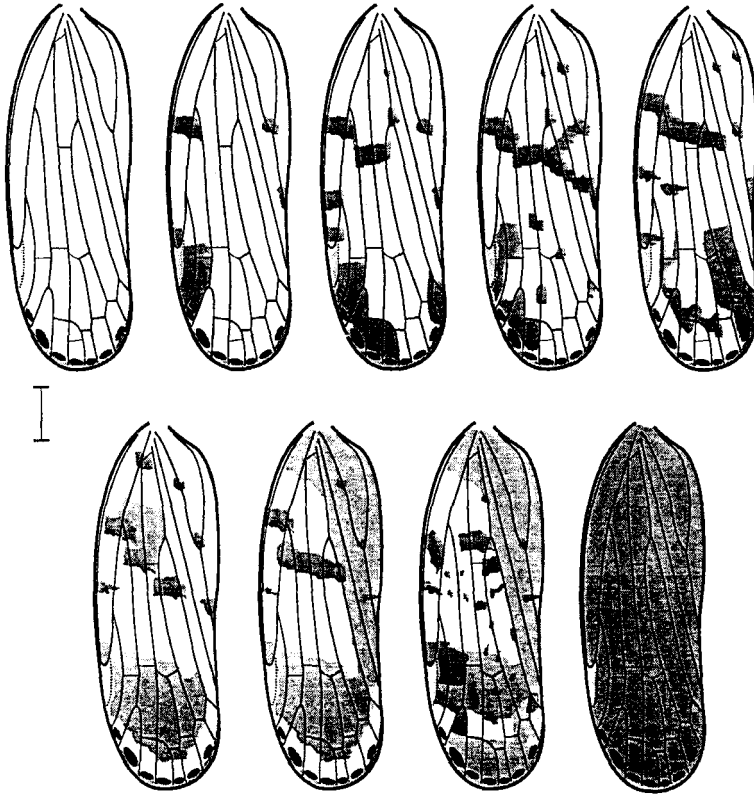
spinose processes subapically near base of flagellum—processes subequal in length, directed basad; flagellum nearly as long as aedeagus, unarmed, directed basad.

Body length of males ( $n = 10$ ) 3.68–4.36 (4.21) mm, of females ( $n = 10$ ) 4.20–5.25 (4.80) mm. Other characters as in generic description.

**Remarks.** In addition to the specific spine configuration of the aedeagus, the dorsal surface of head and mesonotum is remarkably more blackish than in other species. Females, however, can be paler than males.

**GEOGRAPHICAL DISTRIBUTION** (Fig. 23). Central eastern and southeastern South Island

**CHOROLOGICAL AFFINITIES.** The distribution range of this species appears nearly parapatric with that of *S. westlandiae* sp. nov., in the south, and *S. clypeatus*, in the north. Collection records suggest that these taxa do not co-exist with *S. southlandiae* in the same local community.



