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ODONATA OF THE ARGENTINE YUNGAS CLOUD FOREST: DISTRIBUTION PATTERNS AND CONSERVATION STATUS

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Odon. of streams, small rivers and ponds were sampled in the Yungas cloud forest of NW Argentina, and presence / absence information of spp. from samples and from examination of collections was recorded in a spatial-relational data base. Alpha, beta, and gamma diversity and total species richness expected for the area were estimated. Similarity in composition of odon. communities from lotic and lentic environments were analyzed according to latitudinal and altitudinal gradients, using multivariate cluster analysis. Assemblages from NW Argentina were compared to those from equivalent sites in SE Peru. Odon. species diversity was found to follow both a latitudinal (decreasing from N to S) as an altitudinal gradient (decreasing from low to high elevations). Based on IUCN (2001) criteria, the conservation status of the odon. spp. endemic to the Yungas cloud forest was assessed at a global scale; 6 spp. were assessed as of Least Concern and 2 as Near Threatened.

INTRODUCTION

The Yungas cloud forest extends from Venezuela south into NW Argentina along the eastern slope of the Andean cordillera. Biogeographically it belongs to the Yungas province included in the neotropical region (CABRERA & WILLINK, 1973), and is encompassed in a large biodiversity hot-spot known as 'Tropical Andes' (MYERS et al., 2000). In Argentina it represents one of the most species-rich biogeographic provinces, and is distributed discontinuously along the Subandean chains within the provinces of Salta, Jujuy, Tucumán, and Catamarca (Fig. 1).

The knowledge of the odonates of the Argentine Yungas cloud forest has increased considerably during the last few years, with the number of recorded species increasing from 44 in 1999 (MUZÓN & VON ELLENRIEDER, 1999) to 102 in 2007 (VON ELLENRIEDER & GARRISON, 2007a; 2007b).

The goal of this study is to analyze the patterns of odonate diversity along latitudinal and altitudinal gradients within the Yungas cloud forest and assess the conservation status of its endemic species according to IUCN (2001) criteria.

STUDY AREA

The Yungas cloud forest extends in Argentina along an approximately 50 km wide strip between 22° to 28°40' S and 63° to 68° W (Fig. 1). Climate is warm and humid to sub-humid, and altitude as-

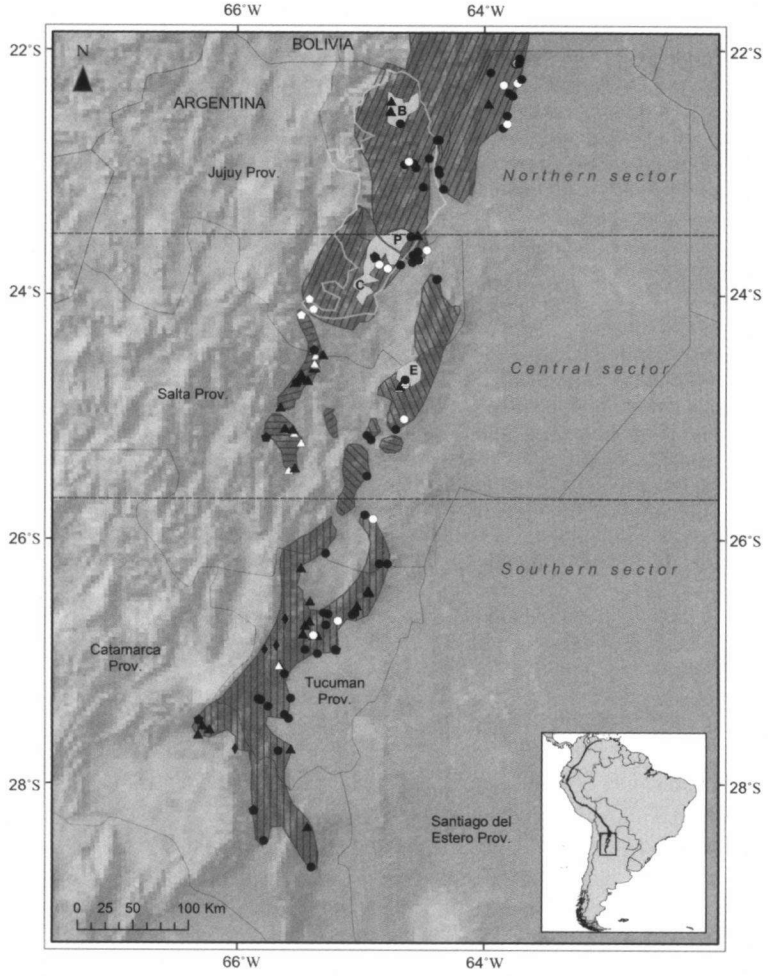

Fig. 1. Map of NW Argentina showing localities studied. Extension of Yungas cloud forest in South America is shown in black in inset map. Colours indicate type of environment, black: lotic; white: lentic, and shapes indicate vegetation zone, circles: foothill rain forest; triangles: mountain rain forest; pentagons: mountain forest; diamonds: highland grassland.

