

# Ecological niche models and patterns of richness and endemism of the southern Andean genus *Eurymetopum* (Coleoptera, Cleridae)

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**ABSTRACT.** Ecological niche models and patterns of richness and endemism of the southern Andean genus *Eurymetopum* (Coleoptera, Cleridae). *Eurymetopum* is an Andean clerid genus with 22 species. We modeled the ecological niches of 19 species with Maxent and used them as potential distributional maps to identify patterns of richness and endemism. All modeled species maps were overlapped in a single map in order to determine richness. We performed an optimality analysis with NDM/VNDM in a grid of 1° latitude-longitude in order to identify endemism. We found a highly rich area, located between 32° and 41° south latitude, where the richest pixels have 16 species. One area of endemism was identified, located in the Maule and Valdivian Forest biogeographic provinces, which extends also to the Santiago province of the Central Chilean subregion, and contains four endemic species (*E. parallelum*, *E. prasinum*, *E. proteus*, and *E. viride*), as well as 16 non-endemic species. The sympatry of these phylogenetically unrelated species might indicate ancient vicariance processes, followed by episodes of dispersal. Based on our results, we suggest a close relationship between these provinces, with the Maule representing a complex area.

**KEYWORDS.** Andean region; Central Chilean subregion; Maxent; NDM; Subantarctic subregion.

**RESUMEN.** Modelos de nicho ecológico y patrones de riqueza y endemismo del género andino austral *Eurymetopum* (Coleoptera, Cleridae). *Eurymetopum* es un género de cléridos andinos con 22 especies. Modelamos los nichos ecológicos de 19 especies con Maxent y los utilizamos como mapas de distribución potencial para identificar patrones de riqueza y endemismo. Todos los mapas de las especies se superpusieron en un mapa único para determinar la riqueza. Realizamos un análisis de optimalidad con NDM/VNDM en una cuadrícula de 1° de latitud-longitud para identificar el endemismo. Hallamos un área de mayor riqueza, localizada entre los 32° y 41° de latitud sur, donde los píxeles más ricos poseen 16 especies. Se identificó un área de endemismo en las provincias biogeográficas del Maule y el Bosque Valdiviano, la cual se extiende también a la provincia de Santiago de la subregión Chilena Central, y que contiene cuatro especies endémicas (*E. parallelum*, *E. prasinum*, *E. proteus* y *E. viride*), así como 16 especies no endémicas. La simpatria de estas especies filogenéticamente no relacionadas podría indicar antiguos procesos de vicarianza, seguidos de episodios de dispersión. Con base en nuestros resultados, sugerimos una relación cercana entre estas provincias, representando el Maule un área compleja.

**PALABRAS CLAVE.** Maxent; NDM; Región Andina; subregión Chilena Central; subregión Subantártica.

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The high number of insect species represents a challenge for biodiversity studies. Additionally, their distributional data exhibit a higher level of uncertainty than other groups (like mammals, birds, plants, etc.), complicating the generation of databases to identify biodiversity patterns. Thus, studies about these patterns are usually undertaken for specific groups whose geographic distribution and ecological characteristics are better known, like ants in South America (Ruggiero 2001).

South America has been divided into the Neotropical and Andean regions and the South American Transition Zone (Morrone 2006). The Andean region, which extends basically in central Chile and Patagonia, is equivalent to southern South America (Marino *et al.* 2001). Most of the Andean biota

originally evolved in Patagonia and then gradually spread northwards, into the South American Transition Zone, during Tertiary and Pleistocene (Kuschel 1969; Morrone 1994a). The Andean region comprises three subregions: Central Chilean, Subantarctic and Patagonian (Morrone 2006). The Central Chilean subregion extends in central Chile, between 30 and 34° south latitude. The Subantarctic subregion comprises the southern Chile and Argentina, and the Malvinas, South Georgia, and Juan Fernandez islands. It is divided into six provinces: Maule, Valdivian Forest, Magellanic Forest, Magellanic Moorland, Juan Fernández Islands, and Malvinas Islands. The Patagonian subregion extends in southern

Argentina, from central Mendoza, widening through Neuquén, Río Negro, Chubut, and Santa Cruz, to northern Tierra del Fuego; and reaching Chile in Aisén and Magallanes. Some authors suggested that the Subantarctic and Central Chilean subregions are biotically related (Morrone 1994a; Morrone *et al.* 1997). In particular, a cladistic biogeographic analysis based on weevil species (Coleoptera: Curculionidae) suggested a close relationship between the Maule and Valdivian Forest biogeographic provinces with the Central Chilean subregion (Posadas & Morrone 2001).

