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REVISION OF AUSTROPETALIIDAE (ANISOPTERA: AESHNOIDEA)*

F.L. CARLE
Department of Entomology, Cook College,
New Jersey Agricultural Experiment Station, Rutgers University,
New Brunswick, New Jersey 08903, United States

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Austropetaliid taxonomy, phylogeny, and biogeography are reviewed, and keys and descriptions to subfamilies, tribes, genera, and species provided. Behavioral and ecological information is also summarized. Classification of the Austropetaliidae is revised as follows: Archipetaliinae subfam. n.: (Archipetaliini trib. n.): *Archipetalia auriculata* Tillyard; Austropetaliinae subfam. n.: (Austropetaliini trib. n.): *Austropetalia patricia* (Tillyard), incl. *A. patricia*, and *A. victoria* sp.n. (holotype ♂: Australia, Mt. Kosciusko, 12-XII-1931); Hypopetaliinae subfam. n.: (Hypopetaliini trib. n.): *Hypopetalia pestilens* McLachlan; Eurypetaliinae subfam. n.: (Rheopetaliini trib. n.): *Rheopetalia* gen n. [type *R. rex* sp. n. (holotype ♂: Chile, Puente Los Morongos, 2-I--1992)], incl. *Phyllopetalia a. apicalis* Selys, and *P. apicalis decorata* McLachlan in Selys; *Odontopetalia* gen. n. [type *P. apollo* Selys]; (Eurypetaliini trib. n.): *Eurypetalia* gen n. [type *E. altarensis* sp. n. (holotype ♂: Chile, Estero de Yerba loca along La Leonera, 4-XI-1995)], incl. (*Crenopetalia* subgen. n.) [type *E. excrescens* sp. n. (holotype ♂: Chile, Puente Los Morongos, 10-XII-1993); *Ophiopetalia* gen n. [type *O. diana* sp. n. (holotype ♂: Chile, Antillanca, 27-XII-1992)], incl. *P. pudu* Dunkle, *O. auragaster* sp. n. (holotype ♂: Chile, Estero de Yerba loca, XII-1988), and *O. araucana* sp. n. (holotype ♂: Chile, Piedra del Aguila, 11-XI-1995); and *Phyllopetalia stictica* Selys.

INTRODUCTION

Austropetaliidae Carle & Louton was established for the archaic antipodean Aeshnoidea formerly placed in Neopetaliidae. Discovery of the unique yet distinctly cordulegastridlike larva of *Neopetalia punctata* (Hagen) confirmed the necessity to transfer the Neopetaliidae to Libelluloidea (sensu CARLE, 1982, 1986),

* Dedicated to the memory of Louis E. Peña

while leaving austropetaliids within Aeshnoidea. A close relationship between *Neopetalia* and *Cordulegaster* was first recognized by SELYS (1854) who placed *Petalia* (now *Neopetalia*) and *Thecaphora* (now *Zoraena*) with *Cordulegaster* in his legion Cordulegaster. The establishment of the subgenus *Phyllopetalia* (SELYS, 1858) for two newly discovered Chilean "*Neopetalia*" represented the first of many misplacements. Surprisingly, discovery of female *Neopetalia* (SELYS, 1869) and female *Phyllopetalia* (SELYS, 1878) with their very different ovipositors did not result in taxonomic revision. Austropetaliids were first reported from Australia by TILLYARD (1907), and discovery of their larva led to the following conclusion by TILLYARD (1910): "The consequent conviction that *Phyllopetalia* was a true Aeschnine [sic] genus is, I trust, happily vindicated by the present paper, on the evidence of this truly remarkable nymphal form." Unfortunately, Tillyard's conclusions were extended to include the entire "*Petalia*-group of genera".

FRASER (1933) revised Petaliidae (= Neopetaliidae Cowley, 1934) and unfortunately included several errors. For example, Fraser incorrectly attributed characteristics of then *Petalia* to the included austropetaliids such as the absence of basal subcostal crossveins. Fraser also repeated SELYS' (1858, 1859, 1878) error regarding the relative development of tergal flanges in *P. apicalis* Selys, although this was also correctly described by SELYS (1878) and again by SCHMIDT (1941). However, another error, the supposed postnodal red blotch of *P. apollo* Selys, was repeated by SCHMIDT (1941) and FRASER (1957). This error apparently originates from De Selys' unpublished supposition that *Phyllopetalia* females were characterized by a red blotch between nodus and pterostigmata. This is evidenced by misidentifications of *Austropetalia* females in the Selys' collection; one female as *P. stictica* Hagen *in* Selys supposedly from Chile, and two females as *P. apollo*, one supposedly from Peru, the other unlabelled (e.g. FRASER 1933). Unfortunately, Dr Ris had evidently compared TILLYARD's (1907) undescribed austropetaliid female to the Australian females mislabelled and misidentified as *P. apollo*, and therefore incorrectly identified Tillyard's specimen to be *P. apollo*. Subsequently Dr Ris sent a photograph of the wings of the true *P. apollo* to Tillyard which led to the description of *Austropetalia patricia* (TILLYARD, 1910, 1917a).

This error was repeated and compounded in FRASER's (1933) composite description of *P. apollo* which included a female *Austropetalia*, the wings of which were photographed and included as figure 10 by Fraser. Therefore, DUNKLE (1985) proposed combining *Austropetalia* and *Phyllopetalia* based in part on the assumption that *P. apollo* may have a postnodal blotch, although SELYS (1857, 1859, 1873) repeatedly characterized *Phyllopetalia* as lacking a red blotch between the nodus and pterostigmata. Fortunately, the identity of *P. apollo* is not in doubt since SELYS (1878) described several unique characteristics including an orange occipital hair tuft, male cerci with large medial tooth, and moderate sized flanges of abdominal terga 7 and 8. TILLYARD's (1910) comment is equally clear, "On all four wings in *P. patricia* there is a fourth spot placed... midway between the nodus

and pterostigmata, ... No such spot exists in *P. apollo*."

Not mentioned by DUNKLE (1985) are several other differences between *Austropetalia* and *Phyllopetalia* including poorly developed marginal facial hair fringe, wide separation of lateral ocelli, distally displaced pterostigmatal brace vein and associated red blotch, typically T-shaped postnodal red blotch, male auricles longer than wide, female auricles present, staggered dorsal abdominal markings, rudimentary lateral carinae on terga 3-8 of female and 3 of male, and male epiproct with elongate quadrate apical shelf, apomorphies italicized. Dunkle further states "The secondary genitalia and wing venation is essentially identical in both genera". However, in *P. apollo*, as in all eurypetaliine Austropetaliidae, the genital lobe is functionally replaced by a large bilobate expansion of penile segment 1; the apices of the posterior hamuli are directed slightly medially, and the pterostigmatal brace vein is located at or near the proximal end of the pterostigmata. The false perception that Neopetaliidae and Austropetaliidae form a "compact group" (DAVIES, 1981) is based on pervasive plesiomorphy, similar wing color patterns related to possible warning coloration and mimicry, and the almost total lack of good quality taxonomic material. For example, McLACHLAN (1870) comments "My single example (type of *Hypopetalia pestilens*) has evidently been placed between the pages of a book...", and SELYS (1878) states "... les espèces ayant été établies d'abord sur des exemplaires uniques d'un seul sexe et en assez mauvais état." The resulting perception of uniformity has nurtured little appreciation for either the diversity within the Austropetaliidae, or the phylogenetic significance of the group as a whole.

DISCUSSION

Austropetaliids comprise the isolated antipodean remnants of archetypal aeshnoid evolution. Their distribution is mirrored in the northern hemisphere by cordulegastrids which exhibit a similar morphologic grade (CARLE, 1983). The sister group relationship proposed by CARLE (1982, 1986, 1995) between Aeshnoidea (Aeshnidae + Austropetaliidae) and Libelluloidea (Cordulegastridae + Neopetaliidae + Chlorogomphidae + Synthemistiidae + Gomphomacromiidae + Libellulidae) is supported by the 137 year misassociation of *Phyllopetalia* with *Neopetalia*. Although many similarities between these superfamilies are undoubtedly due to symplesiomorphy, others such as dorsal development of the compound eyes in adults and larvae, phragmatic transverse abdominal musculature of larvae, and moundlike proventricular lobes, are noncorrelated, forming a neapomorphic congruent triplet of considerable analytical weight. Although larval Gomphoidea and Petaluroidea are relatively specialized, lack of the above neapomorphies suggest that their larval specialization occurred before the phylogenetic split between Aeshnoidea and Libelluloidea.

Aeshnoidea, although decidedly plesiotypic are characterized by diverse

neapomorphy including fore wing triangle typically more than 3/4 length of supratriangle, larval epiproct typically bifurcate apically, proventricular lobes small--moundlike with 8 or fewer clustered teeth, larval compound eyes produced forward (widest anterior to antennal bases), and several apparent coapomorphies of the adult genitalia including anterior lamina with elongate medial cleft, anterior hamuli lamellate and directed medially, posterior hamuli vestigial, median process of male abdominal segment 2 short L-shaped with anteroventral face developed into a sharp edged valve separator, and ovipositor hyperdeveloped being suited for endophytic oviposition. Considering the secondary genitalia and ovipositor of Aeshnoidea plesiomorphic has led some workers to consider them the sister group to extant Anisoptera. This is unfortunate since the complementary apomorphies are predominantly correlated exapomorphies, and therefore of little analytical weight. The supposed plesiotypic nature of aeshnoid oviposition, and correlated male secondary genitalic type, is also in doubt as the petaluroid complete ovipositor is associated with exophytic oviposition and is most similar to that of Apterygota among extant Odonata. In addition, certain fossil "Zygoptera" are characterized by exophytic ovipositors, and Meganisoptera, Epiophlebia, Petaluridae, Austroptaliidae, and Aeshnidae lack the spinose ventral metagonocoxal ridge of extant Zygoptera suggesting that the latter condition is apomorphic. Finally, the similarity between petaluroid and cordulegastrid secondary genitalia given the annectent position of Aeshnoidea (CARLE, 1995), indicates that the petaluroid type is most similar to the plesiotypic secondary genitalic type from which the gomphoid and aeshnoid types have been independently derived. Also the sperm canal of austropetaliids apparently opens distally on the third penile segment between the bases of the flagellae. Although speculative, pendulous cornua may have served for the initial occlusion of the apical sperm canal in plesiotypic Aeshnidae.

Austropetaliid autapomorphies recall an ancient youthful era in creation when bizarre solutions to evolutionary problems were seemingly more common. The most outstanding autapomorphy is the costal series of 5-8 blood red or brown transparent blotches which may serve as a warning coloration. This pattern has been apparently mimicked in the Neopetaliidae (CARLE & LOUTON, 1994). Another unusual characteristic of adult austropetaliids is the leaflike lateral expansion of terga 7 and 8 exhibited by several Chilean representatives of the family. Larvae are apomorphically distinguished from all Anisoptera by the strongly distally widened labrum, massive ventrolateral development of the occipital ridge, dorsally excrescent femora, obsolete transverse abdominal muscles, extensively granulate body surface, and well developed lateral lobes of abdominal segments 1-10 which apparently mimic the serrate edges of detrital *Nothofagus* leaves. However, considerable austropetaliid plesiomorphy relative to Aeshnidae exists and includes: compound eyes approximate or meeting at a point dorsally (eyes not meeting along a dorsal eye seam), abdomen without well developed lateral carinae (except on segments 7 and 8 where carinae may be flangelike), wings without well developed

planates (weak radial planates typically developed), fore wing triangle with proximal side more than 1/2 anterior side, penis laterally exposed, penile prepuce well developed, anterior lamina with wide medial cleft, larval prementum only slightly widened distally, larval paraprocts shorter than 1/2 width of abdominal segment 9, and penile segment 4 pendulous with huge paired flagella directed posteroventrally. With regard to the latter character, the flagella or apparent fourth penile segment of austropetaliids may be derived from the cornual flanges of the third penile segment; note that they are also fully articulated in plesiotypic Gomphoidea.