cends from 300 to 2400 m a.s.l. Temperature and humidity vary in relation to altitude, latitude, and slope exposure. Average yearly precipitation is about 900-1000 mm, reaching 1300 mm in some areas. The strong altitudinal gradient generates considerable climatic variations resulting in different plant communities or vegetation zones: foothill rain forest (ca. 300-900 m), warm and humid; mountain rain forest (ca. 900-1500 m), temperate-warm and humid; mountain forest (ca 1500-2400 m), temperate (with frequent winter frost) and humid; and high elevation grasslands, also called cloud grasslands or humid puna (ca. 2400-3000 m or more), temperate-cold and sub-humid (BURKART et al., 1994; not considered as part of the Yungas biome by some authors, i.e. BROWN, 1995).

METHODS

Lotic (streams and small rivers) and lentic (ponds) environments were sampled between September 2005 and April 2007, both in protected (National Parks Baritú, Calilegua and El Rey, private Reserve El Pantanoso, and Yungas Protected Area of the Biosphere) and non-protected areas of the Yungas cloud forest of NW Argentina (Fig. 1). Presence/ absence information of species from samples and from examination of collections (Instituto y Fundación Miguel Lillo, Tucumán, Argentina; Museo de La Plata, La Plata, Argentina; Rosser W. Garrison collection, Sacramento, USA) was recorded in a spatial-relational database. Stations were classified according to type of environment (lotic or lentic), altitudinal zone (foothill rain forest, mountain rain forest, mountain forest, or highland grassland), and latitudinal sector (Northern: 22° to 23°30'S; Central: 23°31' to 25°39'S; and Southern: 25°40'S to 28°40'S; Fig. 1).

Three diversity indices were calculated: alpha diversity (average specific richness per locality); beta diversity (a measurement of the heterogeneity of the data, calculated as the ratio between total number of species and average number of species); and gamma diversity (diversity at landscape level, calculated as total number of species across all localities). Total species richness expected for the area was calculated using first-order jackknife and Chao 2 estimators. Similarity in composition of odonate communities from lotic and lentic environments was analyzed by latitudinal sector and altitudinal zone, using multivariate cluster analysis with Sorensen (Bray-Curtis) distance coefficient and flexible beta as linkage method at a value of $\beta = -0.25$ (McCUNE & GRACE, 2002). The resulting dendrograms were based on Wishart's objective function converted to a percentage of remaining information. Percentage complementarity (a measurement of distinctness or dissimilarity; COLWELL & CODDINGTON, 1994) was calculated among the latitudinal sectors and altitudinal zones of the Argentine Yungas, and among foothill forest sectors of Argentina and two sites of lowland forest in SE Peru (Manu, partially included in the Yungas, and Tambopata, belonging to the Amazon forest; data from LOUTON et al. (1996) and PAULSON (1985, 2006, pers. comm.).

Based on IUCN (2001) criteria, the conservation status of the odonate species endemic to the Yungas cloud forest was assessed on a global scale.

RESULTS

DIVERSITY PATTERNS

A total of 103 odonate species in 45 genera and 10 families from 142 localities was analyzed (Appendix 1). Alpha diversity was 5.1, beta 20.2, and gamma 103. Maximum richness at a single locality was 22 species; 23 species were found at only one locality, and 17 at only two. Most common species (recorded from 20 or more localities) were *Mnesarete grisea* (Calopterygidae), *Acanthagrion ablutum*, *A. peruvianum* and *Argia joergenseni* (Coenagrionidae), *Rhionaeschna planaltica*

and *R. vigintipunctata* (Aeshnidae), *Erythrodiplax* sp. n. and *Macrothemis imitans* (Libellulidae). Best represented family was Libellulidae with 45 species, followed by Coenagrionidae (22 species) and Aeshnidae (19 species). Megapodagrionidae, Protoneuridae, Pseudostigmatidae and Corduliidae were each represented by a single species. First-order jackknife estimate for total number of species to be expected in the studied area was of 125.8 species, and Chao 2 estimate of 118.5 species.

Lentic and lotic environments shared 42 (about 41%) of their odonate species, with 61 species found exclusively at lotic (37%) or lentic (22%) water bodies. Lentic environments included representatives of five families: Lestidae, Pseudostigmatidae, Coenagrionidae, Aeshnidae and Libellulidae, with Lestidae and the specialized treehole-breeding *Mecistogaster ornata* (Pseudostigmatidae) exclusive to them. Lotic assemblages were represented by eight families: Calopterygidae, Coenagrionidae, Megapodagrionidae, Protoneuridae, Corduliidae, Gomphidae, Aeshnidae and Libellulidae, with Calopterygidae, Megapodagrionidae, Protoneuridae and Corduliidae found only in them (Appendix 1; Figs 2-3).

