

Beyond the Valdivian Forest: expanding the distribution of the vulnerable *Tanyderus pictus* (Diptera: Psychodomorpha: Tanyderidae) to the endangered Maulino Forest ecosystem

Más allá del Bosque Valdiviano: ampliando la distribución del vulnerable *Tanyderus pictus* (Diptera: Psychodomorpha: Tanyderidae) al ecosistema amenazado del Bosque Maulino

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ABSTRACT

Here we report the presence of the endemic and threatened primitive crane fly *Tanyderus pictus* Philippi, 1865, associated for the first time with the endangered Maulino Forest ecosystem in the Ñuble region, using high-quality photos under the citizen science model. We expanded the distribution of this species 182 km north of the next verified locality. We also reported *T. pictus* for the first time in the Chiloé Archipelago. Biogeography and conservation notes are discussed for this crane fly species.

Keywords: citizen science, habitat fragmentation, primitive crane fly, Valdivian origin.

RESUMEN

En este trabajo reportamos la presencia de *Tanyderus pictus* Philippi, 1865 —un típulo primitivo, endémico y amenazado— por primera vez asociada con el ecosistema amenazado del Bosque Maulino en la región del Ñuble, usando fotos de alta calidad bajo el modelo de ciencia ciudadana. Aumentamos la distribución de esta especie 182 km al norte desde la siguiente localidad verificada. También reportamos a *T. pictus* por primera vez en el archipiélago de Chiloé. Notas biogeográficas y de conservación son discutidas para esta especie.

Palabras claves: ciencia ciudadana, fragmentación de hábitat, origen valdiviano, típula primitiva.

Tanyderidae Osten-Sacken, 1880 (Diptera: Psychodomorpha) is an ancient basal family within the lower Diptera with a consistent sister-group relationship among Tanyderidae, Psychodidae, and Blepharideridae (Wiegmann *et al.* 2011). The extant Tanyderidae is composed of 10 genera and 38 species + fossil species (Skibińska *et al.* 2014; Eskov & Lukashevich 2015; Madriz 2017a). Except for the Palearctic and Antarctic regions, Tanyderidae species are present in all continents, with the greatest diversity occurring in the South Global, and many of them exhibit a Gondwanic relationship (Madriz 2017a).

Neotropics are represented by Chilean Tanyderidae with four species: *Tanyderus pictus* Philippi 1865, *Araucoderus gloriosus* (Alexander, 1920), *Neoderus patagonicus* (Alexander, 1913), and *Neoderus chonos* Madriz (Madriz *et al.* 2018). Saproxylic, aquatic, and free-living larvae burrow on soft and semi-flooded deadwood in or near cobble and sand-bottom streams, often surrounded by native forests composed mainly of *Nothofagus* trees (Lukashevich & Shcherbakov 2014, 2016; Madriz & Courtney 2016; Madriz *et al.* 2018).

The most studied Chilean tanyderid species over time is *T. pictus* (Fig. 1). Larval morphology and biology studies

were provided by Lukashovich & Shcherbakov (2014, 2016), whereas adult descriptions and redescription were conducted by Philippi (1865), Alexander (1930), and Madriz (2017b). Different authors (Alexander 1935; Lukashovich & Shcherbakov 2014, 2016; Madriz 2017b; Barahona-Segovia *et al.* 2018) have established that this tanyderid is restricted from Concepción (Biobío Region) to the Parque Nacional Alerce Andino (Los Lagos Region). Given the structural habitat characteristics of both larval and adult phases, this species occurs mainly in the Valdivian Forest type, not being present throughout the North-Patagonian Forest to the south of its distribution and Maulino Forest to the north. Additionally, *T. pictus* is currently classified as a vulnerable species using the IUCN criteria at the regional level by the Ministry of the Environment of Chile (DS 79/2018; Barahona-Segovia 2018).