KEY TO THE SUBFAMILIES, TRIBES, AND GENERA OF AUSTROPETALIIDAE

1 Compound eyes separated by ca width of median ocellus, antefrons with dorsal yellow stripe, postfrontal suture present, anterior face of occiput trapezoidal; dorsal mesanepisternal stripes obtuse triangular; thorax laterally with yellowish white stripes, metanepimeral stripe curvate; wings with 7-8 brown costal blotches; forewing basal blotch vestigial and hindwing basal blotch well developed; male epiproct ca as wide as long; female with abdominal terga less than twice as long as high; female without carinae or flanges on abdominal segments. Measurements: total length ♂ 56.0-57.0 mm, ♀ 50.0-53.0 mm; abdominal length ♂ 41.0-42.0 mm, ♀ 36.0-39.0 mm; hind wing ♂ 31.0-32.0 mm, ♀ 33.0-34.0 mm ..... **Archipetaliinae** subfam.n. – ***Archipetalia auriculata*** Tillyard

Distribution: Australia: Tasmania – Cradle Mountain (TILLYARD, 1917a), St. Clair, Broad River Valley (FRASER, 1960).

Flight Season: 18-X-1917 to 15-I-1917 at Cradle Mountain, R.J. Tillyard leg.

– Compound eyes contiguous, antefrons not brown with dorsal yellow stripe, postfrontal suture absent, anterior face of occiput triangular; dorsal mesanepisternal stripes not obtuse triangular; thorax laterally with yellow non-curvate stripes or white spots; wings with 4-7 red costal blotches; fore and hindwings with basal blotches similar; male epiproct longer than wide; female with abdominal terga more than twice as long as high; female with at least vestigial lateral carinae or flanges on abdominal segment 7 2

2 Face without well developed marginal hair fringe; lateral ocelli separated by more than width of median ocellus; brace vein located near middle of pterostigmata, pterostigmal red blotch centered behind pterostigmata; abdominal markings pea-green; abdominal postantecostal spots offset laterally from basal stripes; abdominal segments 3-7 in female and 3 in male with rudimentary lateral carinae; female forewing with 8 costal blotches; male auricles longer than wide, female auricles present ..... **Austropetaliinae** subfam.n. – ***Austropetalia*** Tillyard

– Face with well developed marginal hair fringe; lateral ocelli separated by less than width of median ocellus; brace vein not located near middle of pterostigmata, pterostigmal red blotch centered behind proximal end of pterostigmata; abdominal markings yellow, bluish green, or obsolete; abdominal postantecostal spots in line with basal stripes or obsolete; abdominal segments 7 and 8 with well developed lateral carinae or flanges; female fore wing with 5-7 costal blotches; male auricles wider than long, female auricles absent 3

3 Postclypeus brown; lateral ocelli and compound eyes not contiguous; occiput transverse with dorsally directed spine; thorax with middorsal mesanepisternal and ventrolateral metepimeral carinae hyperdeveloped; thorax dorsally coarsely granulate without stripes, laterally with 3 white spots; subtriangles 2-3 celled; forewings with blotch at base of distal pleat; wings with blotch between nodus and pterostigmata; brace vein proximal to pterostigmata, associated red blotch centered proximal to pterostigmata, pterostigmata yellow; abdomen reddish brown with basolateral

white spot on segment 2; segments 3-7 laterally compressed with middorsal carinae; segment 8 with lateral carinae; penile receiver cleftlike, lower than genital lobes, posteriorly with shallow V-shaped notch; posterior hamuli with apices directed slightly laterally; male abdominal tergum 2 higher than long; male cerci flat with slight ventral inflation near base. Measurements: total length ♂ 81.0-85.0 mm, ♀ 78.0-86.0 mm; abdominal length ♂ 63.0-67.0 mm, ♀ 60.0-67.0 mm; hind wing ♂ 46.0-50.0 mm, ♀ 49.0-53.0 mm ..... **Hypopetaliinae** subfam.n. – ***Hypopetalia pestilens*** McLachlan

Distribution: Chile: Precordillera andina (PIRION, 1933); Arauco Prov. – Contulmo (SCHMIDT, 1941), Caramavida, Peillem-Pill (PENA, 1954); Cautin Prov. – Cholchol (NEEDHAM & BULLOCK, 1943), Pucón; Chiloé Prov. – Ahoni; Curicó Prov. – precordillera de Curicó (PEÑA, 1968, 1987), Quebrada Honda (El Coigo); Linares Prov. – Embalse Bullileo; Llanquihue Prov. – Lago Chapo (PEÑA, 1968), Raúlin (MOORE, 1992); Malleco Prov. – Angol (NEEDHAM & BULLOCK, 1943), Cordillera de Nahuelbuta (PEÑA, 1968, 1987), Lonquimay Rio Picoiquen; Talca Prov. – Vilches; Valdivia Prov. – Isla Teja (JURZITZA, 1975), Rio Futa (JURZITZA, 1989); Valpariso? (FRASER, 1957).

Flight season: 5-X-1944, Cordillera de Nahuelbuta, M. Cerda leg. to 20-I-1905, Contulmo, O. Schonemann leg.

– Postclypeus yellow; lateral ocelli and compound eyes nearly contiguous; occiput not transverse with dorsally directed spine; thorax with middorsal mesanepisternal and ventrolateral metepimeral carinae normal; thorax dorsally finely granulate with stripes, laterally with yellow stripes; subtriangles 1 celled; forewings without blotch at base of distal pleat; wings without blotch between nodus and pterostigmata; brace vein near proximal end of pterostigmata, associated red blotch centered at proximal end of pterostigmata, pterostigmata red; abdomen brown with dorsal and lateral markings; segments 3-7 cylindrical without middorsal carinae; segment 8 with lateral flanges; penile receiver bilobate, higher than genital lobes, posteriorly with wide U-shaped notch; posterior hamuli with apices directed slightly medially; male abdominal tergum 2 longer than light; male cerci ventrally inflated beyond base ..... **Eurypetaliinae** subfam.n. – 4

4 Antefrons and clypeus subequal in height, frons slightly narrower than clypeus; occiput transverse ridgelike with thin pale hair fringe; lateral thoracic yellow stripes ventrally margined with black; mesepimeral stripes strongly constricted above middle; membranule well developed; abdominal tergum 7 with lateral flange at most 1/6 as wide as long; dorsal abdominal stripes 3-6 separated by narrow brown line; anal brace originates proximal to Cu-A crossvein; male with hind wing margin level distal to tornus; male epiproctal rami extended well beyond cerci ..... **Rheopetaliini** trib.n. – 5

– Antefrons higher than clypeus, frons slightly wider than clypeus; occiput globose or pyramidal without thin hair fringe; lateral thoracic yellow stripes not ventrally margined with black; mesepimeral stripes at most slightly constricted above middle; membranule vestigial; abdominal tergum 7 with lateral flange at least 1/4 as wide as long; dorsal abdominal stripes 3-6 separated at least by width of stripe; anal brace originates near Cu-A crossvein; male with hind wing margin concave distal to tornus; male epiproctal rami near apex of cerci ..... **Eurypetaliini** trib.n. – 6

5 Labrum predominantly brown; occipital hair fringe blond; dorsal mesanepisternal stripe widest near middle, not extended to antealar slope; metepimeral stripe wider than midbasal space; abdominal segment 8 with lateral flange large-finlike, that of segment 7 rimlike; abdominal segments 3-7 with submedian yellow spots distal to antecostal suture; male cerci without large medial tooth; anal brace curved apically; male epiproctal length ca 3 times width at rami ..... ***Rheopetalia*** gen.n.

Type-species: *R. rex* sp.n.

– Labrum predominantly yellow; occipital hair fringe coppery orange; dorsal mesanepisternal stripes parallel sided, extended to near antealar carinae; metepimeral stripe not wider than midbasal space; abdominal segments 3-7 predominantly brownish yellow distal to antecostal suture; abdominal terga 7 and 8 with lateral flanges subequal, both narrow flangelike; male cerci with large

medial tooth; anal brace nearly straight; male epiproctal length ca 2 times width at rami. Measurements: total length ♂ 65.0-72.0 mm, ♀ 63.0-71.0 mm; abdominal length ♂ 48.0-56.0 mm, ♀ 47.0-54.0 mm; hind wing ♂ 36.0-41.0 mm, ♀ 41.0-44.mm ..... ***Odontopetalia*** gen.n.
Type-species: *P. apollo* Selys, monotypic.
Distribution: Chile (SELYS, 1878); Arauco Prov. – Caramavida (DUNKLE, 1985); Biobio Prov. – Troyo; Cautin Prov. – Cholchol (DUNKLE, 1985); Chiloé Prov. – Ahoni, Dalcahue; Concepción Prov. – Concepción (HERRERA et al., 1955/56); Linares Prov. – Linares; Lianquihue Prov. – Peulla; Malleco Prov. – Angol (DUNKLE, 1985), Las Raices, Victoria; Maule Prov. – Tregualemu; Ñumble Prov. – Quillon; Santiago? Prov. – Las Mercedes (GAZULLA, 1928); Valparaiso? Prov. – Valparaiso (HERRERA et al., 1955/56); Valdivia Prov. – Valdivia, Sto. Domingo (JURZITZA, 1989), Pilicahuin.
Flight season: 20-IX-1940, Cautin, D. Cayun leg. to 29-I-1995, Pilicahuin, A. Ugarte leg.

6 Occiput not tripartite ridgelike with anterodorsal spine; antefrons entirely black, or brown with antefrontal carinae yellow; wings with basal blotch entirely wine red and extended to proximal costal brace, basal brown obsolete; dorsal mesanepisternal and dorsal abdominal stripes bluish green; lateral flanges of tergum 7 widest near posterior tergal carina; male cerci without ventral keellike spine ..... ***Eurypetalia*** gen.n.
Type-species: *E. altarensis* sp.n.

– Occiput tripartite ridgelike with anterodorsal spine; antefrons mostly black with antefrontal carina yellow; wings with basal blotch brown, often reduced to vestigial basal spot; dorsal mesanepisternal stripes yellow, dorsal abdominal stripes light green or yellow; lateral flanges of tergum 7 widest well anterior to posterior tergal carina; male cerci with ventral keellike spine 7

7 Labrum yellow; antefrons 1.3-1.7 times height of postclypeus; anterior surface of antefrons with wide dorsal yellow band; occiput with dense blond hair; post occipital horns present; metepimeral stripes wider than midbasal space; male with basal wing blotches vestigial; female dorsal abdominal stripes on 3-6 separated by two stripe widths; lateral flanges of abdominal tergum 7 ca as wide as those of tergum 8; male cerci bootlike ..... ***Ophiopetalia*** gen.n.
Type-species: *O. diana* sp.n.