Odonate species richness was found to decrease following both a latitudinal gradient (from north to south) in lotic environments (Fig. 2; lentic environments were richest in the central sector), and an altitudinal gradient (from low to high

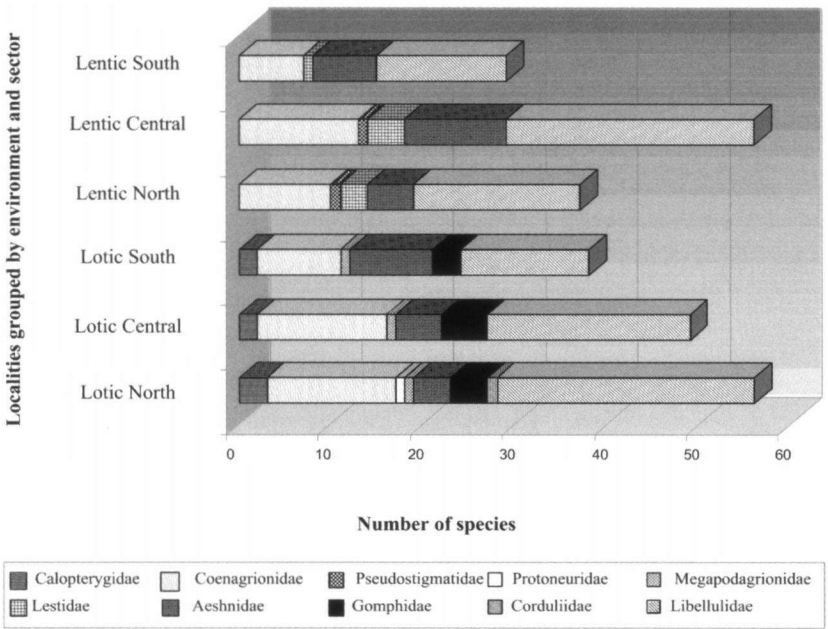

Fig. 2. Stacked bars showing species richness per family for odonate assemblages of Argentine Yungas grouped by environment along a latitudinal gradient.

elevations), both in lotic and lentic environments (Fig. 3). Hierarchical cluster analysis of environments classified according to a latitudinal gradient (Fig. 4) shows odonate communities to be segregated first by type of environment (lotic or lentic) and then by latitude, with assemblages from northern and central sectors of both lentic and lotic environments more similar among them than with those of the southern sector. Considering the combined odonate fauna for the three sectors, the central one was the richest in number of species (Tab. I), and the same relationship among the three sectors was found, with northern and central sectors more similar among them (complementarity of 39 %) than central and southern sectors (complementarity of 52 %) or northern and southern sectors (63 %, Tab. I).

Analyzing localities grouped according to an altitudinal gradient (Fig. 5) it is evident that altitude was the main factor organizing composition of odonate assemblages, with both lotic and lentic environments of foothill and mountain rain forest more similar in species composition among them than with environments

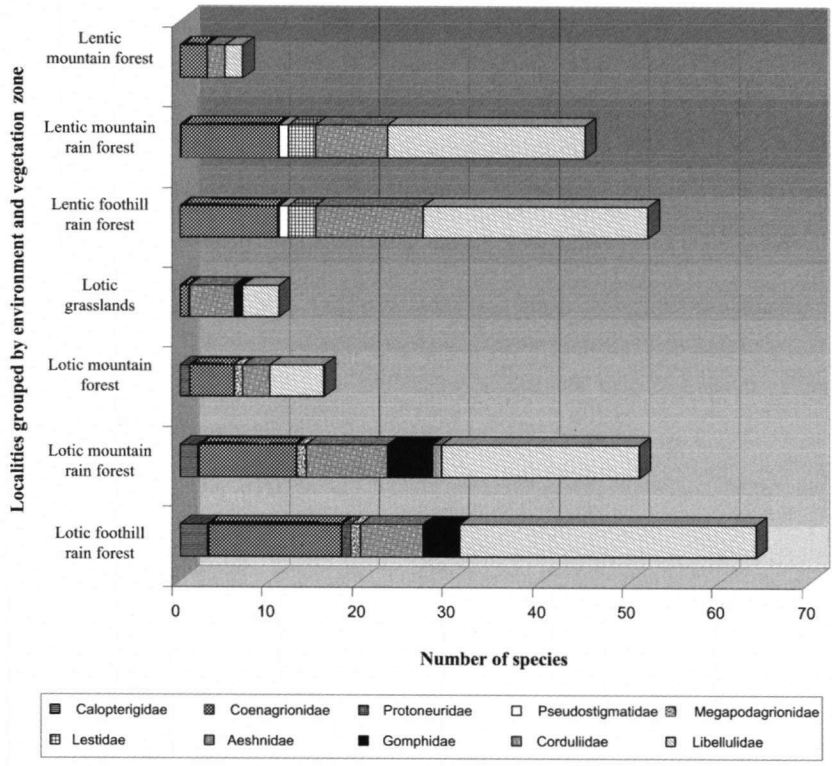

Fig. 3. Stacked bars showing species richness per family for odonate assemblages of Argentine Yungas grouped by environment along an altitudinal gradient.