*Eurymetopum* Blanchard, 1844 (Coleoptera, Cleridae) is an Andean genus with 22 species, mainly associated to broadleaf evergreen forest from central and southern Chile, with preference for the Valdivian temperate forest, although some species are also distributed in the Subantarctic evergreen forest (Solervicens 1986, 2002, 2005). Species of *Eurymetopum* are distributed between 30° and 55° S in Chile and Argentina, occupying a narrow strip in the eastern slope of the Andes (Solervicens 1986, 2002). The taxonomy and geographical distribution of the species of this genus have been studied extensively (Solervicens 1980, 1986, 1987, 1992, 1993, 2001, 2002, 2005; Solervicens & Rodríguez 1985; Solervicens & Huarapil 1992), so we believe that their biogeographic patterns may be investigated fruitfully.

Distributional patterns are discovered from individual distributional areas, which are inferred from data points of records in literature, collections and field work. Distributional areas obtained exclusively from data points, however, may be under-representing the real area of occupancy of a species. In order to improve the distributional maps of species obtained from data points, species' ecological niche modelling may be used (Stockwell & Peters 1999). These models have been widely used in recent years (see Guisan & Thuiller 2005), and their use as potential distributional areas may improve identification of biogeographical patterns (Escalante *et al.* 2007). Maximum entropy or Maxent (Phillips *et al.* 2006) is an efficient algorithm to develop ecological niche models (see Illoldi & Escalante 2008; Peterson *et al.* 2007).

Richness and endemism are the main distributional patterns used to characterize biodiversity. Species richness is the most frequently used measurement of biodiversity (Gaston 1996; Moreno 2001). It is measured as the number of species present in a sample, in this case, a geographic area. On the other hand, endemism is referred to exclusivity to a geographic area, and it is used to discover patterns of biogeographical homology (Morrone 2001). Areas of endemism are areas of non-random distributional congruence among different taxa, and there are several methods to identify them (Morrone 1994b; Szumik *et al.* 2002; Szumik & Goloboff 2004; Deo & DeSalle 2006; Moline & Linder 2006). The optimality method (Szumik *et al.* 2002; Szumik & Goloboff 2004) computes an index of endemism based on the presence of a species in a particular combination of grid-cells in a grid, and is implemented in NDM/VNDM software (Goloboff 2005). This algorithm has proven to perform better than other methods under certain "noise" conditions (Casagrande & Taher 2007).

We analyze herein the distributional patterns of richness

and endemism of 22 species of *Eurymetopum* in austral South America, based on ecological niche models projected as potential distributional areas of species.

## MATERIAL AND METHODS

Ecological niche modeling. - We compiled a database with 498 specimen records of 22 species of *Eurymetopum* from Chile and Argentina (Solervicens 1986; Neira & Rivas 2007; see Appendix for the list of species and the number of records). Our first area of study comprises a grid with extreme coordinates 10°30' - 57°00' south latitude and 48°30' - 79°00' west longitude. It includes basically the South American Transition Zone (except the Northern Andean Paramo province, Morrone 2006) and the Andean region.

We modeled only 19 species with more than five records (*E. breve*, *E. inerme* and *E. vittula* were not modeled, although they are considered in the discussion) with Maxent 2.3 (Phillips *et al.* 2006). We used 19 bioclimatic variables (Hijmans *et al.* 2005; <http://www.worldclim.org/>; annual mean temperature, mean diurnal range, isothermality, temperature seasonality, maximum temperature of warmest month, minimum temperature of coldest month, temperature annual range, mean temperature of wettest quarter, mean temperature of driest quarter, mean temperature of warmest quarter, mean temperature of coldest quarter, annual precipitation, precipitation of wettest month, precipitation of driest month, precipitation seasonality, precipitation of wettest quarter, precipitation of driest quarter, precipitation of warmest quarter, and precipitation of coldest quarter), four topographic variables (<http://edc.usgs.gov/products/elevation/gtopo30/hydro/index.html>; elevation, compound topographic index, aspect and slope), and 12 Modis satellite images (corresponding to average monthly surface reflectance values drawn from the normalized difference vegetation index (NDVI; for years 1992, 1993 and 1995). All the environmental variables were re-sampled to 0.02° of resolution.