– Labrum light brown; antefrons 1.7-2.2 times height of postclypeus; antefrontal carinae narrowly yellow; male occiput with dense black hair, female occiput with scattered light brown hair; post occipital horns absent; metepimeral stripes narrower than midbasal space; male with basal wing blotches well developed; female dorsal abdominal stripes on 3-6 separated by one stripe width; lateral flanges of abdominal tergum 7 wider than those of tergum 8; male cerci stalklike in basal half. Measurements: total length ♂ 58.0-62.0 mm, ♀ 57.0-66.0 mm; abdominal length ♂ 45.0-48.0 mm, ♀ 43.0-50.0 mm; hind wing ♂ 33.0-36.0 mm, ♀ 37.0-40.0 mm ..... ***Phyllopetalia stictica*** Hagen
Distribution: Argentina: Neuquén Prov. – Puerto Tromen (MUZON & DEBANDI, 1992); Chile: Arauco Prov. – Contulmo (SCHMIDT, 1941), Caramavida (DUNKLE, 1985); Chiloé Prov. – Ahoni, Dalcahue, Chaiten, Cucau; Malleco Prov. – Las Raices; Osorno Prov. – Aguas Calientes, Antillanca; Valdivia prov. – Valdivia (SELYS, 1858), Comudes (SCHMIDT, 1941), Sto. Domingo (JURZITZA, 1989).
Flight season: 5-IX-1904 to 13-I-1905, Contulmo, O. Schonemann leg.

ARCHIPETALIINI

Type genus: *Archipetalia* Tillyard 1917.
Monotypic: *Archipetalia auriculata* Tillyard.

Very small austropetaliids colored brown and marked with yellow and white.

H e a d. – Labrum dusky yellow with medial and marginal areas brown, anteclypeus brown, postclypeus yellow with apices of lateral lobes brown, antefrons brown with wide anterior yellow band on dorsal surface, antefrons narrower than postclypeus, and 1.3 ♂, 1.2 ♀ times median height of postclypeus, antefrontal carinae weak, not developed laterally, face with lateral setae diffuse, compound eyes separated by ca width of median occulus, lateral ocelli separated by more than width of median ocellus, lateral ocelli separated from compound eyes by ca 1/2 width, postfrontal suture present, occipital crest rounded without dorsal spine and with weakly developed posterior transverse hair fringe.

T h o r a x. – Thorax brown, dorsal mesanepisternal stripes obtuse triangular, thoracic dorsum not coarsely granulate, mesanepimeral stripes yellowish white, parallel sided, and without ventral black border, metanepimeral stripes curved.

W i n g s. – Wings with 7-8 brown costal blotches, fore wings without blotch at base of distal pleat, wings with blotch between nodus and pterostigmata, pterostigmal red blotch centered behind pterostigmata, brace vein located at ca proximal fifth of pterostigma, pterostigmata red, triangles 2 celled, subtriangles 1 celled, anal brace originates proximal to Cu-A crossvein, male hind wing margin straight distal to tornus, membranule well developed.

A b d o m e n. – Abdominal markings yellow, dorsal postantecostal spots offset laterally from basal stripes, dorsal abdominal stripes 3-6 separated by at least 1/2 width of stripe, female abdominal terga less than twice as long as high, female auricles present without carinae or flanges on abdominal segments, male epiproct ca as wide as long, male epiproctal shelf shorter than wide, with apical margin truncate, male cerci twisted straplike.

G e n i t a l i a. – Posterior hamuli slightly L-shaped with apices directed posteroventrally and slightly laterally, penile receiver slightly bilobate and lower than genital lobes, posteriorly with level V-shaped notch.

AUSTROPETALIINI

T y p e g e n u s: *Austropetalia* Tillyard 1916.
Austropetaliini include: *Austropetalia patricia* Tillyard, and *A. victoria* sp.n.

Small austropetaliids colored reddish brown and marked with pea green and yellow.

H e a d. – Labrum brown with irregular transverse subapical yellow band, anteclypeus brown, postclypeus yellow with apices of lateral lobes brown, antefrons brown narrower than postclypeus, and 1.4-1.5 ♂, 1.2-1.3 ♀ times median height of postclypeus, antefrontal carinae well developed, pale yellow medially, bright yellow laterally, face with lateral setae diffuse, compound eyes nearly contiguous, lateral ocelli separated by more than width of median ocellus, lateral ocelli and compound eyes separated by ca 1/2 width, postfrontal suture obsolete, occipital

crest rounded with transverse ridge, without dorsal spine, and with well developed slightly posterior transverse hair fringe.

T h o r a x. – Thorax brown, dorsal mesanepisternal stripes parallel sided, thoracic dorsum not coarsely granulate, mesanepimeral stripes green without well developed ventral black border, stripes slightly constricted, metanepimeral stripes slightly sinuous.

W i n g s. – Wings with 5-6 red costal blotches and basal brown blotch, distal blotches bordered with brown, female antenodals often with small brown blotches, fore wings without blotch at base of distal pleat, wings with blotch between nodus and pterostigmata, pterostigmal red blotch centered behind pterostigmata, pterostigmata red, brace vein located at ca proximal third of pterostigma, triangles 2-3 celled, subtriangles 1 celled, anal brace originates proximal to Cu-A crossvein, male hind wing margin straight distal to tornus, membranule well developed.

A b d o m e n. – Abdominal markings pea green, dorsal postantecostal spots offset laterally from basal stripes, dorsal abdominal stripes 3-6 separated by at least 1/2 width of stripe, female abdominal terga more than twice as long as high, female auricles present, abdomen without lateral flanges, male with rudimentary carinae on abdominal terga 3 only, female with rudimentary carinae on abdominal segments 3-7, male epiproct longer than wide, male epiproctal shelf longer than wide, with apical margin truncate, male cerci straplike.

G e n i t a l i a. – Posterior hamuli sicklelike with apices directed posteroventrally, penile receiver slightly bilobate and lower than genital lobes, posteriorly with level V-shaped notch.

KEY TO THE SPECIES OF *AUSTROPETALIA*

1 Anterior face of antefrons strongly convex in lateral view; lateral ocellar elevations without anterior processes; dorsal mesanepisternal stripes parallel sided, dorsally separated by more than 3 times width; lateral pterothoracic stripes narrower than supratriangles, and slightly sinuous with dorsal end of mesanepisternal lateral stripe produced posteriorly, metanepisternum without dorsal spot; costa yellow, wing blotches with wide brown margins; metapoststernum with vestigial anterior transverse ridge; lateral margin of tergum 9 with uniform pale band; male lateral genital carinae denticulate and strongly upcurved, genital shelf 1/3 as wide as long; male cerci angulate apically, ca 1/4 as wide as long, and with well developed ventromedial denticle; male epiproct with ventrolateral ridges parallel; female wings with blotches at arculus and subcostal antenodals proximal to distal costal brace, nodal blotch extended onto bridge cells; female abdominal tergum 9 ca 1.2 times as long as high at base, gonostyli ca 1.0 mm long. Measurements: total length ♂ 61.0-65.0 mm, ♀ 57.0-60.0 mm; abdominal length ♂ 47.0-51.0 mm, ♀ 42.0-44.5 mm; hind wing ♂ 32.0-35.0 mm, ♀ 36.5-39.0 mm ..... ***patricia*** (Tillyard)
D i s t r i b u t i o n: Australia: New South Wales – Blue Mountains at Leura and Blackheath (TILLYARD, 1907, 1910, 1916), Kosciusko and Berrima Districts (FRASER, 1960), Fitzroy Falls near Robertson, Wentworth falls; Victoria – Kingslake National Park (FRASER, 1960).
F l i g h t s e a s o n: 5-X-1950, Wentworth Falls, R. Dobson leg. to December (FRASER, 1960).

– Anterior face of antefrons slightly convex in lateral view; lateral ocellar elevations with anterior processes; dorsal mesanepisternal stripes widest dorsally, dorsally separated by less than 3 times

width; lateral pterothoracic stripes wider than supratriangles, and nearly straight without dorsal end of mesanepisternal lateral stripe produced posteriorly, metanepisternum with dorsal spot; costa reddish brown, wing blotches with narrow brown margins; metapoststernum with well developed anterior transverse ridge; lateral margin of tergum 9 with pale band vestigial posteriorly; male lateral genital carinae nondenticulate and gently upcurved, genital shelf 1/4 as wide as long; male cerci rounded apically, ca 1/3 as wide as long, and with weakly developed ventromedial denticle; male epiproct with ventrolateral ridges convergent distally; female wings without blotches at arculus and subcostal antenodals proximal to distal costal brace, nodal blotch at most slightly extended onto bridge cells; female abdominal tergum 9 ca as long as high at base, gonostyli ca 1.5 mm long. Measurements: total length ♂ 63.0-66.0 mm, ♀ 64.0-65.0 mm; abdominal length ♂ 48.5-50.5 mm, ♀ 46.0-47.0 mm; hind wing ♂ 35.0-37.0 mm, ♀ 41.0-43.0 mm ..... ***victoria*** sp.n.

Holotype ♂: Australia: New South Wales, Mt. Kosciusko 5,000-7,000 feet, 12-XII-1931, Darlington leg., deposited Museum of Comparative Zoology, Boston. **Allotype** ♀: same as for holotype. **Paratypes**: 1 ♀, New South Wales: Blue Mountains, Wentworth Falls, 18-XI-1921, R.J. Tillyard leg., deposited British Museum (Natural History), London; 1 ♂, Australian Capital Territory, Gibraltar Falls, 8-XI-1972, T.W. Donnelly leg., deposited Florida State Collection of Arthropods (FSCA).

F l i g h t s e a s o n: 8-XI-1972, Gibraltar Falls, T.W. Donnelly leg. to 12-XII-1931, Mt. Kosciusko, Darlington leg.

HYPOPETALIINI

T y p e g e n u s: *Hypopetalia* McLachlan 1870.
Monotypic: *Hypopetalia pestilens* McLachlan

Large austropetaliids colored reddish brown and marked with white and black.

H e a d. – Labrum light brown, anteclypeus dark brown, postclypeus light brown, antefrons light brown, narrower than postclypeus, and 1.2 ♂, 1.1 ♀ times median height of postclypeus, antefrontal carinae well developed, face with lateral setae diffuse-fringelike, compound eyes nearly contiguous, lateral ocelli separated by less than width of median ocellus, lateral ocelli and compound eyes separated by ca 1/2 width, postfrontal suture obsolete, occipital crest transverse ridgelike with dorsally directed spine and with well developed transverse hair fringe.

T h o r a x. – Thorax grayish brown, middorsal and antealar carinae dark brown, dorsal mesanepisternal stripes obsolete, thoracic dorsum coarsely granulate, mesanepimera with ventral yellowish white spots with black border, metanepimeral stripes divided into two yellowish white spots, ventral spot bordered with black.

W i n g s. – Wings with 7-8 red costal blotches, basal blotch brown basally, all blotches brownish with age, fore wings with small blotch at base of distal pleat, wings with blotch between nodus and pterostigmata, pterostigmal red blotch centered proximal to pterostigmata, brace vein proximal to pterostigma, pterostigmata yellow, yellowish brown with age, triangles 3-4 celled, subtriangles 2-3 celled, anal brace originates proximal to Cu-A crossvein, male hind wing margin slightly concave distal to tornus, membranule well developed.