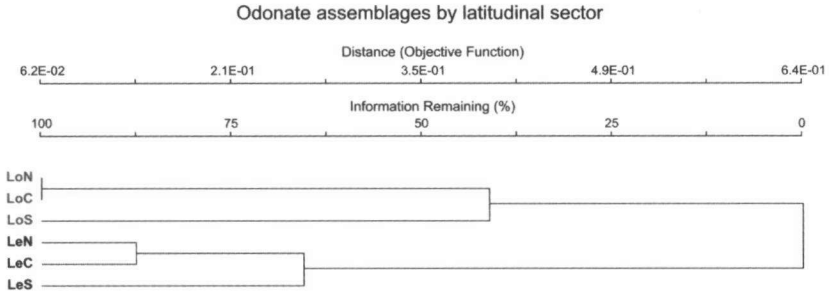

Fig. 4. Dendrogram showing relationships between odonate assemblages of Argentine Yungas grouped according to a latitudinal gradient. Lo: lotic; – Le: lentic; – N: northern sector; – C: central sector; – S: southern sector (as per Fig. 1); – 1: foothill rain forest; – 2: mountain rain forest; – 3: mountain forest; – 4: highland grassland.

from mountain forest and highland grassland (see also complementarity values in Tab. II). Lowland assemblages (foothill and mountain rain forest) are clustered according to type of environment, with lotic environments from both rain forest zones separated from lentic environments. Highland assemblages (mountain forest and highland grassland) are clustered by altitudinal zone, with lotic environments of mountain forest more similar in composition to lentic environments of mountain forest than to lotic environments of highland grasslands (no lentic environments were sampled in highland grasslands). Combined odonate assemblages per altitudinal zone decreased in richness from low to high altitude, with maximum richness (82) in foothill rain forest and minimum (11) in highland grassland (Tab. II).

Odonate assemblages of NW Argentina foothill rain forest present a much lower species richness than comparable sites in SE Peru, with which they share less than 10 % of their species (Tab. III). The latitudinal gradient is also evidenced at this scale by the increase of complementarity among northern and southern pairs with increasing latitude (Tab. III).

Table I
Richness and percentage complementarity (in brackets number of species in common) of odonate assemblages among Argentine Yungas latitudinal sectors

I	Northern sector	Central sector	Southern sector
Species richness	72	82	51
Central sector	39.58 (58)		
Southern sector	63.33 (33)	52.22 (43)	

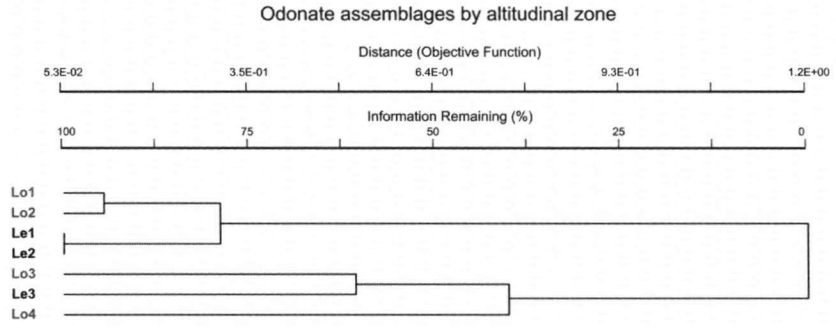

Fig. 5. Dendrograms showing relationships between odonate assemblages of Argentine Yungas according to an altitudinal gradient. Lo: lotic, Le: lentic; – 1: foothill rain forest; – 2: mountain rain forest; – 3: mountain forest; – 4: highland grassland.

CONSERVATION STATUS OF ARGENTINE YUNGAS ODONATES

Slightly over half of the recorded species (55, representing 54%) were found within one or more of the protected areas surveyed (Appendix 1). However almost all of the species of restricted distribution in the Yungas are distributed across other biomes of the neotropical region. Many of the restricted species are widely distributed in the Amazon, Chaco and / or Paranense forests, and reach in the Yungas cloud forest of NW Argentina their southernmost limit of distribution; i.e. *Rhionaeschna psilus*, *Macrothemis inacuta*, *M. musiva*, *Micrathyria atra*, and *Tramea binotata* (all from Mexico to N Argentina), *Orthemis aequilibris* (Costa Rica to NW Argentina), *Micrathyria venezuelae* (Venezuela to NW Argentina), *Hetaerina sanguinea*, and *Neoneura bilinearis* (both from Colombia to Brazil and NW Argentina), *Acanthagrion aepiolum* (Peru to Brazil and N Argentina), *Gynacantha convergens* (Bolivia and Paraguay to N Argentina), or westernmost limit of distribution; i.e. *Lestes spatula*, *Homeoura ambigua*, *Coryphaeschna perrensi*, *Dasythemis mincki*, *Perithemis icteroptera* and *Tauriphila risi* (all from Bra-