**Fig. 22** Forewing colour pattern variation, *Semo clypeatus*. Scale line = 0.5 mm.

**MATERIAL EXAMINED.** A total of 24 males and 21 females (including type specimens), from the following localities:

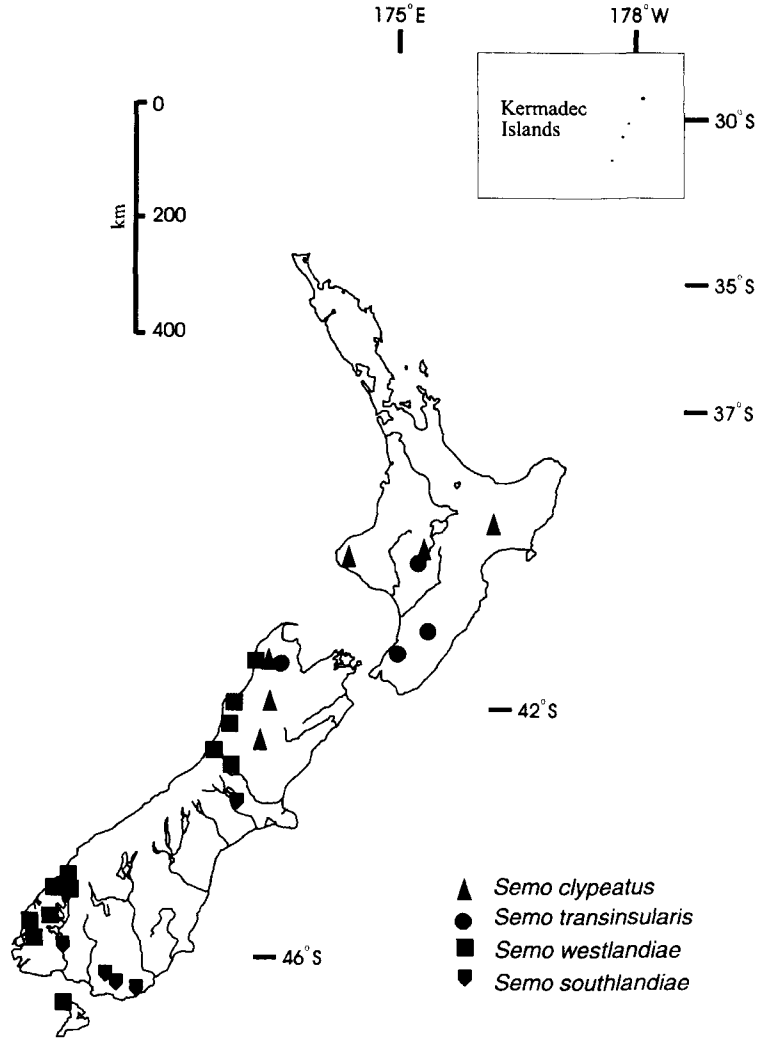
**South Island.** **MC.** Cass (UCNZ). Porters Pass (NZAC). **MK.** Mount Cook National Park (LUNZ). **DN.** Waitahuna Hill, Berwick Forest, Meggat Burn (BPNZ). **SL.** Blue Mountains (BPNZ). Mokoreta No. 2 (NZAC). Mt Hedgehope (NZAC). Takitimu Range: Cheviot [Hills] face (NZAC); Tower Peak (NZAC).

**BIOLOGY.** Montane to subalpine shrublands and grasslands, often in the vicinity of streams. Found on *Coprosma-Cassinia-Dracophyllum* associations in tussocks, *Hebe odora*, vegetation surrounding bogs, and in a *Nothofagus* forest (fully mature adults). Fully mature adults collected from December to February, but apparently most abundant in January.

*Semo transinsularis*, sp. nov. Fig. 11, 15, 19, 23.

**TYPE MATERIAL.** **Holotype:** Male (NZAC) labeled "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 5 Feb 1985; C.F. Butcher / sweeping / HOLOTYPE; *Semo*; *transinsularis* sp. nov.; Larivière & Hoch, 1998 (red)". Note—male genitalia

dissected, stored underneath specimen in minivial filled with glycerol. **Allotype:** Female (NZAC) labeled "as holotype / sweeping; tussock and; fern / ALLOTYPE; *Semo*; *transinsularis* sp. nov.; Larivière & Hoch, 1998 (red)". **Paratypes** (NZAC, MONZ): 27 males, 19 females from the same locality. Label details as follows: 1 female "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 5 Feb 1985; C.F. Butcher / sweeping; tussock and; fern"; 1 female "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 5 Feb 1985; B.A. Holloway / sweeping; tussock & *Olearia*"; 1 male "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 10 Feb 1985; G.W. Gibbs"; 1 female, "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 10 Feb 1985; B.A. Holloway / on Outside; walls of; toilet"; 1 male "NEW ZEALAND WN; Tararua Ra; Dundas Hut; 10 Feb 1985; C.F. Butcher / sweeping; near stream"; 2 males "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 10 Feb 1985; C.F. Butcher / sweeping"; 1 female "NEW ZEALAND WN; Tararua Ra; Dundas Hut, 1250 m; 6–13 Feb 1985 / G. Hall; Pan trap 6"; 2 females "NEW ZEALAND WN; Tararua Ra; Dundas Hut; 8 Feb 1985; G.W. Gibbs / sweeping; below; hut"; 2 males, 3