Ecological niche modeling for species with more than 15 records was performed using the default parameters (maximum iterations to 500 and using convergence threshold in 1.0E-5); and for species with less than 15 records, using the default parameters, varying maximum iterations to 350 and convergence threshold in 1.0E-5 (Pawar *et al.* 2007). The models of ecological niche were projected as maps of potential distributional areas, choosing all pixels beginning with the probability that coincides with all data point of presence of each species (Illoldi-Rangel *et al.* 2008).

Richness patterns. - The maps of potential distributional areas to each species were summed to obtain a unique map showing the number of predicted species in each pixel. We identified the pixels with the highest number of predicted species, namely the potential areas with highest species richness.

Endemism patterns. - We used the models obtained to undertake an analysis of endemism using the optimality criteria in NDM/VNDM (Szumik *et al.* 2002; Szumik & Goloboff,

2004; Goloboff 2005). The study area was overlapped to a grid of 218 grid-cells of 1° latitude-longitude. A matrix was built coding the presence of a species in a grid-cell with “1”, and the absence with “0” (see Appendix). This matrix was run in NDM/VNDM (Goloboff 2005), using the default parameters (save sets of areas with two or more endemic species, save sets with score above to 2.000, and edge proportion option). As we constructed our matrix based on ecological niche models, it was not necessary to use “fill” and “assume” options of Szumik & Goloboff (2004). We chose optimal sets that were above 50% different (in endemic species) to the highest score.

## RESULTS AND DISCUSSION

**Ecological niche modeling.** - We obtained 19 ecological niche models, one per species, projected as their potential distributional areas. Models were compared with the distributional maps and latitudinal distributions of Solervicens (1987, 2005), and were found to be consistent with them, except for a few overpredictions. We confirm the presence of *Eurymetopum* in central and southern Chile, with some species predicted also for Argentina. Although we still lack records, three species are predicted to be distributed in Argentina, but with low probabilities: *E. eburneocinctum*, *E. modestum* and *E. rubidum*. Moreover, *E. eburneocinctum* and *E. modestum* were predicted to be present in northern Chile, in the Atacama and Coastal Peruvian Desert biogeographic provinces, both with low probabilities. This coincides with Solervicens (2005), who noted that *E. eburneocinctum*, *E. modestum* and *E. semirufum* have wide distribution. Some species were predicted to the south: *E. fulvipes* to the Magellanic Moorland province, and *E. modestum* and *E. rubidum* even to the Magellanic Forest, Central Patagonian and Malvinas Islands provinces, all of them predicted with low probabilities. Furthermore, the predicted distribution of *E. frigidum* and *E. longulum* exceed the distributional latitudinal limit of 26° suggested by Solervicens (2005).

**Richness patterns.** - *Eurymetopum* is basically distributed in the Andean region, with most of the species found between 32°-41° south latitude (Fig. 1). In these places, the non-modeled species are also distributed. This area is located in the Chilean matorral and Valdivian temperate forest ecoregions (<http://www.worldwildlife.org/science/ecoregions/item1847.html>), in dry, sub-humid and humid ombrotypes (Luebert & Plissock, 2006). The main vegetation types in this area are sclerophyll woodlands and forests and spiny forests (Luebert & Plissock 2006). Other taxa showing a similar richness in the area are Asteraceae (at 33°-34°, Moreira-Muñoz & Muñoz-Schick 2007), *Senecio* (Rovito *et al.* 2004) and weevils of the tribe Aterpini (Morrone 1996).