Table II
Richness and percentage complementarity (in brackets number of species in common) of odonate assemblages among Argentine Yungas atitudinal zones

II	Foothill rain forest	Mountain rain forest	Mountain forest	Highland grassland
Species richness	82	76	19	11
Mountain rain forest	42 (100)			
Mountain forest	81.17 (16)	76.62 (18)		
Highland grassland	93.1 (6)	91.25 (7)	75 (6)	

zil, Uruguay and E Argentina to NW Argentina). And the following four species, characteristic of shrublands or grasslands of Monte, Pampean, or Patagonian biomes, reach their northernmost distribution limit here: *Oxyagrion rubidum* and *Rhionaeschna confusa* (both from S Argentina and Chile to N Argentina and Paraguay), and, only found in high elevation grasslands of the Yungas, *Rhionaeschna haarupi* and *Progomphus joergenseni* (both from W central Argentina to NW Argentina).

Eleven species were identified as cloud forest endemics (Figs 6-7); from them three are still undescribed and practically nothing is known about them precluding a meaningful evaluation of their conservation status (*Limnetron* sp., *Micrathyria* sp. 1, *Micrathyria* sp. 2; Appendix 1). From the remaining eight species six were assessed as of Least Concern (LC) and two as Near Threatened (NT) (Tabs IV-V).

DISCUSSION

The odonate fauna of the Argentine Yungas cloud forests is reduced and marginal as compared to the same biome farther north, *i.e.* 103 species in 10 families compared to 136 species in 13 families in Manu National Park, Peru (LOUTON et al., 1996), but it is still high compared to other areas of Argentina, housing over a third of the total number of species recorded from the country (VON ELLENRIEDER & MUZÓN, 2008). The total number of species found in this biome is higher than that registered for NE Argentina wetlands (75) from a comparable latitude (MUZÓN et al., 2008), but the maximum number of species recorded for a particular locality is considerably lower (22 against 45; most likely due to combination of different habitats for each locality in MUZÓN et al., 2008). The

Table III

Richness and percentage complementarity (in brackets number of species in common) of odonate assemblages among foothill sites of Yungas in Argentina and lowland cloud forest in SE Peru (data for Manu from LOUTON et al., 1996, and for Tambopata from PAULSON, 1985; 2006; pers. comm.)

III	Lowland cloud forest in Peru		Foothill rain forest in Argentina		
	Manu	Tambopata	Northern sector	Central sector	Southern sector
Altitude (m)	250-550	100-300	340-840	300-880	325-865
Latitude (S)	11°55'-12°55'	12°55'-13°21'	22°-23°30'	23°31'-25°39	25°40'-28°40'
Species richness	135	177	67	56	39
Tambopata	72.13 (68)				
Distance (km)	250				
Northern sector	91.97 (15)	93.91 (14)			
Distance (km)	1,350	1,100			
Central sector	93.29 (12)	94.09 (13)	36 (48)		
Distance (km)	1,600	1,350	250		
Southern sector	93.9 (10)	95.65 (9)	60.52 (30)	56.06 (29)	
Distance (km)	1,850	1,600	500	250	

higher overall diversity seen here is explained by the high environmental heterogeneity of this forest which offers suitable environments for a wide array of specialized but localized species, thus resulting in a high replacement of species among localities as is indicated by the high ß diversity value. These results agree with observations by PAULSON (2006), who noted that forest environments support a more diverse odonate fauna than those of open lands.