**Fig. 23** Distribution of *Semo* species.

females "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; Dec 1984; R.C. Craw / sweeping; *Chionochoa*; at night"; 4 males, 2 females "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 6 Dec 1984; R.C. Craw / sweeping; *Chionochoa*; with *Olearia*; *Dracophyllum*"; 4 females "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 4 Dec 1984; R.C. Craw / ex; *Olearia*; *lacunosa*"; 1 female "NEW ZEALAND; Tararua Ra; Dundas Hut; 4 Dec 1984; J.S. Dugdale / ex *Hebe*; *akanensis* [sic]"; 2 males "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 4 Dec 1984 / B.G. Bennett & T.K. Crosby; Malaise trap"; 5 males "NEW ZEALAND; Tararua Ra; Dundas Hut 1250 m; 5–6 Dec 1984 / B.G. Bennett & T.K.

Crosby; Malaise trap"; 1 male, 1 female "NEW ZEALAND; Tararua Ra; Dundas Hut 1250 m; 2–3 Dec 1984 / B.G. Bennett & T.K. Crosby; Malaise trap"; 4 males "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; Nov 1984; R.C. Craw / Beating"; 1 male "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1250 m; 28–29 Nov 1984 / B.G. Bennett & T.K. Crosby; Malaise trap"; 1 male, 1 female "NEW ZEALAND; Tararua Ra; Dundas Hut 1200 m; 28 Nov–6 Dec 1984 / B.G. Bennett & T.K. Crosby; Pan trap 2"; 3 males, 2 females "NEW ZEALAND WN; Tararua Ra; Dundas Hut 1150 m; 28 Nov–6 Dec 1984 / B.G. Bennett & T.K. Crosby; Pan trap 1". Note—Several paratypes are teneral.

**DESCRIPTION.** **Adults** pale brown dorsally; forewings infumate or opaque pale brown, marked with dark brown across midportion and along costa or heavily mottled throughout.

**Head.** Vertex brown, sometimes nearly black, often with 3 dark spots on anterior compartment. Frons yellowish brown with or without scattered dark spots; outer carinae often pale yellow; median ocellus visible, yellowish or whitish. Postclypeus yellowish brown to almost black.

**Thorax.** Pronotum brown to blackish, often with pale outline. Mesonotum brown to almost black, usually darker medially. Thoracic sterna yellowish brown, always paler than ventral sternites. Forewings venation as in Fig. 19; veins yellowish, sometimes calloused; Sc+R forked slightly basad of Cu or at same level as Cu; r-m located basad of  $M_{3+4}$ ; 7 (in some individuals 8 or 9) apical cells. Legs yellowish brown to dark brown, often with base and apex of femora pale.

**Abdomen.** Ventral sternites brown to blackish. **Male genitalia.** Left genital style as in Fig. 11. Aedeagus (in ventral view, Fig. 15) with 2 long (approx. 0.6–0.7x aedeagal length) spinose processes subapically near base of flagellum—right process longer than left, with apices curved slightly dextrad (right process more distinctly so); flagellum nearly as long as aedeagus, unarmed, directed basad.

Body length of males ( $n = 10$ ) 3.28–4.60 (3.93) mm, of females ( $n = 10$ ) 3.60–5.17 (4.60) mm. Other characters as in generic description.

**GEOGRAPHICAL DISTRIBUTION** (Fig. 23). Southernmost areas of the North Island, south of the Central Plateau, and northernmost South Island, mostly in the west.

**CHOROLOGICAL AFFINITIES.** *Semo transinsularis* appears to be a low altitude species. This species co-occurs with *S. clypeatus* on Mt Ruapehu (North Island central volcanic plateau), where the two species appears to be separated altitudinally; *S. transinsularis* is apparently restricted to below 1000 m. In the Nelson area (NN) the geographic range is almost parapatric with that of *S. clypeatus*. There is no record of the occurrence of both species in the same locality.