The area with the highest predicted richness of species of *Eurymetopum* is located in a grid-cell of the Santiago biogeographic province, between 36°-37° latitude and 71°-72° longitude (Fig. 1). A second rich area is located between 35°-39° latitude and consists of eight grid-cells containing 180 pixels with 15 predicted species. None of these grid-cells

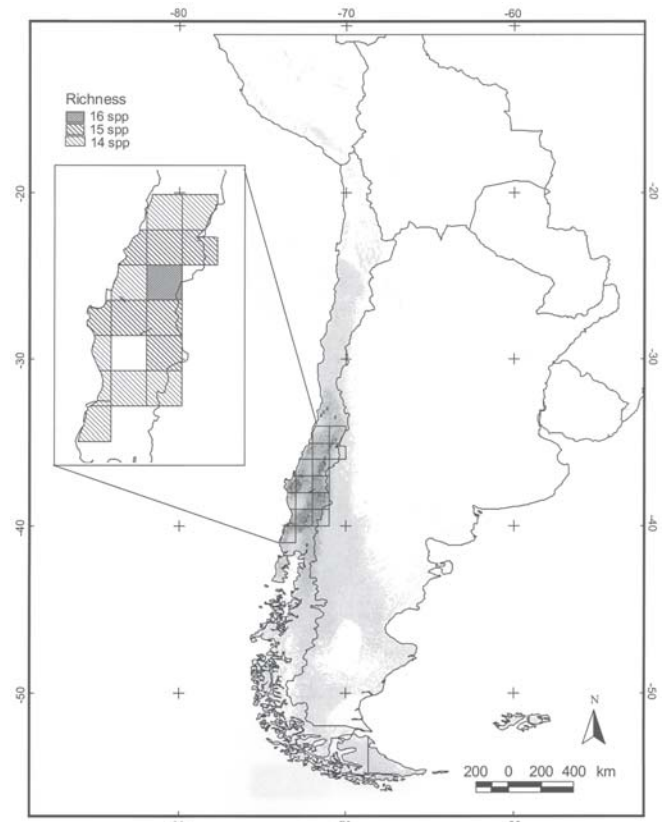


Fig. 1. Map of predicted species richness for 19 species of *Eurymetopum* modeled with Maxent. Data points for *E. breve*, *E. inerme* and *E. vittula* (not modeled) and richest grid-cells are shown.

contains non-modeled species. Other rich grid-cells are located in the southern Santiago province; in the intersection between the Santiago and Central Patagonian provinces; in the intersection between the Santiago, Central Patagonian and Prepanan provinces; in the northern part of the Maule province; in the intersection of the Santiago and Maule provinces; in the intersection of the Santiago, Maule and Central Patagonian provinces; and in the intersection of the Maule and Central Patagonian provinces.

**Endemism patterns.** - We found a single area of endemism comprised of 42 grid-cells, located between 35°-47° latitude (Fig. 2), with a score of 3.512. It has four endemic species: *E. parallelum* (endemism score of 0.8586), *E. prasinum* (0.8913), *E. proteus* (0.8928), and *E. viride* (0.8695). All the remaining species, excepting *E. breve* and *E. inerme* (both not modeled) are also distributed in the area. This area of endemism is situated in the Maule and Valdivian Forest biogeographic provinces, both belonging to the Subantarctic subregion, and its northern part lies in the Santiago province, which belongs to the Central Chilean subregion. A small part of this area of endemism extends to the northwestern portion of the Central Patagonian biogeographic province; however, no data points have been recorded for this province, so it may represent an overprediction of the Maxent models.