The decrease of species richness with increasing latitude found in lotic odonate

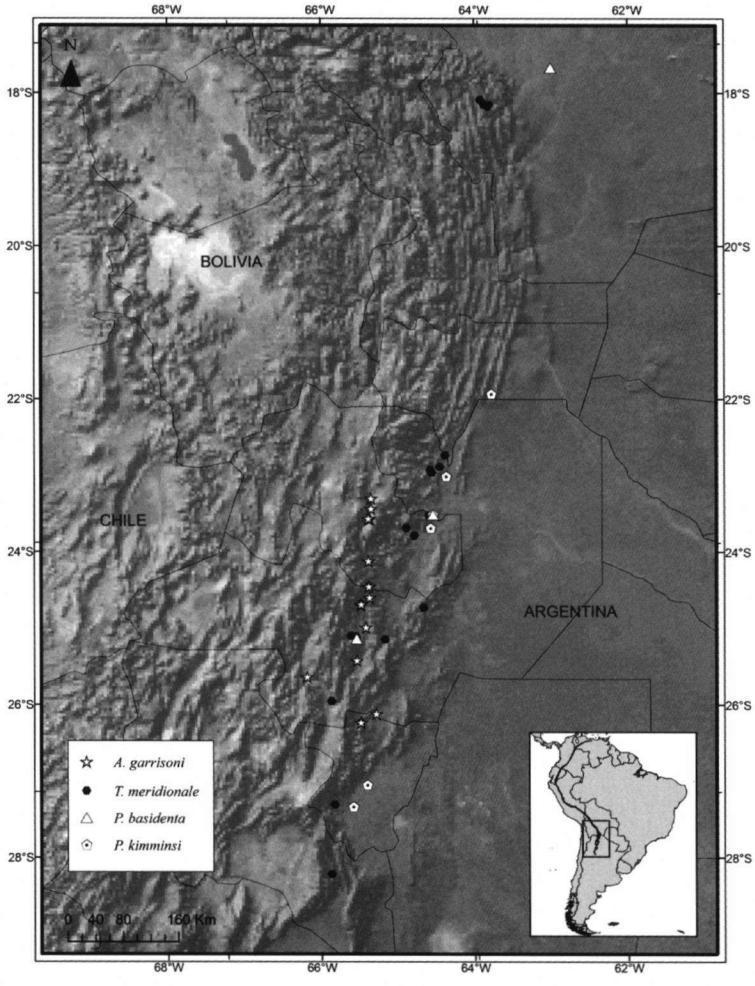

Fig. 6. Known distribution area of Yungas cloud forest endemic species: *Andinagrion garrisoni* (Zygoptera, Coenagrionidae); *Teinopodagrion meridionale* (Zygoptera, Coenagrionidae); *Phyllocycla basidenta* (Anisoptera, Gomphidae); and *Progomphus kimminsi* (Anisoptera, Gomphidae).

communities of the Argentine Yungas had already been observed for other groups of organisms, and has been referred to as a 'latitudinal climatic impoverishment' or 'peninsular effect' (DE LA SOTA, 1972; OJEDA & MARES, 1989; BROWN et al., 2001). Within odonates, assemblages of northern and central sectors are more similar between them than with southern sector assemblages, differing from the situation reported for trees, where central and southern sectors are more sim-

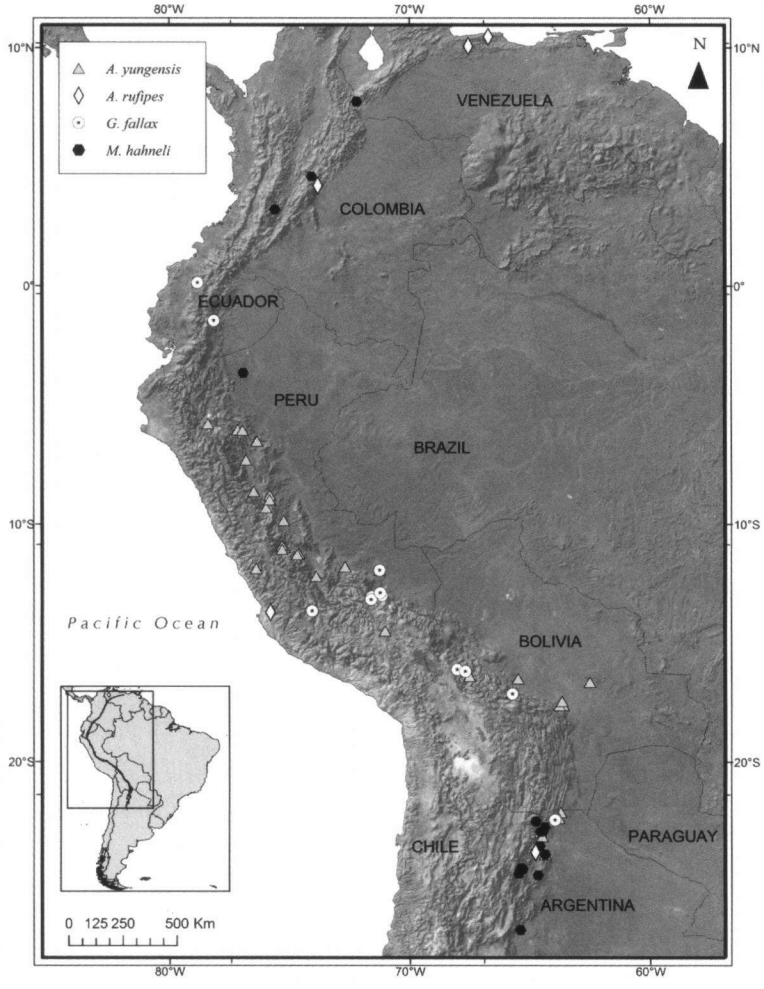

Fig. 7. Known distribution area of Yungas cloud forest endemic species: *Argia yungensis* (Zygoptera, Coenagrionidae); *Andaeschna rufipes* (Anisoptera, Aeshnidae); *Gomphomacromia fallax* (Anisoptera, Corduliidae); and *Macrothemis hahneli* (Anisoptera, Libellulidae).