This short communication aims to report the first record of the vulnerable species *T. pictus* in the endangered Maulino Forest ecosystem in central Chile, moving the northern limit of this species. Maulino Forest is considered an endangered forest type because, since 1974, it has been replaced at high rates (Bustamante & Castor 1998; Echeverría *et al.* 2006; Miranda *et al.* 2017). In addition, we provided the first insular and most southern record of *T. pictus*, updating the distribution of this species throughout Chile with new biogeographic and conservation notes that could aid this primitive crane fly species.

First, we used the distribution provided by Madriz (2017b) and Barahona-Segovia *et al.* (2018) as a baseline. The new records of this tanyderid species were obtained thanks to the citizen science program “*Moscas Florícolas de Chile*” on Facebook (<https://web.facebook.com/groups/774986852548819>) and iNaturalist (<https://www.inaturalist.org/projects/moscas-floricolas-de-chile>), which were photographed in different years and locations. For each occurrence, we obtained (1) the specific locality and coordinates provided by each user, (2) the date of the occurrence (day/month/year), and (3) the original photo per record. Missing information regarding the bullet points mentioned above was consulted with each citizen scientist; if the citizen scientists did not respond or did not supply us with all required data, we discarded that occurrence. To compare the extent of occurrence (EOO) and area of occupancy (AOO) between our work and the dataset of the Ministry of Environment (MMA), we applied a chi-square test with given probabilities using R software (R Development Core Team 2022). To ensure taxonomical identification of the individuals photographed, we corroborated each photo with wing venation and other morphological characteristics provided by Madriz (2017b). The sex of the individuals in the photos was ensured by the presence of epandrium convex

and darkish gonocoxite and gonostylus, forming some kind of claspers in males, whereas female individuals did not present these structures and the Terminalia is highlighted by the orange-yellowish cerci (Madriz 2017b; Fig. 1). Institutions and acronyms used: CS -- Moscas Florícolas de Chile Citizen Science program; IEUMCE -- Instituto de Entomología, Universidad Metropolitana de Ciencias de la Educación, Santiago de Chile, Chile; ISIC -- Iowa State University Insect Collection, Ames, IA, USA; MNHNCL -- Museo Nacional de Historia Natural, Santiago de Chile, Chile; USNM -- Smithsonian National Museum of Natural History, Washington DC, USA; masl = meters above sea level; ♂ = male; ♀ = female.

Seven new records have been added to the known distribution of *T. pictus* (Madriz *et al.* 2017b; Barahona-Segovia *et al.* 2018). The information related to these new records is as follow: **new records. CHILE.** *Ñuble*: Parque El Avellano, 30.v.2023, 1♀ leg. Vicente Valdés (CS); *La Araucanía*: Curacautín, 12.iii.2021, 1♀ leg. Daniela Sánchez (CS); Laguna Llancañil, Pucón, 20.ii.2019, 1 ♀ leg. Alejandra Quezada (CS); *Los Ríos*: Pichirropulli, Paillaco, 13.iii.2019, 1 ♀ leg. Supi Píriz (CS); *Los Lagos*: Puerto Chalupa, Lago Rupanco, 27.iv.2023, 1♀ leg. Daniel Stange (CS); Ensenada, Puerto Varas, 23.v.2021, 1♀ leg. Juan Tole (CS); Estero Gamboa, Castro, Chiloé, 19.ii.2022, 1♂ leg. Matías Gargiulo (CS). All information about these records, including links to original photos, has been published in an open access repository with a link and digital object identifier (<https://figshare.com/s/815c9d8ada4b5f02b944>; <https://doi.org/10.6084/m9.figshare.24312847>).