A b d o m e n. – Abdominal markings obsolete except for basolateral white spot

on segment 2, female abdominal terga more than twice as long as high, female auricles obsolete, abdomen with carinae on abdominal terga 7 and 8, male epiproct longer than wide, male epiproctal shelf shorter than wide, with apical margin convex, male cerci straplike with slight ventrosubbasal inflation.

G e n i t a l i a. – Posterior hamuli J-shaped with apices directed posteroventrally and slightly laterally, penile receiver slightly bilobate and lower than genital lobes, posteriorly with V-shaped notch.

RHEOPETALIINI

T y p e g e n u s: *Rheopetalia* gen.n.
Rheopetaliini include: *R. rex* sp.n., *R. apicalis* (Selys), and *Odontopetalia apollo* (Selys).

Large austropetaliids colored brown and marked with yellow.

H e a d. – Labrum brown with medial yellow spot, or yellow with marginal areas brown, anteclypeus brown, postclypeus yellow with apices of lateral lobes brown, antefrons dark brown, slightly narrower than postclypeus, and 1.0-1.3 ♂, 0.9-1.2 ♀ times median height of postclypeus, antefrontal carinae black, face with lateral setae fringelike, compound eyes nearly contiguous separated by narrow setal row, lateral ocelli separated by less than width of median ocellus, lateral ocelli and compound eyes nearly contiguous, postfrontal suture obsolete, occipital crest transverse ridgelike without dorsal spine and with transverse hair fringe.

T h o r a x. – Thorax brown, dorsal mesanepisternal stripes spindlelike or parallel sided, thoracic dorsum not coarsely granulate, mesanepimeral yellow stripes with ventral black border and strongly constricted above middle, metanepimeral stripes straight and nearly parallel sided.

W i n g s. – Wings with 5-6 red costal blotches, basal blotch without basal brown area, blotches bordered with light brown with age, fore wings without blotch at base of distal pleat, wings without blotch between nodus and pterostigmata, pterostigmal red blotch centered at proximal end of pterostigmata, pterostigmata red, brace vein near proximal end of pterostigma, triangles 2-3 celled, subtriangles 1 celled, anal brace originates proximal to Cu-A crossvein, male hind wing margin slightly concave distal to tornus, membranule well developed.

A b d o m e n. – Abdominal markings yellow, dorsal postantecostal spots in line with basal stripes, dorsal abdominal stripes 3-6 separated by narrow brown line, female abdominal terga more than twice as long as high, female auricles obsolete, abdomen with carinae or flanges on abdominal segment 7 and with flanges on abdominal segment 8, male epiproct longer than wide, male epiproctal shelf shorter than wide, with apical margin convex, male cerci with medial inflation.

G e n i t a l i a. – Posterior hamuli stublike and directed anteroventrally with apices slightly curved medially, penile receiver strongly bilobate and higher than genital lobes, posteriorly with wide U-shaped notch.

KEY TO THE SPECIES AND SUBSPECIES OF *RHEOPETALIA*

1 Antefrons higher than postclypeus, ca 1.1 in male and 1.0 in female; dorsal surface of male antefrons ca 1/3 as long as wide; occipital hair fringe black with narrow medial blond tuft; fore wing with pterostigmal red blotch similar to blotches at distal costal brace and nodus, apical blotch extended over 10-20 cells; male abdominal terga 4-9 with at most vestigial dorsal yellow markings posterior to antecostal suture; male abdominal segment 9 wider than long; flanges of male tergum 8 ca 1/4 as wide as long, ca 3/4 as wide as ventral surface of tergum 7. Measurements: total length ♂ 78.0-84.0 mm, ♀ 71.0-78.0 mm; abdominal length ♂ 61.0-66.0 mm, ♀ 54.0-59.0 mm; hind wing ♂ 44.0-47.0 mm, ♀ 44.0-48.0 mm ..... ***rex*** sp.n.
Holotype ♂: Chile: Curicó Prov., Las Tables at Puente Los Morongos, 2-I-1992, F.L. Carle leg., deposited U.S. National Museum of Natural History, Washington D.C., (USNM). **Allotype** ♀: same as for holotype. **Paratypes**: 2 ♂, same as for holotype; 1 ♂, same locality, 21-XII-1942, L.E. Peña leg., F.L. Carle Collection (FLC); 1 ♀, 10-XII-1993, O.S. Flint, Jr. leg., USNM; 2 ♂, 1 ♀, 6-XI-1995, FLC & H. Navarrete leg., FLC; Biobio Prov. – 1 ♀, El Abanico, 30-XII-1950, Ross & Michelbacher leg., FSCA; Curico Prov. – 2 ♂, El Coigo at Quebrada Honda, X and XI--1959, M. Rivera & L.E. Peña leg., FLC; 2 ♂, 1 ♀, XII-1979, L.E. Peña leg., LEP; 4 ♂, 2 ♀, XII--1980, L.E. Peña leg., LEP; 1 ♂, 1 ♀, Los Arrayanes?, 19-X-1981, L.E. Peña leg., LEP; Linares Prov. – 1 ♂, Las Cruces Cordillera Parral, X-15-1958, L.E. Peña leg., FLC, 1 ♂, La Balsa Cordillera Parral, 26-XI-1960, L.E. Peña leg., FLC; Malleco Prov. – 3 ♂, Victoria, I-1985, Madariaga leg., LEP; Ñuble Prov. – 1 ♂, Cordillera de Chillan, 1899, Germaine, Museo Nacional De Historica Natural, Santiago, (MNHS); 2 ♂, 1 ♀, Los Lleugues, XI-1993, L.E. Peña & A. Ugarte leg., FLC and LEP; O'Higgens Prov. – 1 ♂, Las Nieves, 12-XI, MNHS; Santiago Prov. – 1 ♂, Cajonde Lisboa, 20-XII-1989, A. Ugarte leg., LEP; 9 ♂, El Membrillo, 5-XI-1995, FLC, H. Navarrete, & P. Vidal leg., FLC; 3 ♂, 1 ♀, C° del Roble nr. Caleu, 2-XI-1995, FLC leg., FLC; Talca Prov. – Vilches, 3 ♂, 2 ♀, XII-1989, R. Perez De Arce, MNHS, LEP & FLC; 3 ♂, 13-I-1995, L.E. Peña & A. Ugarte leg., FLC; 1 ♂, 12-XI-1995, FLC & H. Navarrete leg., FLC; Valparaiso Prov. – 1 ♂, C° La Campana, 3-XI-1974, P. Vissi leg., LEP; 1 ♂, 18-X, MNHS; 1 ♀, Cuesta Dormida, 29-X--1995, H. Navarrete leg., FLC; 1 ♀, Valparaiso, 1945, FSCA. Material not studied but referable to *R. rex* sp.n. includes: Arauco Prov. – Contulmo (SCHMIDT, 1941); Linares Prov. – Longavi (SCHMIDT, 1941), Tranque de Bullileo (DUNKLE, 1985); Valparaiso Prov. – Los Perales farm, Marga-Marga (NAVAS, 1918); Cuesta Dormida (JURZITZA, 1989).
Flight season: 15-X-1959, Las Cruces, L.E. Peña leg. to 13-I-1995, Vilches, L.E. Peña & A. Ugarte leg.
Antefrons lower than postclypeus, ca 1.0 in male and 0.9 in female; dorsal surface of male antefrons ca 2/7 as long as wide; occipital hair fringe blond, black behind compound eyes; fore wing with pterostigmal red blotch smaller than blotches at distal costal brace and nodus, apical blotch extended over 0-8 cells; male abdominal terga 4-5 with large rectangular yellow spots, 6 and 7 with yellow triangles, and 8 and 9 with full length yellow stripes, all posterior to antecostal suture; male abdominal segment 9 longer than wide; flanges of male tergum 8 ca 1/5 as wide as long, ca 1/2 as wide as ventral surface of tergum 7. Measurements: total length ♂ 66.0-72.0 mm, ♀ 67.0--70.0 mm; abdominal length ♂ 53.0-59.0 mm, ♀ 49.0-53.0 mm; hind wing ♂ 38.0-44.0 mm, ♀ 43.0-45.0 mm ..... ***apicalis*** (Selys) – 2
Distribution: Chile (SELYS, 1858); Aconcagua Prov. – Los Andes (DUNKLE, 1985), Guardia Vieja, Resguardo de los Patos, San Filipe; Atacama Prov. – Conay; Coquimbo Prov. – Rio Los Molies east of Ovalle (DUNKLE, 1985), Alcohuas, El Piden, El Pangue, Hacianda Illapel; Curicó Prov. – Los Queñes; Santiago Prov. – El Canelo (FRASER, 1957), Macul, Pudahuel, (JURZITZA, 1989), El Peumo, El Volcán, Los Maitenes, Rio Molina, Farellones, Yerba Loca; Talca Prov. – Vilches.
Flight season: IX-1940, Los Andes, B. Aborich leg. to 18-I-1964, Los Queñes, L.E. Peña

leg.

2 Postclypeus yellow; wing blotches well developed, basal blotch contiguous or nearly contiguous with blotch at proximal costal brace ..... ***apicalis apicalis*** (Selys)
Type locality: Santiago at El Peumo. Typical form found in Santiago Province. The syntype ♂ in the Hagen collection at MCZ and mislabeled Valdivia, Chile is here designated as the Lectotype of *R. a. apicalis*. Valdivia is further south than the range of ***Rheopetalia*** and in any event the Lectotype is typical of ***Rheopetalia*** from 800 km to the north near Santiago.

– Postclypeus yellowish white; wing blotches vestigial, basal blotch separate from blotch at proximal costal brace ..... ***apicalis decorata*** (McLachlan *in* Selys)
Type locality: Los Andes. Typical form found in Atacama, Aconcagua, and Coquimbo Provinces.

EURYPETALIINI

Type genus: *Eurypetalia* gen.n.

Eurypetaliini include: *E. alterensis* sp.n., *E. excrescens* sp.n.; *Ophiopetalia araucana* sp.n., *O. auregaster* sp.n., *O. diana* sp.n., *O. pudu* (Dunkle); and *Phyllopetalia stictica* Selys.

Medium sized austropetaliids colored brown or black and marked with yellow and green.

Head. – Labrum light brown or yellow with medial and marginal areas brown, anteclypeus brown, postclypeus yellow with apices of lateral lobes brown, antefrons brown or black with wide dorsal yellow band on anterior surface, antefrons wider narrower than postclypeus, and 1.3-1.9 ♂, 1.3-1.6 ♀ times median height of postclypeus, antefrontal carinae black or yellow, face with lateral setae fringelike, compound eyes slightly separated, lateral ocelli separated by less than width of median ocellus, lateral ocelli and compound eyes separated by 1/3 width to nearly contiguous, postfrontal suture obsolete, occipital crest typically tripartite ridgelike with anterodorsal spine and V-shaped hair fringe.

Thorax. – Thorax brown and black, dorsal mesanepisternal stripes elongate and nearly parallel sided, thoracic dorsum not coarsely granulate, mesanepimeral yellow stripes without ventral black border and slightly constricted or parallel sided, metanepimeral stripes straight and nearly parallel sided.