**MATERIAL EXAMINED.** A total of 55 males and 46 females (including type specimens), from the following localities:

**North Island**, south of the Taupo-line. **TO.** Tongariro National Park (NZAC). Ohakune (NZAC). **RI.** Ruahine Range, Shuteye Camp (NZAC). **WN.** Tararua Range: Dundas Hut/Ridge

(NZAC); Logan E Basin (NZAC). **South Island.** **BR.** Inangahua State Forest, Fletchers Creek (NZAC). **NN.** Balloon Hut (NZAC). Flora Track (NZAC).

**BIOLOGY.** Montane to subalpine shrublands and grasslands, often in the vicinity of streams. Found mostly on *Chionochloa* sp. (teneral and fully mature adults); also on *Hebe rakaiensis*, *Olearia lacunosa*, and *Nothofagus* sp. (fully mature adults). Teneral found in November, December and February, but most abundantly in November. Fully mature adults collected from November to February, but apparently most abundant in December and February.

***Semo westlandiae*, sp. nov.** Fig. 12, 16, 20, 23.

**TYPE MATERIAL.** **Holotype:** Male (NZAC) labeled "NEW ZEALAND BR; Mt Sewell; TV Station; 853 m; 22 Nov 1984; B.A. Holloway / sweeping / HOLOTYPE; *Semo; westlandiae* sp. nov.; Larivière & Hoch, 1998 (red)". Note—male genitalia dissected, stored underneath specimens in mini-vial filled with glycerol. **Allotype:** Female (NZAC) labeled "as holotype /ALLOTYPE; *Semo; westlandiae* sp. nov.; Larivière & Hoch, 1998 (red)". **Paratypes** (NZAC, LUNZ): 5 males and 3 females, same data as primary types, bearing blue paratype labels.

**DESCRIPTION.** **Adult** pale yellowish or brownish dorsally, often with a rusty tinge; forewings opaque brown or whitish brown, often pale in proximal third, with rather large brown patches or heavily mottled with brown across midportion and smaller scattered spots distally.

**Head.** Vertex pale brown, often with a rusty tinge or thick yellow margins and carinae, and in some specimens with three dark spots on anterior compartment. Frons yellowish or brownish, often with scattered dark spots; outer carinae often pale yellow; median ocellus visible, yellowish or whitish. Postclypeus yellowish brown to almost black.

**Thorax.** Pronotum pale brown (in some individuals with a little black), often with pale outline. Mesonotum yellowish brown to rusty brown, usually darker medially. Thoracic sterna yellowish brown, always paler than ventral sternites. Forewings venation as in Fig. 20; veins yellowish brown, sometimes calloused, yellowish; Sc+R forked basad of Cu; r-m usually located basad of  $M_{3+4}$ ; 7 or 8 apical cells. Legs yellowish brown to dark brown, often with base and apex of femora pale.

**Abdomen.** Ventral sternites yellowish brown to dark brown. **Male genitalia.** Left genital style as in Fig. 12. Aedeagus (in ventral view, Fig. 16) with 2 long (approx. 0.6–0.7x aedeagal length), thin spinose processes (more slender than in *S. clypeatus* and *S. transinsularis*) subapically near base of flagellum—left process directed basad, right process longer, sinuate, almost hook-shaped, its apex curved slightly dextrad; flagellum nearly as long as aedeagus, unarmed, directed basad.

Body length of males ( $n = 10$ ) 3.48–4.40 (4.05) mm, of females ( $n = 10$ ) 3.72–5.17 (4.46) mm. Other characters as in generic description.

**Remark.** Generally of a paler hue than *S. clypeatus* or *S. transinsularis*, with head more heavily outlined in yellow, and in most individuals a pale patch resembling a ‘shoulder-strap’ in the proximal third of each forewing.

**GEOGRAPHICAL DISTRIBUTION** (Fig. 23). South Island west coast, western Stewart Island, and Owaka, eastern Southland.

**CHOROLOGICAL AFFINITIES.** Collection data suggest that the distribution range of this species is parapatric with that of *S. clypeatus*, in the north, and *S. southlandiae*, in the south. At the local population level there is no record of these species living sympatrically with *S. westlandiae*.