Table IV
Conservation status of four endemic species of the Yungas (Fig. 6)

	Teinopodagrion meridionale De Marmels, 2001 (Zygoptera, Megapodagrionidae)	*Andinagrion garrisoni* von Ellenrieder & Muzón, 2006 (Zygoptera, Coenagrionidae)	*Phyllocycla basidenta* Dunkle, 1987 (Anisoptera, Gomphidae)	*Progomphus kimminsi* Belle, 1973 (Anisoptera, Gomphidae)
Distribution	S Bolivia to NW Argentina	NW Argentina	Bolivia to NW Argentina	Bolivia to NW Argentina
Altitude (m a.s.l)	485-1,900	800 -3,150	330-1,360	330-1,200
Extent of occurrence (km2)	47,200	15,660	20,000	9,450
Habitat and ecology	Streams and rivers. Adults perch on vegetation overhanging water or on grass blades on shore; freshly emerged individuals may perch with wings closed. Tandems land on vegetation near shoreline, and females oviposit while still in tandem in leaves of riparian macrophytes. Larvae live under stones and among riparian vegetation	Seepages, pools and still waters at stream edges with abundant aquatic vegetation, from mountain rain forest to highland grasslands. Males patrol flying close to water's surface and perching horizontally on leaves of emergent aquatic vegetation, and remain in horizontal position when in tandem. Pairs in copula land on grasses and bushes near water, and females oviposit in water plants while still in tandem. Larvae live among aquatic vegetation	Streams and rivers, where males patrol river areas with rapids with swift and straight beat very close over water surface, frequently settling on rocks. Larva unknown	Streams and rivers. Males patrol sections of stream when sunny, often chasing one another, frequently land on ground or twigs at shore always returning to the same spot. Larva unknown
Red List assessment	Least Concern (LC)	Near Threatened (NT)	Least Concern (LC)	Near Threatened (NT)
Rationale	Extent of occurrence of 47,200 km2; known from 16 locations, 4 within protected areas (Baritú and El Rey N.P. in Salta province; Calilegua N.P. and Reserva El Pantanoso in Jujuy province, Argentina)	Known from more than 10 locations (13) across three vegetation zones of Yungas, where it can be locally abundant (i.e. over 20 adults observed at a single site). Based on collection data available for entire range dating from 1967 to 2007 there is no evidence of decrease in extent of occurrence. Listed in this category due to known extent of occurrence lower than 20,000 km2 and absence of records from protected areas, requiring monitoring to ensure its existence does not become threatened by habitat reduction in the future	Extent of occurrence of 20,000 km2; known from 3 locations; not known within protected areas, but most likely more widely distributed, especially across S Bolivia which has been scarcely sampled for odonates. Searching for further localities needed	Extent of occurrence lower than 20,000 km2 and known from less than 10 locations; not listed as vulnerable due to distribution most likely greater than recorded, especially across S Bolivia which has been scarcely sampled, and overlooked by non-specialist collectors due to pale and cryptic colors. Searching for further localities needed, as well as monitoring to ensure its existence does not become threatened by habitat reduction in the future
References	DE MARMELS, 2001; VON ELLENRIEDER & GARRISON, 2007a, b	VON ELLENRIEDER & MUZÓN, 2006; VON ELLENRIEDER & GARRISON, 2007a, b	DUNKLE, 1987; VON ELLENRIEDER & GARRISON, 2007a, b	BELLE, 1973; VON ELLENRIEDER & GARRISON, 2007a, b

Table V
Conservation status of four endemic species of the Yungas (Fig. 7)