Wings. – Wings with 4-5 red costal blotches, basal blotch often reduced to basal brown area, fore wings without blotch at base of distal pleat, wings without blotch between nodus and pterostigmata, pterostigmal red blotch centered at proximal end of pterostigmata, brace vein near proximal end of pterostigma, pterostigmata red, triangles 1-3 celled, subtriangles 1 celled, anal brace originates near or distal to Cu-A crossvein, male hind wing margin concave distal to tornus, membranule vestigial.

Abdomen. – Abdominal markings bluish green or yellow, dorsal postantecostal spots in line with basal stripes, dorsal abdominal stripes 3-6 separated by at least 1/2 width of stripe, female abdominal terga more than twice as long as high, female auricles obsolete, abdomen with lateral flanges on abdominal terga 7 and 8, male

epiproct longer than wide; male epiproctal shelf shorter than wide, with apical margin convex, male cerci inflated beyond base.

G e n i t a l i a. – Posterior hamuli boomerang-like, directed anteroventrally and with apices directed ventromedially, penile receiver strongly bilobate and higher than genital lobes, posteriorly with wide U-shaped notch.

KEY TO THE SUBGENERA AND SPECIES OF *EURYPETALIA*

1 Antefrons with posterior surface strongly tumose, in female produced to within ca 1/2 length of ocelli from medial ocellus, male antefrontal carinae yellow; occiput rounded-transverse, highest posterodorsally, without medial fringe of dark setae overlying anterior blond tuft; wing blotches vestigial, male first postnodal cell less than 1/3 red, female without small brown blotches on subcostal crossveins; male cerci gradually inflated ventrally to near midlength to about 1.4 times basal width; male epiproctal shelf less than 1/2 as long as wide; female dorsal abdominal stripes separated by less than width; female abdominal segment 2 with lateral yellow stripe ca 3/4 length. Measurements: total length ♂ 58.5-65.0 mm, ♀ 65.5 mm; abdominal length ♂ 45.0-50.5 mm, ♀ 50.0 mm; hind wing ♂ 34.0-37.0 mm, ♀ 42.0 mm..... (***Eurypetalia*** subgen.n) ***altarensis*** sp.n. **Holotype** ♂: Chile: Santiago Prov. – Cordillera Santiago near Estero de Yerba loca (La Leonera), 4-XI-1995, FLC leg., USNM. **Allotype** ♀: same locality, 4-XI-1995, FLC leg., FLC. **Paratypes**: Santiago Prov. – 4 ♂, same locality, 1-XI-1995, FLC leg., FLC; 8 ♂, 4-XI-1995, FLC, A. Ugarte, & H. Navarrete leg., FLC; 1 ♂, 14-XI-1995, FLC leg., FLC; 2 ♂, Cordillera Santiago near Yerba loca, XI-1988, R. Perez De Arce F. leg., LEP and MNHS; 1 ♂, El Canelo, 3-X-1970, G. Barria leg., LEP; 1 ♂, Las Condes, 25-X-1948, collector unknown, MNHS; 1 ♀ (abdomen missing), locality, date and collector unknown, MNHS.
F l i g h t s e a s o n: 3-X-1970, El Canelo, G. Barria leg. to 14-XI-1995, Yerba loca, FLC leg.
Antefrons with posterior surface slightly tumose, in female produced to within ca. length of ocelli from medial ocellus, male anterfrontal carinae at most tinted with yellow laterally; occiput produced anteriorly into raised V-shaped elevation, with medial fringe of dark setae overlying anterior blond tuft; wing blotches well developed, male first postnodal cell more than 2/3 red, female with small brown blotches on subcostal crossveins; male cerci abruptly inflated ventrally near midlength to about twice basal width; male epiproctal shelf more than 1/2 as long as wide; female dorsal abdominal stripes separated by more than width; female abdominal segment 2 with lateral yellow stripe full length. Measurements: total length ♂ 61.0-64.0 mm, ♀ 57.0-63.0 mm; abdominal length ♂ 46.0-50.0 mm, ♀ 44.0-50.0 mm; hind wing ♂ 35.0-37.0 mm, ♀ 38.0-41.0 mm (***Crenopetalia*** subgen. n.) Type species: ***E. excrescens*** sp.n.
Holotype ♂: Chile: Curicó Prov. – Las Tables near Puente Los Morongos, 10-XII-1993, C.M. & O.S. Flint, Jr. leg., USNM; **Allotype** ♀: same locality, 5-XI-1995, FLC & H. Navarrete leg., FLC. **Paratypes**: 1 ♂, same as for holotype; 1 ♂, same locality, 11-XII-1993, A. Ugarte leg., FLC; 1 ♀, same as for allotype; Curicó prov. – 2 ♂, El Coigo at Quebrada Honda, XII-1959, L.E. Peña leg., FLC; 1 ♂, El Coigo at Quabrada Honda, X-XI-1959, M. Rivera leg., FLC; Linares prov. – 1 ♀, Cordillera Parral near Villega, 8-XII-1960, L.E. Peña leg., FLC; 1 ♀, Cordillera Parral near Las Cruces, X-1958, M. Rivera leg., FLC; Santiago Prov.? – 1 ♀, Cordillera Santiago near Yerba loca?, XII-1988, R. Perez De Arce F. leg., MNHS; Talca Prov. – 1 ♀, Cordillera de Talca near Vilches, 7-XII-1986, R. Perez De Arce F. leg., MNHS. Material not studied but referable to *E. excrescens* sp.n. includes: O"Higgins – 1 ♀, Rancagua, 14-X-1901, O. Schonemann leg., Berlin Museum (SCHMIDT, 1941).
F l i g h t s e a s o n: 14-X-1901, Rancagua, O. Schonemann leg. to 11-XII-1993, Las Tables, A. Ugarte leg.

KEY TO THE SPECIES OF *OPHIOPETALIA*

1 Antefrons brown dorsally, laterally ca 1/2 length of postclypeus; median distance between antefrontal carinae and postfrontal suture ca 1/3 width of antefrons; abdominal terga 3-6 laterally golden brown posterior to antecostal suture; male cerci without medioventral subbasal lobe, cercal length ca 1.2 times distance between apices of epiproctal rami; epiproctal shelf ca 3/10 as long as wide. Measurements: total length ♂ 67.0 mm; abdominal length ♂ 50.0 mm; hind wing ♂ 39.0 mm ..... ***auregaster*** sp.n.
Holotype ♂: Chile: Santiago Prov. – Cordillera Santiago near Estero de Yerba loca, XII-1988, R. Perez De Arce F. leg., USNM.

– Antefrons black dorsally, laterally ca 7/10 length of postclypeus; medial distance between antefrontal carinae and postfrontal suture ca 2/5 width of antefrons; abdominal terga 3-6 laterally dark brown or black posterior to antecostal suture (females also with vestigial stripe); male cerci with medioventral subbasal lobe, cercal length ca 1.4 times distance between apices of epiproctal rami; epiproctal shelf 2/5-3/5 as long as wide 2

2 Hind wing triangle with anterior side 1.1-1.3 times length of proximal side; blotch at distal costal brace nearly as large as that at pterostigmal brace vein, male with small brown blotch at proximal costal braces, female with small blotches on subcostal antenodals; male with flange of abdominal terga 8 full length, that of 7 extended anterior to antecostal suture, female with flange of abdominal tergum 7 ca 0.5 width that of 8; male with paired submedial stripes of abdominal tergum 2 full length, wider than submedial stripes of tergum 3, female abdominal terga 3-7 with posterior stripes extended to posterior carina, here as wide as anterior stripes; male cerci with ventrobasal ridge extended posteriorly to form rounded basal angulation. Measurements: total length ♂ 66.0--72.0 mm; abdominal length ♂ 51.0-56.0 mm, ♀ 49.5-50.5 mm; hind wing ♂ 37.0-40.0 mm, ♀ 41.5-43.5 mm ..... ***pudu*** (Dunkle)
Distribution: Chile: Biobio Prov. – Troyo; Malleco Prov. – Manzanar; Cordillera de Clillan at Las Trancas (DUNKLE, 1985).
Flight season: XI-1979, Manzanar, A. Ugarte & L.E. Peña leg. to 20-XII-1994, Troyo, H. Navarrete leg.

– Hind wing triangle with anterior side 1.3-1.5 times length of proximal side; blotch at distal costal brace distinctly smaller than blotch at pterostigmal brace vein, male without small brown blotch at proximal costal braces, female without or with vestigial small blotches on subcostal antenodals; male with flange of abdominal terga 8 not full length, that of 7 not extended anterior to antecostal suture, female with flange of abdominal tergum 7 0.6-0.9 width that of 8; paired submedial stripes of male abdominal tergum 2 at most 2/3 length, narrower than submedial stripes of tergum 3, female abdominal terga 3-7 with posterior stripes vestigial, not extended to posterior carina; male cerci with ventrobasal ridge ended at angulation to form pointed lobe 3

3 Dorsal mesanepisternal stripes 6 times as long as wide, lateral mesanepisternal stripes vestigial or absent; anterior face of antefrons ca 1/3 as high as wide; blotch at distal costal brace red, female with forewing pterostigmata ca. 3 mm long; dorsal abdominal stripes light green; male with paired submedial stripes on tergum 2 posterior to antecostal suture; male with flange of abdominal tergum 8 developed along 9/10 of acrotergite, female with flange of abdominal terga 7 and 8 subequal in width; male cerci with dorsomedial profile somewhat arrowheadlike with pointed apex, divergent sides, and basal slope set at about 70° to dorsal carinae; male cerci with wide trough between ventral carinae and basal lobe. Measurements: total length ♂ 69.0-74.0 mm, ♀ 68.0 mm; abdominal length ♂ 53.0-57.0 mm, ♀ 53.0 mm; hind wing ♂ 40.0-42.0 mm, ♀ 43.0 mm. ..... ***araucana*** sp.n.
Holotype ♂: Chile: Malleco Prov. – Cordillera Nahuelbuta near Piedra del Aguila, 11-XI-1995, FLC leg., USNM. **Allotype** ♀: Same locality as for holotype, 17-XII-1993, C.M. & O.S. Flint, Jr. leg., USNM. **Paratypes**: 1 ♂, Same locality and date as for allotype, C.M. & O.S. Flint, Jr. leg.,

USNM; 4 ♂, same locality and date as for allotype, A. Ugarte leg., FLC; 7 ♂, 19-XII-1994, A. Ugarte leg., FLC & LEP; 1 ♂, 11-XI-1995, H. Navarrete leg., FLC.
Flight season: 11-XI-1995, Nahuelbuta, FLC and H. Navarrete leg. to 19-XII-1994 A. Ugarte leg.