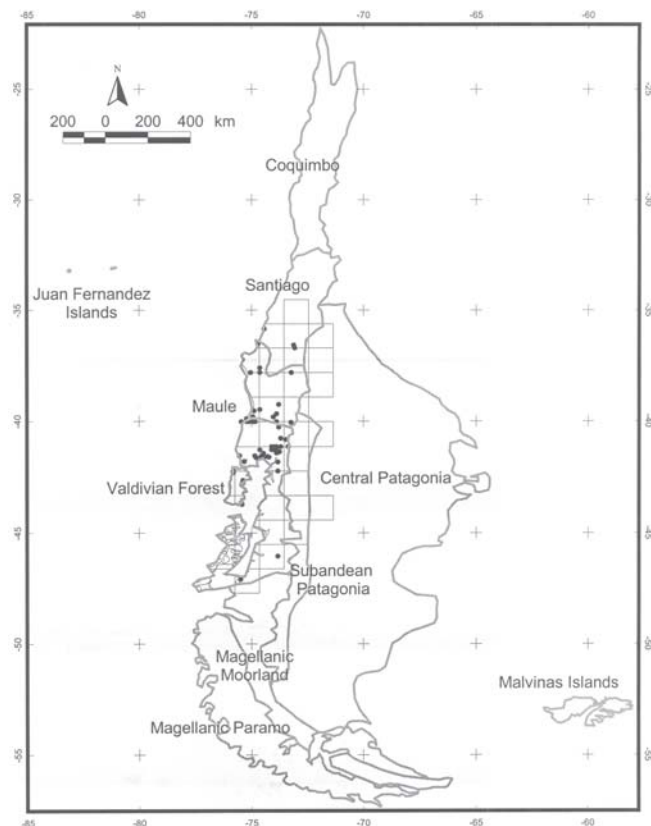


Fig. 2. Area of endemism found for the species of *Eurymetopum*, based on ecological niche models and a grid of 1° latitude-longitude. Data points of four endemic species and provinces of the Andean region (*sensu* Morrone 2006) are shown.

The altitudes of the area of endemism vary between 500-4000 m, but altitudes between 500-2000 m are predominant. Sclerophyll woodlands and forests, evergreen forest and laurel-leaved forests are the dominant vegetation types (Luebert & Plischoff 2006). The richest area of species coincides with the northern grid-cells of the area of endemism, in the southern portion of the Santiago province (Central Chilean subregion). Peña (1966) recognized 18 entomological regions in Chile, where the Northern Valdivian Forest and Valdivian Forest regions correspond to our area of endemism.

Neira & Rivas (2007) identified three areas of endemism using the data points of all the 22 species of *Eurymetopum* in grid-cells of 1°, located in Quillota-Teno (between 32.9°- 34.9° latitude), Los Vilos-Río Negro (31.9°- 41.9° latitude) and Longaví-Río Negro (35.9°- 41.9° latitude), identifying each with three or four endemic species. Of the endemic species, only *E. prasinum* and *E. viride* were identified as endemic in our analysis. The area of endemism identified herein is equivalent to their third area de endemism, but our area is bigger, extending to 47°. We did not find their former area of endemism, maybe because our models expand the distributional areas; and their latter area is partially nested within the third one. Our area of endemism, however, has the highest score (3.512) with respect to Neira & Rivas's (2007) areas of endemism (3.027, 2.398, and 2.824).

Potential distributional models can improve the ruggedness in the identification of areas of endemism.

Solervicens (1987) used a cladistic biogeographic approach to analyze the relationships between the areas of endemism of *Eurymetopum*. He arranged most of the species into three groups of areas. Our endemic species belong to the three groups (*E. parallelum* is not assigned to any group, *E. viride* belongs to the *E. modestum* group, *E. proteus* to the *E. eburneocinctum* group, and *E. prasinum* to the *E. maculatum* group), and all of them are distributed in the Valdivian forest. The sympatry of these phylogenetically unrelated species might indicate ancient vicariance processes, followed by episodes of dispersal, as suggested by Solervicens (1987), who also postulated that the Valdivian forest was the original habitat of *Eurymetopum*, and that its species extended subsequently to xeric and mesic habitats. Solervicens (2005) mentioned that *Eurymetopum* has a Gondwanic origin, and its ancestral populations were isolated because the development of arid habitats segregated the temperate forest of Argentina and Chile.

Morrone (1996) undertook a panbiogeographic analysis of 23 species of Aterpini (Coleoptera: Curculionidae) in Central Chile, and the Maule, Valdivian Forest and Magellanic Forest provinces. He found two generalized tracks (Central Chile-Maule and Maule-Valdivian Forest-Magellanic Forest) and identified the Maule, where both generalized tracks overlapped, as a node. Rovito *et al.* (2004) suggested a floristic division at 35° approximately. Moreira-Muñoz & Muñoz-Schick (2007) also suggested the existence of a panbiogeographic node in this zone. We conclude also that the Maule is a complex biotic area for *Eurymetopum*, because the northern portion of the Maule province and the southern portion of the Central Chilean subregion contain the richest grid-cells, and the area of endemism begins in this boundary.