Other material examined or published. CHILE. *Biobío*: Concepción, no date given, 1♀ leg. E. Reed (USNM); Liceo B56, Fuerte Tucapel, Cañete, 9.iii.2017, 1♀ leg. Francisco Rivas-Fuenzalida (CS; Barahona-Segovia *et al.* 2018); *La Araucanía*: Parque Nacional Nahuelbuta, Pehuenco, small creek, 1160 masl, 24–25.i.2014, leg. E.D. Lukashovich (Lukashovich & Shcherbakov 2014); Contulmo, no data given, leg. NN (Alexander 1935); *Los Ríos*: Los Ulmos, Valdivia, iii.1865, leg. Philippi (MNHNCL, probably lost); Valdivia, no data given, Leg. Wagenknecht (IEUMCE); Parque Nacional Alerce Costero, sector Chaihuín, 2–4 km E Chaihuín, 20–30 masl, 20–26.i.2015, leg. M. Chertoprud and E. Lukashovich; *Los Lagos*: Purranque, Osorno province, 1954, 1♂ leg. E. Reed (USNM); Puyehue, xi.1939, leg. Wolffhügel (Alexander 1935); Road to Cayetué, 299 masl, 2.ii.2015, 1 ♂ 1♀ leg. R.I. Madriz (ISIC); Puerto Varas, no data given, leg. 2♂ supposedly collected by Wolffhügel and 1♀ by Schroeder (Alexander 1935); Parque Nacional Alerce Andino, Lenca River, 340 masl, 8.i.2014, leg. Lukashovich & Shcherbakov (2014).