– Dorsal mesanepisternal stripes 3-4 times as long as wide, lateral mesanepisternal stripes represented by large dorsal oval spot ca 1/2 length of dorsal stripe; anterior face of antefrons ca 2/5 as high as wide; blotch at distal costal brace brown, female with forewing pterostigmata ca. 4 mm long; dorsal abdominal stripes yellow; male without paired submedial stripes on tergum 2 posterior to antecostal suture; abdominal tergum 8 of male with flange developed along 1/2 of acrotergite, female with flange of abdominal tergum 7 ca 0.6 width that of 8; male cerci with dorsomedial profile somewhat bulletlike with rounded apex, subparallel sides, and basal slope set at about 90° to dorsal carinae; male cerci with narrow trough between ventral carinae and basal lobe. Measurements: total length ♂ 62.0-69.0 mm, ♀ 60.0-67.0 mm; abdominal length ♂ 48.0-54.0 mm, ♀ 46.0-51.0 mm; hind wing ♂ 37.0-39.0 mm, ♀ 39.0-42.0 mm ..... ***diana*** sp.n.
Holotype ♂: Chile: Osorno Prov. – Small valley ca 10 km along road from Rio Nauto to Antillanca, 27-XII-1992, F.L. Carle leg., USNM. **Allotype** ♀: Same as for holotype. **Paratypes**: Argentina: Neuquén Prov. – 1 ♂, 1 ♀, stream along north side of Lago Lolog 19 km north of San Martin de Los Andes, 3-I-1994, C.M. & O.S. Flint, Jr leg., USNM; Chile: Osorno Prov. – 3 ♂, 1 ♀, same as for holotype, FLC; 1 ♂, 1 ♀, same locality, 5-XI-1992, L.E. Peña & A. Ugarte leg., FLC; 2 ♂, 1 ♀, same locality, 14-XI-1992, L.E. Peña & A. Ugarte leg., FLC; 9 ♂, 4 ♀, same locality, 15-XI-1992, L.E. Peña & A. Ugarte leg., FLC; 31 ♂, 2 ♀, same locality, 10-XII-1994, L.E. Peña & A. Ugarte leg., FLC and LEP; 25 ♂, 1 ♀, same locality, 15-XII-1994, L.E. Peña & A. Ugarte leg., FLC & LEP; 1 ♀, near same locality, 7/8-II-1978, O.S. Flint, Jr leg., USNM, (a paratype of *P. pudu*); Lianquihue Prov. – 2 ♂, Raúlin, 10-XI-1992, L.E. Peña & A. Ugarte leg., FLC. Material not studied but referable to *O. diana* sp.n. includes: Valdivia Prov. – 1 ♂, Pucura, I-1978, collector unknown, Carl Cook Collection, Center Kentucky, (a paratype of *P. pudu*).
Flight season: 5-XI-1992, Antillanca, L.E. Peña & A. Ugarte leg. to 7-II-1978, Antillanca, O.S. Flint, Jr leg.

PHYLOGENY AND BIOGEOGRAPHY

Monophyly for Aeshnidae is supported by diverse congruent neapomorphy, but the situation in Austropetaliidae is different suggesting that the group may be paraphyletic. Aeshnid neapomorphy includes dorsal development of the compound eyes, development of the anal loop, and medial planate, elongation of the forewing triangle, extensive development of lateral abdominal carinae, loss of prepuce and formation of swablike apical penile lobe and other correlated modifications of the male secondary genitalia, apical widening of the larval labium, and attenuation of larval terminalia into an organ apparently used as a predator deterrent. Apparent congruent neapomorphy of austropetaliids involves the costal wing blotches and various aspects of the larvae including distally widened labrum, strongly developed ventral occipital ridges, excrescent femora, prominent lateral abdominal lobes, and granulate cuticular texture. Although the major austropetaliid groups are allopatric, the wing blotches may be involved in warning coloration or mimicry, (note similar patterns in the unrelated *Neopetalia*). In addition larval specializations may represent correlated adaptations to lotic environments, note that lotic adaptations in larval *Epiophlebia* are quite similar.

Austropetaliid phylogeny is depicted in Table I; suspected coapomorphy has been combined with listed exapomorphy or neapomorphy or deleted altogether. Because Aeshnidae and Austropetaliidae are normally considered sister groups, plesiotypic aeshnids such as *Gomphaeschna* or *Allopetalia* have not been included in the table. However, if costal blotches and larval modifications to the lotic environment are considered to have been originally present and now lost in Aeshnidae, Austropetaliidae could be considered paraphyletic, note that a simple change from lotic to lentic habitats could account for such losses. Assuming these losses and comparing aeshnid morphology to Table I, suggests the necessity to recognize four extant aeshnoid families, i.e. the Tasmanian Archipetaliidae, the Chilean Eurypetaliidae (Hypopetaliinae and Eurypetaliinae), the Australian Austropetaliidae, and the cosmopolitan Aeshnidae. Aeshnidae shares neapomorphies 1'a, 1'c, and 1'd, with non-Tasmanian austropetaliids; but lacks neapomorphies 2'a, and 2'b, of Chilean austropetaliids (aeshnids also lack neapomorphies 3'a, 3'b, 3'c, and 3'e of Eurypetaliinae). However, the presence of at least rudimentary lateral carinae in female Austropetaliidae and Aeshnidae (neapomorphy 2b), indicates that these groups may form a monophyletic group. Therefore the evolutionary branching sequence may be Archipetaliidae → Eurypetaliidae → Austropetaliidae → Aeshnidae. Although *Austropetalia* has only rudimentary lateral abdominal carinae on abdominal segments 3-7 of the female and on segment 3 of the male it is perhaps the first stage of abdominal strengthening as seen in Aeshnidae. Greater initial female development of abdominal carinae suggests a function related to oviposition, and not one related to tandem flight or copulation. This would also explain the highly derived male secondary genitalia of Aeshnidae which accommodated the greatly strengthened female abdomen and ovipositor. However, dramatic taxonomic revision is not warranted without additional evidence, especially in light of the anagenetic or "evolutionary" taxonomy preferred by some odonatologists and exemplified by continued recognition of apophyletic groups such as the Anactinae of FRASER (1957), and WALKER (1958).

Austropetaliid phylogeny as revealed by the sorted data matrix is characterized by abundant congruent neapomorphy and very little contradictory evidence. The matrix forms a pectinate topology with only three bifurcating side branches, these comprise *Austropetalia* with two species, Rheopetaliini with three species, and *Eurypetalia* with two species. Although *Austropetalia* shares abdominal carinae with all Aeshnidae, and pea green dorsal abdominal stripes with some Aeshnidae, other listed neapomorphy is unique and support its monophyly, i.e. distal placement of the costal brace, and the elongate male epiproctal shelf. Two characters seem to support paraphyly for Rheopetaliini, but variation between and within groups is so great that these characters are for now not considered in the analysis. These characters are the only slightly distally placed pterostigmal brace and slightly elevated frons of *Odontopetalia* which parallel similar developments in Eurypetaliini. In *Odontopetalia* the pterostigmal brace may be positioned as in *Rheopetalia* sug-

Table I

Sorted character state matrix for austropetaliid genera; – HA = *Hagenius*, – TA = *Tachopteryx*, – – OD = *Odontopetalia*, – EU = *Eurypetalia*, – OP = *Ophiopetalia*, – PH = *Phyllopetalia*

Couplet and apomorphy
1a Antefrons brown with dorsal yellow stripe
1b Dorsal mesanepisternal stripes obtuse triangular
1c Lateral thoracic stripes yellowish white
1d Metanepimeral stripe curvate
1e Wings with 7-8 brown costal blotches
1f Female abdominal terga less than twice as long as high
1a' Compound eyes nearly contiguous
1b' Wings with 4-7 red costal blotches
1c' Male epiproct longer than wide
1d' Female with lateral carinae or flange on abdominal tergum 7
2a Dorsal abdominal stripes pea green
2b Rudimentary lateral abdominal carinae on female segments 3-7 and on male segment 3
2c Brace vein located near proximal third of pterostigma
2d Male apical epiproctal shelf longer than wide
2a' Face with marginal hair fringe
2b' Lateral ocelli separated less than width of median ocellus
2c' Abdominal terga 7 and 8 with carinae or flange
2d' Male epiproctal apex convex medially
2e' Female auricles obsolete
3a Occiput transverse ridgelike with dorsal spine
3b Labrum, postclypeus, and antefrons light brown
3c Thorax gray, abdomen brown, both with white spots
3d Subtriangles 2-3 celled
3e Wings with red blotch at base of distal pleat
3f Brace vein proximal to pterostigmata
3g Pterostigmata yellow
3h Male abdominal tergum 2 higher than long
3i Abdomen laterally compressed, with middorsal carinae on abdominal terga 3-7
3a' Lateral ocelli nearly touching compound eyes
3b' Abdominal tergum 8 with lateral flanges
3c' Penile receiver bilobate with wide posterior notch
3d' Posterior hamuli with apices directed slightly médially
3e' Male cerci ventrally inflated beyond base
3f' Red blotch between nodus and pterostigmata obsolete
4a Lateral thoracic stripes ventrally bordered with black
4b Mesepimeral stripes distinctly constricted above middle
4c Submedian abdominal stripes 3-6 narrowly separated
4d Male cerci with subapical medial inflation
5a Dorsal mesanepisternal stripes spindle shaped
5b Abdominal tergum 7 with carinae and 8 with flanges
5c Male epiproctal length ca 3 times width at rami
5a' Occipital hair fringe coppery orange
5b' Abdominal terga 3-7 predominently brownish yellow
5c' Male cerci with large medial tooth

Table I

– ZO = *Zoraena*, – AR = *Archipetalia*, – AU = *Austropetalia*, – HY = *Hypopetalia*, – RH = *Rheopetalia*,

Location	HA	TA	ZO	AR	AU	HY	RH	OD	EU	OP	PH
1a Head	–	–	–	N	–	–	–	–	–	–	–
1b Thorax	–	–	–	N	–	–	–	–	–	–	–
1c Thorax	–	–	–	N	–	–	–	–	–	–	–
1d Thorax	–	–	–	N	–	–	–	–	–	–	–
1e Wings	–	–	–	N	–	–	–	–	–	–	–
1f Female abdomen	–	–	–	N	–	–	–	–	–	–	–
1a' Head	–	–	–	–	N	N	N	N	N	N	N
1b' Wings	–	–	–	–	N	N	N	N	N	N	N
1c' Male terminalia	–	–	–	–	N	N	N	N	N	N	N
1d' Female abdomen	–	–	–	–	N	N	N	N	N	N	N
2a Abdomen	–	–	–	–	N	–	–	–	–	–	–
2b Abdomen	–	–	–	–	N	–	–	–	–	–	–
2c Wings	–	–	–	–	N	–	–	–	–	–	–
2d Male terminalia	–	–	–	–	N	–	–	–	–	–	–
2a' Head	–	–	–	–	–	N	N	N	N	N	N
2b' Head	–	–	–	–	–	N	N	N	N	N	N
2c' Abdomen	–	–	–	–	–	N	N	N	N	N	N
2d' Male terminalia	–	–	–	–	–	N	N	N	N	N	N
2e' Female abdomen	–	–	–	–	–	X	X	X	X	X	X
3a Head	–	–	–	–	–	N	–	–	–	–	–
3b Head	–	–	–	–	–	N	–	–	–	–	–
3c Thorax and abdomen	–	–	–	–	–	N	–	–	–	–	–
3d Wings	–	–	–	–	–	N	–	–	–	–	–
3e Wings	–	–	–	–	–	N	–	–	–	–	–
3f Wings	–	–	–	–	–	N	–	–	–	–	–
3g Wings	–	–	–	–	–	N	–	–	–	–	–
3h Male abdomen	–	–	–	–	–	N	–	–	–	–	–
3i Abdomen	–	–	–	–	–	N	–	–	–	–	–
3a' Head	–	–	–	–	–	–	N	N	N	N	N
3b' Abdomen	–	–	–	–	–	–	N	N	N	N	N
3c' Male genitalia	–	–	–	–	–	–	N	N	N	N	N
3d' Male genitalia	–	–	–	–	–	–	N	N	N	N	N
3e' Male terminalia	–	–	–	–	–	–	N	N	N	N	N
3f' Wings	–	–	–	–	–	–	X	X	X	X	X
4a Thorax	–	–	–	–	–	–	N	N	–	–	–
4b Thorax	–	–	–	–	–	–	N	N	–	–	–
4c Abdomen	–	–	–	–	–	–	N	N	–	–	–
4d Male terminalia	–	–	–	–	–	–	N	N	–	–	–
5a Thorax	–	–	–	–	–	–	N	–	–	–	–
5b Abdomen	–	–	–	–	–	–	N	–	–	–	–
5c Male terminalia	–	–	–	–	–	–	N	–	–	–	–
5a' Head	–	–	–	–	–	–	–	N	–	–	–
5b' Abdomen	–	–	–	–	–	–	–	N	–	–	–
5c' Male terminalia	–	–	–	–	–	–	–	N	–	–	–