Posadas & Morrone (2001) hypothesized that the Central Chilean subregion is the sister group of the two septentrional provinces of the Subantarctic subregion: the Maule and Valdivian Forest. Posadas *et al.* (1997) also suggested that the northern Subantarctic subregion and southern Central Chilean subregion have complex relationships. Estrada *et al.* (2007) identified an area of endemism, based on insect and plant data, between 27°-38° latitude, which includes part of the Central Chilean subregion and the Maule province. These results suggest a complex area in this latitude; however, further studies are necessary to contrast this hypothesis.

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Appendix. Data matrix used in the NDM analysis. Columns (number of records between parenthesis): 1, *Eurymetopum bispinosum* (6); 2, *E. brevevittatum* (13); 3, *E. eburneocinctum* (42); 4, *E. frigidum* (28); 5, *E. fulvipes* (20); 6, *E. iridescens* (18); 7, *E. longulum* (26); 8, *E. maculatum* (97); 9, *E. maculipes* (10); 10, *E. modestum* (58); 11, *E. obscurum* (12); 12, *E. parallelum* (15); 13, *E. penai* (5); 14, *E. prasinum* (18); 15, *E. proteus* (19); 16, *E. rubidum* (49); 17, *E. semiprasinum* (17); 18, *E. semirufum* (19); 19, *E. viride* (17); 20, *E. breve* (3); 21, *E. inerme* (2); 22, *E. vittula* (4).

A1-5	0010000001000000000000	A17-7	0010000001000001000000
A2-5	0011001101001001000000	A17-8	0000000001000000000000
A3-5	0011001111001001000000	A17-9	0000000001000000000000
A3-6	1011001101000001100000	A17-10	0000000001000000000000
A4-5	0011001101001001000000	A17-11	0000000001000000000000
A4-6	1011001101001001100000	A18-2	011111010111011111000
A5-4	0011001101000001000000	A18-3	0111110001110111111000
A5-5	0011001101001001100000	A18-4	0111111001110111111000
A5-6	0011001101001001100000	A18-5	0011000101000001110000
A6-4	0011001101001001000000	A18-6	0010000101001001100000
A6-5	1011001101001001100000	A18-7	0010000001000001000000
A6-6	1011001101000001100000	A18-8	0000000001000000000000
A7-4	0011001101001001000000	A18-9	0000000001000000000000
A7-5	1011001101001001100000	A18-10	0000000001000000000000
A7-6	0010001101000001000000	A18-11	0000000001000000000000
A8-4	0011001101001001100000	A19-1	0011110001010111100100
A8-5	1011001101001001100000	A19-2	0011110001110111111000
A8-6	0010001100000001000000	A19-3	0011111001110111111001
A9-4	0011001111001001110000	A19-4	0011111011110111111000
A9-5	1011001111001001110000	A19-5	0011000001000001110000
A10-4	1111101111001001110010	A19-6	0010000101000001100000
A10-5	1011101111001001110000	A19-7	0000000001000001000000
A11-4	1111101111101001110100	A19-8	0000000001000001000000
A11-5	1111111111101001110100	A19-9	0000000001000000000000
A11-6	0011111111000001110000	A19-10	0000000001000001000000
A12-3	1111111111100101110000	A20-1	0011110001010111111000
A12-4	1111111111101001111000	A20-2	0011110001010111111000
A12-5	1111111111101001110010	A20-3	0011110011110111111000
A12-6	0011111111000001110000	A20-4	0011111011110111111000
A13-3	1111111111100101111000	A20-5	0010000101001001110000
A13-4	1111111111110101111000	A20-6	0010000101000001000000
A13-5	1111111111110001110000	A20-7	0000000001000001000000
A13-6	0010011111000001000000	A20-8	0000000001000001000000
A14-2	0011111101110111111001	A20-9	0000000001000001000000
A14-3	0111111101110111111000	A20-10	0010000001000001000000
A14-4	1111111111110101111000	A20-11	0010000001000001000000
A14-5	0111111111000001110000	A20-12	0010000001000000000000
A14-6	0000000001001001000000	A21-1	0010110001010111101000
A14-7	0000000000000000000000	A21-2	0011110001010111101000
A15-2	1111111101110111111000	A21-3	0011110001110111111000
A15-3	1111111101110111111000	A21-4	0011110001010111111000
A15-4	1111111111110111111000	A21-5	0010000001001001000000
A15-5	0111111111010001111000	A21-6	0010000001000001000000
A15-6	0010000001001001000000	A21-7	0010000001000001000000
A15-7	0000000001000000000000	A21-8	0000000001000001000000
A15-8	0000000001000000000000	A21-9	0010000001000001000000
A16-2	0111110101110111111000	A21-10	0010000001000001000000
A16-3	0111110101110111111000	A21-11	0010000001000001000000
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A16-5	0111111101010001111000	A22-2	0010110001010111111000
A16-6	0000000001000001000000	A22-3	0011110001010111111000
A16-7	0010000001000000000000	A22-4	0011110001010111111000
A16-8	0000000001000000000000	A22-5	0000000001000001000000
A16-9	0000000001000000000000	A22-6	0010000001000001000000
A16-10	0000000001000000000000	A22-7	0010000001000001000000
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A17-3	0111110101110111111000	A22-9	0010000001000001000000
A17-4	0111111111110111111000	A22-10	0010000001000001000000
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A17-6	0010000101000001000000	A23-1	0000110001010111001000
		A23-2	0010110001010111011000
		A23-3	0010110001010111111000
		A23-4	0010110001000001100000
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		A23-6	0010000001000001000000
		A23-7	0010000001000001000000
		A23-8	0010000001000001000000
		A23-9	0010000001000001000000
		A23-10	0010000001000001000000
		A24-0	0010100001000101000000