**MATERIAL EXAMINED.** A total of 78 males and 99 females (including type specimens), from the following localities:

**South Island.** **NN.** Denniston (NZAC). Mt Arthur Range, Ellis Basin (UCNZ). Mt Domett (NZAC). **BR.** Mt Sewell, TV station (NZAC). Paparoa Range: Buckland Peaks Track (NZAC); Hochstetter State Forest, Flagstaff Res. (NZAC); Lochnagar Ridge Lake (NZAC); Mt Dewar (NZAC); Mt Priestly (NZAC); Mt Priestly-Mt Dewar basins, Lochnagar Ridge (NZAC). **WD.** Fox Glacier, Chancellor Shelf (LUNZ). Franz Josef (NZAC), Alex Knob (NZAC). Mt Tuhua (NZAC). Westland National Park: Castle Rocks Valley (LUNZ). **NC.** Arthur’s Pass (NZAC). **OL.** Key Summit (NZAC); Mount Aspiring National Park: Haast Pass, Davis Flat (UCNZ); Liverpool Bivouac (LUNZ). Route Burn (NZAC). **FD.** Alpine Garden, Homer Tunnel to Milford Rd (NZAC). Fiordland National Park: Darran Mountains, Tutoko Bench (NZAC); Gertrude Valley, Homer Hut (LUNZ); head of Lake Orbell (NZAC), north side (NZAC); Homer Valley (LUNZ); Murchison Mountains, McKenzie Burn (LUNZ), Plateau Creek (LUNZ); Point Burn Valley, Main Flat (NZAC); Secretary

Island (NZAC), ridge towards Mt Grono (NZAC); Takahe Valley (NZAC); Homer [saddle/tunnel] (NZAC). [Lake] Manapouri, Wilmot Pass (NZAC), Wolfe Flat (NZAC). **SL.** Owaka (NZAC). **Stewart Island.** Codfish Island: Loop track (NZAC), Upper Miro track (NZAC), Valley track (NZAC). Mount Anglem (LUNZ). Old Tin Hut (UCNZ).

**BIOLOGY.** Montane to subalpine shrublands and grasslands, often in the vicinity of streams; on Stewart Island apparently in podocarp-broadleaved forest. Found mostly on *Dracophyllum* species, including *D. traversii* and *D. longifolium*, but also on *Coprosma propinqua* (teneral and fully mature adults). In addition, fully mature adults recorded on *Hebe* sp., *Olearia ilicifolia*, tussocks and other, yet undetermined, subalpine plants. Teneral collected from November to January, but were most abundant in December. Fully mature adults found from November to February, but largely in December.

## PERSPECTIVES OR FUTURE RESEARCH OBJECTIVES

### Species status

The present paper provides evidence that within *Semo* the degree of speciation is higher than previously recognized: the results of our morphological study support the assumption of at least four (instead of one) species. The biological status of these “morphospecies”, however, still remains to be clarified. Studies on mating behavior, ecology (especially host-plant relationships), and distribution are necessary to assess the degree of reproductive isolation between (and possibly even within) morphospecies.

### Evolutionary history

The high similarity in external characters and virtually identical configuration of male genital structures suggest that all *Semo* species share a common ancestral species, i.e., that they are a monophyletic group. Their morphological configuration has not been found elsewhere, so *Semo* must be regarded endemic to New Zealand. The observed high variability within species along with the comparatively small morphological differentiation between species suggests that they have speciated comparatively recently. As the species are largely allopatric and/or live at different altitudes (*S. clypeatus* and *S. transinsularis*), it seems plausible to assume that speciation events may be correlated with recent geologic events. The New Zealand Alpine zone itself is

suggested to be geologically young, probably established in the Pleistocene. Rapid and continuing speciation has been suggested for the evolution of many Alpine biota (e.g., Kuschel 1975; Wardle 1991).

A cladistic analysis, preferably integrating morphological and genetic information, is needed to determine the phylogenetic position of *Semo* within the Cixiini. Only then can we attempt to decipher the evolutionary history of this group, i.e. to confirm or reject the hypothesis that *Semo* is a Gondwana relict, to reconstruct the sequence of speciation and colonization events, and to understand its evolution in general or that of its host-plant relationships.

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