Table I, continued

Couplet and apomorphy
4a' Frons wider than and at least 1.3 times as high as clypeus
4b' Anal brace orginates near Cu-A crossvein
4c' Male hind wing margin concave distal to tornus
4d' Membranule vestigial
6a Thoracic and abdominal dorsal stripes bluish green
6b Flanges of tergum 7 extended beyond segment
6c Basal costal blotches wine red, basal brown obsolete
6a' Occiput tripartite ridgelike with anterodorsal spine
6b' Male cerci with ventral spinelike keel
6c' Male basal costal blotches reduced to basal brown
7a Anterior surface of antefrons with dorsal yellow band
7b With postoccipital horns
7c Male cerci bootlike
7b Male and female basal costal blotches vestigial brown
7a' Antefrons black with frontal carinae narrowly yellow
7b' Flanges of abdominal tergum 7 wider than those of 8
7c' Male cerci stalklike in basal half

gesting that it is not as firmly locked to the proximal end of the pterostigmata as in Eurypetaliini, and the frons is not as elevated as in several diverse groups such as *Austropetalia, Neallogaster, Neopetalia*, and *Chloropetalia* suggesting a high probability of parallel development. Such characters are typically utilized in trend or multistate analysis and only serve to cloud genuine neapomorphy in a blizzard of phenetic noise and make-believe character transitions. The triangular-raised occiput of *E. excrescens* sp.n. is similar to that of *Phyllopetalia* and *Ophiopetalia* except that it lacks the dorsal spine, suggesting that *Eurypetalia* may be paraphyletic. Because *Eurypetalia* is characterized by neapomorphies 6a, 6b, and 6c, the raised triangular occiput is for now considered to be lost in *E. altarensis* sp.n.

Antarctica has served as both dispersal route and geographical barrier in early aeshnoid evolution. Early aeshnoids had evidently entered southern Gondwana via the trans-pangaeian mountain system at least 180 million years ago, with subsequent vicariance isolating successive steps of early aeshnoid evolution on alternating sides of Antarctica as follows: Tasmania-*Archepetalia* → Chile-*Hypopetalia* and Eurypetaliini → Australia-*Austropetalia* → America-*Gomphaeschna* and *Allopetalia*. Additional austropetaliid speciation on the Australian side is limited to the derivation of *A. patricia* from northern populations of *A. victoria* sp.n., a somewhat similar speciation pattern is exemplified in the *Austrogomphus angeli* Tillyard - *A. amphiclitus* (Selys) species pair.

However, austropetaliid evolution on the American side led to a significant adaptive radiation. Phyletic splitting was induced by a fluctuation between wet and dry climates in conjunction with varied geography. The most significant biogeographi-

Table I, continued

Location	HA	TA	ZO	AR	AU	HY	RH	OD	EU	OP	PH
4a' Head	–	–	–	–	–	–	–	–	N	N	N
4b' Male wings	–	–	–	–	–	–	–	–	N	N	N
4c' Male wings	–	–	–	–	–	–	–	–	N	N	N
4d' Wings	–	–	–	–	–	–	–	–	X	X	X
6a Thorax and abdomen	–	–	–	–	–	–	–	–	N	–	–
6b Abdomen	–	–	–	–	–	–	–	–	N	–	–
6c Wings	–	–	–	–	–	–	X	–	X	–	–
6a' Head	–	–	–	–	–	–	–	–	–	N	N
6b' Male terminalia	–	–	–	–	–	–	–	–	–	N	N
6c' Male wings	–	–	–	–	–	–	–	–	–	X	X
7a Head	–	–	–	–	–	–	–	–	–	N	–
7b Head	–	–	–	–	–	–	–	–	–	N	–
7c Male terminalia	–	–	–	–	–	–	–	–	–	N	–
7b Wings	–	–	–	–	–	–	–	–	–	X	–
7a' Head	–	–	–	–	–	–	–	–	–	–	N
7b' Abdomen	–	–	–	–	–	–	–	–	–	–	N
7c' Male terminalia	–	–	–	–	–	–	–	–	–	–	N

cal barrier influencing the evolution of South American austropetalids is the Biobio river valley, it is apparently an old river with its axis parallel to the Paleozoic Pampean-cape mountains as opposed to the smaller younger rivers which run more perpendicular to the Andes. The lower river valley divides the Cordillera Nahuelbuta from the coastal range to the north, and the upper river valley turns southward cutting deeply into the Andes leaving much of the upper river valley in a partial rain shadow, thus interrupting the continuous line of suitable austropetaliid habitats along the western slope of the Andes. This habitat break is accentuated for austropetaliids because the Biobio valley faces north and is therefore deprived of late season snow melt which maintains the permanent seepage areas necessary for austropetaliid survival. A similar barrier involves the upper Maipo River valley south of Santiago, in this instance the rain shadow affect is amplified by the westerly location of the highest section of the cost range. A second type of barrier, the central valley, trends north-south from the gulf of Ancud, across the River Biobio, north to Santiago; it is dryer than the surrounding mountains and of limited suitability for austropetalids especially in the north. To the north of Rancagua austropetaliid habits are constrained along the Andes in a narrow elevational band between lower semiarid and higher tundralike conditions; this tenuous thread of habitat is variously nurtured by snow fields and cut by steep valleys and rain shadows.

Primary phyletic splitting of Chilean austropetalids apparently occurred in a north--south direction and can be summarized as follows: Hypopetaliini +→ Rheopetaliini → Eurypetaliini. Hypopetaliini is an aberrant ancient derivative of the Tasma-

nian Archipetalini which formed the base of the South American austropetaliid radiation, isolated populations north of the Biobio gave rise to the Rheopetaliini which in turn gave rise to Eurypetaliini in the northern Andean region, note that the "+" represents the river Biobio and that south will be represented to the left. Although Hypopetaliini has subsequently reinvaded the north, additional splitting has not occurred due to a tolerance for large stream habitats and high vagility. Evolution of Rheopetaliini is more complex, but can be summarized as follows: *Odontopetalia* ←+ *Rheopetalia rex* sp.n. → *R. apicalis*. *Odontopetalia* was originally isolated south of the Biobio but has afterward reinvaded the north both along the Andes and along the coastal range. *Rheopetalia apicalis* is a northern isolate of *R. rex* sp.n. which is now sympatric with *R. rex* sp.n. from Rancagua to Curico. However, an isolated and nearly extinct population at C° del Roble is somewhat intermediate suggesting that *Rheopetalia* had originally spread to the northern Andean region by utilizing the cost range in circumventing the barrier of the upper Maipo River valley. *R. rex* sp.n. has also subsequently reinvaded southward along the Cordillera Nahuelbuta. Eurypetaliini originated in the marginal isolated Andean habitats north of Rancagua and are adapted to very small lotic situations; this has dramatically increased the rate of phyletic splitting. Although more complicated than in related groups eurypetaliine evolution at the generic level can be summarized as follows: *Phyllopetalia*←+ *Eurypetalia*, and *Phyllopetalia* +→ *Ophiopetalia*. The Biobio river valley is responsible for much of the phyletic splitting in Eurypetaliini. *Phyllopetalia* is apparently a southern isolate of *Eurypetalia* and although it occurs along the Andes from Lonquimay to Chaiten and from the Cordillera Nahuelbuta to Chiloe Island, it apparently does not occur north of the Biobio. *Ophiopetalia* is in turn derived from a northern isolate of *Phyllopetalia*. Speciation within *Ophiopetalia* has occurred along a southward track and can be expressed as follows: *O. auregaster* sp.n.→ *O. pudu* +→ *O. araucana* sp.n.→ *O. diana* sp.n. Only two *Ophiopetalia* adults are known from north of the Biobio, each of a different Andean species, so that we can only speculate that speciation was related to a geographical barrier near the Rio Maipo. The most recently derived *Ophiopetalia* are limited to south of the Biobio. *O. diana* sp.n. is the most widespread *Ophiopetalia* with its distribution extended along the Andes south of the Biobio from Pucura to Llanquihue; both *O. diana* sp.n. and *P. stictica* enter Argentina at the latitude of Valdivia. *O. araucana* sp.n. is a coastal isolate of *O. diana* sp.n., it is apparently restricted to the Cordillera Nahuelbuta.

BIOLOGY

Remote unusual habitats and secretive behaviors have insured that information about austropetaliid biology would accumulate slowly. Although males of two austropetaliid species had been described as early as 1857 by De Selys, austropetaliid larvae were not known until 9-XI-1908, when Keith Brown discovered an exuviae

beside a cascade along Leura Creek, the adult of which Tillyard would later describe as *Austropetalia patricia* (TILLYARD, 1910, 1916). Tillyard believed the larva to be "... apparently a liver amongst débris and trash on the bottom of the swift mountain-creeks", and although Tillyard carefully dredged along Leura creek on several occasions he did not find either larva or adult in this habitat. Eventually TILLYARD (1926) discovered austropetaliid larvae clinging to the faces of waterfalls and FRASER (1960) reiterated that the larvae were found beneath waterfalls clinging to the rock-face. The larvae of *Hypopetalia pestilens* and *Phylopetalia stictica* were described by SCHMIDT (1940), but no information on larval habitat was included. Additional information on larval habitat can be inferred from published accounts of adult behavior which indicate that habitats range from small rivulets (TILLYARD, 1917a) to small rivers (JURZITZA, 1989), and possibly ponds (NEEDHAM & BULLOCK, 1943).