A24-1	0000100001000101000000	A28-4	0010000001001001000000
A24-2	0010110001000101000000	A28-5	0010000001000001000000
A24-3	0010110001000001100000	A28-6	0010000001000001000000
A24-4	0010010001000001100000	A28-7	0010000001000001000000
A24-5	0000000001000001000000	A28-8	0010000001000001000000
A24-6	0000000001000001000000	A29-0	0000100001000001000000
A24-7	0010000001000001000000	A29-1	0000100001000001000000
A24-8	0010000001000001000000	A29-2	0000000001000001000000
A24-9	0000000001000001000000	A29-3	0000000001000001000000
A25-0	0000110001000001000000	A29-4	0000000001001001000000
A25-1	0010100001000001000000	A29-5	0000000001000001000000
A25-2	0010110001000001000000	A29-6	0000000001000001000000
A25-3	0010000011000001000000	A29-7	0000000001000001000000
A25-4	0010000001001001000000	A30-0	0000100000000001000000
A25-5	0000000001000001000000	A30-1	0000100001000001000000
A25-6	0000000001000001000000	A30-2	0000110001000001000000
A25-7	0010000001000001000000	A30-3	0000000001000001000000
A25-8	0010000001000001000000	A30-4	0000000001000001000000
A25-9	0010000001000001000000	A30-5	0010000001000001000000
A25-10	0010000001000001000000	A30-6	0000000001000001000000
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A26-1	0000100001000001000000	A31-1	0000100000000001000000
A26-2	0000110001000001000000	A31-2	0000110001000001000000
A26-3	0010010001000001000000	A31-3	0000010001000001000000
A26-4	0000000001000001000000	A31-4	0000000001000001000000
A26-5	0000000001000001000000	A31-5	0010000001000001000000
A26-6	0010000001000001000000	A31-6	0000000001000001000000
A26-7	0010000001000001000000	A31-7	0000000001000001000000
A26-8	0010000001000001000000	A31-8	0000000001000001000000
A26-9	0010000001000001000000	A32-2	0000100000000001000000
A26-10	0010000001000001000000	A32-3	0000100001000001000000
A27-0	0000100000000001000000	A32-4	0000000001000001000000
A27-1	0000110001000001000000	A32-5	0010000001000001000000
A27-2	0000100001000001000000	A32-6	0010000001000001000000
A27-3	0010000001000001000000	A32-7	0000000001000001000000
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A27-6	0010000001000001000000	A32-10	0000000001000001000000
A27-7	0010000001000001000000	A33-4	0000000000000000000000
A27-8	0010000001000001000000	A33-5	0000000001000001000000
A28-0	0000100000000001000000	A33-6	0000000001000001000000
A28-1	0000110001000001000000	A33-7	0000000001000001000000
A28-2	0000100001000001000000	A33-8	0000000001000001000000
A28-3	0010000001000001000000	A33-9	0000000001000001000000