	Argia yungensis Garrison & von Ellenrieder, 2007 (Zygoptera, Coenagrionidae)	*Andaeschna rufipes* (Ris, 1918) (Anisoptera, Aeshnidae)	*Gomphomacromia fallax* McLachlan, 1881 (Anisoptera, Corduliidae)	*Macrothemis hahneli* Ris, 1913 (Anisoptera, Libellulidae)
Distribution	Peru and Bolivia to NW Argentina	Venezuela and Colombia to Peru and NW Argentina	Ecuador and Peru to Bolivia and NW Argentina	Venezuela and Colombia to Ecuador, Peru and NW Argentina
Altitude (m a.s.l)	119-1,800	800-1,300	250-3,100	350-1,500
Extent of occurrence (km2)	1,091,850	875,000	525,000	222,250
Habitat and ecology	Shady and narrow streams or creeks enclosed within thick rain forest. Adults perch on leaves in small patches of dappled sunlight, opening and closing their wings two or three times after landing. Larva unknown	Narrow streams and rivulets within thick mountain rain forest. Male patrols a large territory flying up and downstream; female oviposits alone in moss covered logs and tree twigs in the water to up about 1-2 m above water. Larvae live under stones and on sediment	Streams, narrow trickles and seepages. Males defend small territories from other males, patrolling stream margins or forests paths with low flight, occasionally perching on stones or low vegetation; mating pairs land on vegetation along stream margins. Females reported flying beneath cliff sides covered with moss and dripping water, likely ovipositing by flicking abdomen toward moss. Larva undescribed, but most likely semi-terrestrial; larvae belonging to this species (based on distribution) were reported from a moist, moss covered slope on a forest dirt trail in Peru	Adults fly close to streams water's surface, hovering frequently over rapids on narrow enclosed creeks, perching occasionally on grass and twigs or rocks along shores. Pairs in copula perch high in bushes and trees near water. Larvae live at river and stream margins, in areas of abundant aquatic vegetation
Red List assessment	Least Concern (LC)	Least Concern (LC)	Least Concern (LC)	Least Concern (LC)
Rationale	Extent of occurrence of 1,091,850 km2; known from 33 locations; 3 locations known within protected areas (Manu N.P. in Madre de Dios dep., and Tingo María N.P. in Huanuco dep., Peru; Amboro N.P. in Santa Cruz dep., Bolivia)	Estimated extent of occurrence of 875,000 km2; known from 7 locations, 4 within protected areas (El Ávila N.P. in Miranda state, Tamá and Chorro El Indio N.P. in Táchira state, Venezuela; Calilegua N.P. in Jujuy province, Argentina)	Extent of occurrence of 525,000 km2; known from 11 locations; 1 known location within a protected area (Manu N.P. in Madre de Dios department, Peru)	Extent of occurrence of 222,250 km2; known from 17 locations, three within protected areas (Baritú and El Rey N.P. in Salta province, and Reserva El Pantanoso in Jujuy province, Argentina)
References	GARRISON & VON ELLENRIEDER, 2007; VON ELLENRIEDER & GARRISON, 2007a	DE MARMELS, 1981, 1994; VON ELLENRIEDER & GARRISON, 2007a, b	VON ELLENRIEDER & GARRISON, 2005, 2007a, b	VON ELLENRIEDER, 2007b; VON ELLENRIEDER & GARRISON, 2007a, b

ilar in species composition and northern sector less similar (MORALES et al., 1995). The same latitudinal pattern is observed at a broader geographical scale, with assemblages of SE Peru cloud forest much richer and diverse (LOUTON et al., 1996; PAULSON, 1985, 2006) than those of NW Argentina sectors of the same altitudinal zone. Although the distance between the two Peruvian sites is approximately the same as between adjacent Yungas sectors in Argentina (250 km), they are more different in species composition than are any pair of Argentine sectors (Tab. III), indicating their different biogeographic allegiances. Manu, which is partially included within the Yungas cloud forest, is accordingly more similar to NW Argentine sites than is Tambopata, which lies completely within the Amazon forest.

A reduction of richness along an altitudinal gradient similar to the one observed here has been reported for mammals of the Argentine Yungas (OJEDA & MARES, 1989). Altitude has also been recognized as the most important factor organizing the structure of benthic macroinvertebrate communities in the Yungas cloud forest although communities in general did not correlate well to the vegetation zones and were segregated into just two categories, one for lower and one for higher zones (MALDONADO & GOITIA, 2003; VON ELLENRIEDER, 2007a).

The Yungas are known to house a high biodiversity with elements from various biogeographic origins (tropical, from Amazon, Paranense, and Chaco provinces, and austral-gondwanic) but low endemisms (CABRERA & WILLINK, 1973; BROWN et al., 2001). A relatively high endemicity value has been reported only for anurans of the NW Argentine cloud forests corresponding to 10 % of the Argentine species (LAVILLA et al., 2000). Within Odonata, the 11 species that have been identified here as cloud forest endemics represent only 4 % of the Argentine fauna. Six of them are extensively distributed within the cloud forest (Tabs IV-V), and only two, *Andinagrion garrisoni* and *Progomphus kimminsi* (Fig. 6), are known from a more restricted range and require closer monitoring.

According to species richness estimators calculated, known species represent still only 82-85 % of the odonate fauna expected for this area; the early stage of our knowledge of this fauna is also evidenced by the ongoing discovery of new species, and the fact that the biology, including life cycles and habitats, of about a third of the recorded species is still largely unknown (VON ELLENRIEDER & GARRISON, 2007b). The richest zone in odonate species is also the most severely threatened: ninety percent of what once was foothill rain forest has been replaced by monocultures (REBORATTI, 1989). Modification and loss of aquatic habitats by irrational and intensive human exploitation (both agriculture and selective logging; BROWN et al., 2001) are the main threats to the conservation of the high odonate diversity of this cloud forest.

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