My experiences in collecting Chilean austropetaliid larvae indicate that preferred habitats are primarily small streams, waterfall splash zones, and small spring fed rivulets. Rheophylic stream species include *Hypopetalia, Rheopetalia,* and *Odontopetalia.* The streamlined larvae of *Hypopetalia* have been found in rapid streams and rivers 1-4 meters wide where population densities are typically low. However, 7 larvae have been collected from a submerged accumulation of bark and sticks at the sheltered downstream side of a large log jam; the larvae were of 5 size classes suggesting a larval life stage of 6-7 years. *Rheopetalia* larvae are often found clinging to the underside of submerged rocks or logs, and although both *Hypopetalia* and *Rheopetalia* have been found in streams up to 3 meters wide, at least *Rheopetalia* is far more common in streams less than one meter wide where population densities as high as 20 larvae per square meter have been discovered. *Odontopetalia* are typically found clinging to the underside of submerged logs in streams 30-100 cm wide, but on two occasions a larvae was found half submerged on the downstream side of a rock. About 25 *Eurypetalia* larvae have been collected and from these it is apparent that the group is semi-terrestrial. *Eurypetalia* larvae are even more extensively warty than *Phyllopetalia* larvae and are probably the most grotesque of all larval Odonata. Small *Eurypetalia* larvae are typically found clinging to the underside of damp rocks and sticks along tiny rivulets. A nearly full grown larva was found clinging to the underside of a damp log located ca 30 cm from a small spring and an exuviae was also found nearby. *Phyllopetalia* larvae are typically found about small waterfalls where they cling to the underside of damp rocks and logs, associated streams are typically less than 1 m wide. *Ophiopetalia* are typically found in streams less than 50 cm wide, larvae are found under rocks and logs and are typically wet or submerged. When handled larvae of rheophylic groups undertake a strong lengthwise compression into a slightly C-shaped configuration with legs held tight to the body; this protective posture may continue for several minutes after disturbance has ceased. Semiterrestrial larvae undergo a less pronounced compression, but are all characterized by a much greater development of the lateral

abdominal lobes which mimic the serrate outline of small detrital *Nothofagus* leaves found scattered about their larval haunts.

Most published information on adult austropetaliid biology is related to adult feeding behavior or male territoriality where males are observed perching near or patrolling along suitable oviposition areas. TILLYARD (1917a) collected several *Archipetalia* near small rivulets running through marshes at 900-1200 meters elevation along the base and slopes of Cradle Mountain. WATSON (1991) summarized the habitat of *Archipetalia* as streams and boggy seepages. Detailed information is reported by MOORE (1992), "In December 1987 I observed this species by rivulets in open country near Cradle Mountain. It was much less active [than *Hypopetalia*] and spent much of the time by it's breeding habitat perched on the ground." Horizontal perching is apparently unique to *Archipetalia* among Aeshnoidea, being a plesiotypic behavior of Zygoptera and Gomphidae. Although transitional stages between ground stationed and patrolled male territories are evident in other groups (e.g. vertical tree trunk perching in Tachopteryginae and *Gomphaeschna*, and oblique stem perching in Petalurinae and *Zoraena*), such intermediate behaviors are not known in austropetaliids with the possible exception of *Austropetalia*.

Austropetalia breeds in swift mountain streams in the vicinity of cascades (FRASER, 1933), and although information on oviposition and male search flight is not known, the majority of mature adults have been captured near waterfalls indicating that these behaviors occur near these sites. Feeding behavior may explain the slow flight above open plateaus observed by TILLYARD (1910), and slow flight in the forest from 05300-0700 where they dropped nearly to the ground before rising to a perch on the twigs or leaves of bushes (TILLYARD, 1916). However, WATSON et al. (1991) identify waterfall splash zones and *Sphagnum* swamps as preferred habitats, suggesting a much wider niche. Variable habitat preference may be related to specific differences, with the long metagonostyli of *A. victoria* sp.n. adapted for oviposition in plant stems, and the shorter styli of *A. patricia* modified for oviposition in liverworts, etc.

Hypopetalia is undoubtedly among the most bizarre dragonflies known and predictably some of it's behaviors are equally unusual. PEÑA (1954) characterized its habitat in Central Chile as forested valleys at 600-800 meters where it flies along rivers from 1000-1500. Apparent search flight was described by JURZITZA (1989), in which males were observed to fly low while following the shore lines of small foothill rivers. A single male was observed patrolling along a 2-3 meter wide stream from 1328-1402 (MOORE, 1992), it flew up and down 5 meters of stream at about 30 cm above the water surface constantly without stopping to perch. Moore noted that it appeared to feed on flying and perching insects, and "Twice it chased an aeshnid dragonfly vigorously, and once flew at a passing bird." A fearless nature and preference for large prey is also supported by my observations. On one occasion a feeding swarm of over one hundred *Aeshna* rapidly dispersed after being atacked by a few *Phenes* and a *Hypopetalia*. On another occasion several male

Hypopetalia patrolled along a 1-2 meter wide stream at dusk and on into the moonlight from ca 1900-2100. These males rapidly patrolled a 10 meter section of stream while typically flying 5-10 cm above the water surface, they followed the shore line closely as if searching for ovipositing females, but would occasionally dart up to take flying insects. One male was netted after it had captured a male *Aeshna brevifrons* Hagen which also flew against a star filled sky, neither species was seen at this site during the day. During the day male *Hypopetalia* are most often observed patrolling up and down 10-20 meter stream sections typified by abundant moss covered rocks. Oviposition has been observed on one occasion at 1300, and as expected from the stout metagonostyli, is quite different from that of other austropetaliids. The female selected moss and liverwort covered rocks at the tail of a pool; the rocks were 20-30 cm in diameter and stuck up about 15 cm above the water. Eggs were laid from 2-4 cm above the water during which time the wings remained nearly still with the red blotches quite evident. A bird was attracted to this huge insect in the open, but only flitted from rock to rock nearby and did not attempt to eat the insect suggesting a possible warning coloration.

Rheopetaliini are perhaps the most day active austropetaliids. Carl Cook has described the flight of *Rheopetalia* over swift rivers as close to the water surface and as fast as in *Macromia* (DUNKLE, 1985), and JURZITZA (1989) also describes a low flight along forest brooks. I have observed several different flight patterns in *Rheopetalia* which include a high speed straight line *Macromia*-like flight at 1-2 meters above the ground which is used when in pursuit or when moving from one area to another. A slower feeding flight with pauses and frequent directional changes occurs at 0.3-1 meter above the surface along rivers, streams, and roadways; this flight pattern is similar to the search flight of *Pangeagaster* although it is more common toward dusk. Finally a moderate-speed search flight of males and females occurs along small streams at 10-30 cm above the water surface, this pattern is similar to the search flight of *Boyeria*. The flight of *R. rex* sp.n. averages higher than *R. apicalis* and the abdominal club is much more prominent making it perhaps the most impressive clubbed dragonfly in flight. Reopetaliid oviposition occurs along small streams and seeps where females have been observed to place their eggs in the stems of a soft stemmed herbaceous plant. *Odontopetalia* exhibits quite different flight patterns, feeding flight was first noted by Oliver Flint, Jr who collected *Odontopetalia* and *Phylopetalia* near Caramavida in the late afternoon as they fed on swarming Hymenoptera (DUNKLE, 1985). "The austropetaliids worked the lee side of 15-20 foot tall trees in an abandoned pasture" (Flint pers. comm.). I visited the same pasture later in the season, but only *Aeshna* were observed. However, a morning feeding flight of *Odontopetalia* was observed from 0800-0900 above a nearby stream valley; the dragonflies hovered from 5-15 meters above the steamy riffles, making only short maneuvers to capture prey. The low slow search flight of *Odontopetalia* along small forest streams was first reported by JURZITZA (1989), I have observed them to fly slowly over

small streams and seeps at 10-40 cm above the water surface. This flight is quite similar to the search flight of *Taeniogaster*, although *Odontopetalia* males seem to show particular interest in rotting logs, suggesting that wood may be the oviposition substrate.

Eurypetaliini are the most secretive austropetaliids. Although *Phylopetalia* is commonly collected in association with *Neopetalia* and *Odontopetalia*, published information on behavior includes only the feeding flight observed by Oliver Flint Jr and JURZITZA's (1989) statement that they fly slow along small forest streams. I have collected *Phylopetalia* over streams, forest roads, and in forest openings; the flight is typically fast and irregular at 1-3 meters above the ground. *Eurypetalia* are the most poorly known austropetaliids. I have observed a male *E. excrecens* sp.n. to momentarily hover 1-2 meters above a small stream at a road crossing, and other males of this species have been collected near dusk while flying along a stream at 0.5-1 meter above the water surface. Females have been captured while drinking (plunging into a riverine pool) after having oviposited in seeps high up on canyon walls. Male *E. altarensis* typically feed amid tree tops or low brush where they buzz flower heads to drive insect prey into flight. One male was captured while resting obliquely on a twig ca 6 meters above the ground. The allotype female was captured at 1530 while ovipositing in soft herbaceous plants at the head of a steep sloped seep. The type of *Ophiopetalia pudu* was collected while feeding in an open area at 4-8 meters above the ground (Peña pers. comm.). The majority of *Ophiopetalia* have been collected while flying in a slightly undulating fashion at 0.3-1.5 meters along forest roads near the upper end of small forested stream valleys. Oliver Flint, Jr has observed *O. araucana* sp.n. feeding flight at Nahuelbuta National Park, "They flew just off the top of the rock outcrop about 50 feet above our heads." This species was most often observed flying among 1-3 meter tall araucarias at the highest elevations from 1000-1530.

Austropetaliids are undoubtedly declining throughout their range due to introduced fish, grazing, deforestation, dams, water pollution, and the piping of springs for livestock and domestic use. However, only four species are possibly threatened, these are *E. altarensis* sp.n., *O. auregaster* sp.n., *O. pudu*, and *O. araucana* sp.n. *Eurypetalia altarensis* sp.n. and *O. auregaster* sp.n. are only known from Estera de Yerba Loca near Santiago at about 1900 meters elevation. Eurypetaliine populations in this area are apparently restricted to a narrow elevational band between tundra-like and semi arid regions where snow melt is sufficient to maintain isolated springs and spring seeps. North of Rancagua the construction of valley side channels for irrigation has led to the interception and eventual destruction of most austropetaliid habitats. *O. auregaster* sp.n. is known from a single male of uncertain origin and larvae of *E. altarensis* sp.n. are restricted to a small seepage slope near Estero de Yerba Loca. Regional threats include mining, grazing, recreational development, and the diversion of streams and springs for irrigation. *Ophiopetalia pudu* is known from three localities, but unfortunately the spring

brook at the type locality has been diverted into sixteen 2-3 inch polypropylene pipes for use at ski lodges and this population is now extinct. However, a few larvae have been discovered at a nearby seep and in a tiny stream across the valley. Unfortunately this stream was devoid of *Ophiopetalia* downstream from the road, as was a nearby stream in which construction debris had been dumped. *Ophiopetalia araucana* sp.n. is apparently restricted to high elevations along the isolated Cordillera Nahuelbuta, it is only known from the type locality where larvae have been discovered in two small streams which drain Piedra del Aguila. Just below the type locality an entire ancient araucaria forest has been cut down and laid to rot. *Archipetalia auriculata* is also rare and local in occurrence, but Norman Moore (pers. comm.) has indicated that a good number of populations are protected in Tasmanian National Parks. Populations of *Hypopetalia* and *Rheopetalia* seem to be more abundant above impassible falls indicating that introduced salmonid species may have suppressed rheophylic austropetaliid populations over large areas. Rheopetaliini larvae tend to be abundant in smaller streams, but a dramatic transition of benthic communities is observed as small streams enter pastured areas. Almost immediately rheopetaliine populations decline and simuliid (black fly) populations increase dramatically. Ironically, these declining austropetaliids may offer a partial solution to the black fly problem in boreal regions of the northern hemisphere, note that no lotic predator fills the austropetaliid niche in the Holarctic.

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