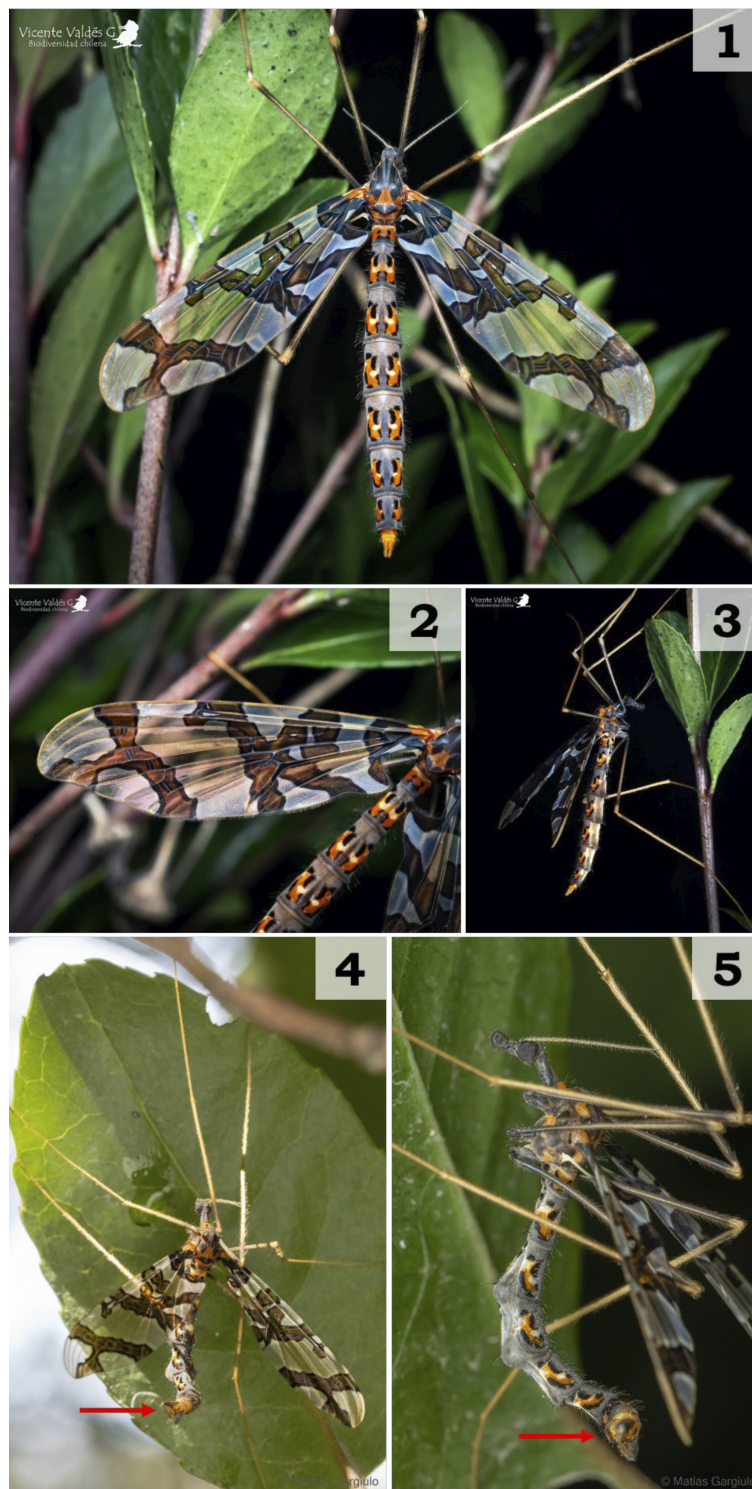


FIGURE 1. *Tanyderus pictus* Philippi, 1865, female and new record of the Ñuble region: (1) dorsal habitus; (2) wing venation, and (3) lateral habitus (photos by Vicente Valdés-Guzmán); male and new record from Chiloé province: (4) dorsal habitus and (5) lateral habitus (photos by Matías Gargiulo). The red arrow highlights the gonocoxite and gonostylus of the male. / *Tanyderus pictus* Philippi, 1865, hembra y nuevo de registro de la región del Ñuble: (1) vista dorsal; (2) venación alar y (3) habito lateral (fotos por Vicente Valdés-Guzmán); macho y nuevo registro de la provincia de Chiloé: (4) vista dorsal y (5) vista lateral (fotos por Matías Gargiulo). Las flechas rojas resaltan los sujetadores del aparato reproductor (gonocoxito y gonostilo) masculino.

In this short communication, we expand the distribution of *T. pictus* by 182 km in a straight line, from Cañete (the southern limit of the Biobío Region) to Parque El Avellano (Ñuble Region). This private protected area is inserted into the southern distribution of the Maulino Forest ecosystem, an endangered forest type present only in central Chile. This ecosystem is characterized by patches of native forest composed of the endemic trees *Nothofagus glauca* (Phil.) Krasser, *Peumus boldus* Molina, *Aextoxicon punctatum* Ruiz et Pav., and *Gomortega keule* Ruiz & Pav., with a dense understory composed mainly of Chilean bamboo of the genus *Chusquea*. The tanyderid was photographed in a ravine of the Maulino Forest with a small muddy stream running slowly. On the other hand, we provide the first insular record of *T. pictus* from Chiloé Province, extending the southern-western limit by more than 136 km in a straight line. This area represents the boundary between the Valdivian and North-Patagonian Forests, mixing vegetation elements such as several Myrtaceae species, *A. punctatus*, *Embothrium coccineum* J.R.Forst. &

G.Forst, *Nothofagus nitida* (Phil.) Krasser, *Pilgerodendron uviferum* (D.Don) Florin, and *Tepualia stipularis* (Hook. & Arn.) Griseb. This record was found near the Cunao stream (~600 m), a sand-bottomed stream surrounded by native trees under humid conditions. Both new records are presented in severely fragmented landscapes caused by forestry and urbanization (Fig. 2).

Regarding the distribution of *T. pictus*, Barahona-Segovia *et al.* (2018) determined that the EOO of this primitive crane fly species was 20,652 km² and an AOO of 8 km², meeting the B2ab(iii) criterion of the IUCN (Barahona-Segovia 2018). The new records obtained significantly increased the EOO and AOO to 66,444.9 km² ($\chi^2 = 24076$, $p < 0.0001$) and 68 km² ($\chi^2 = 47.36$, $p < 0.0001$), respectively, following the information available in the Ministry of Environment of Chile, suggesting that the conservation status of this species must be downgraded from Vulnerable to Near Threatened. However, due to the intense habitat fragmentation of the Biobío and La Araucanía Regions (Miranda *et al.* 2017) and the

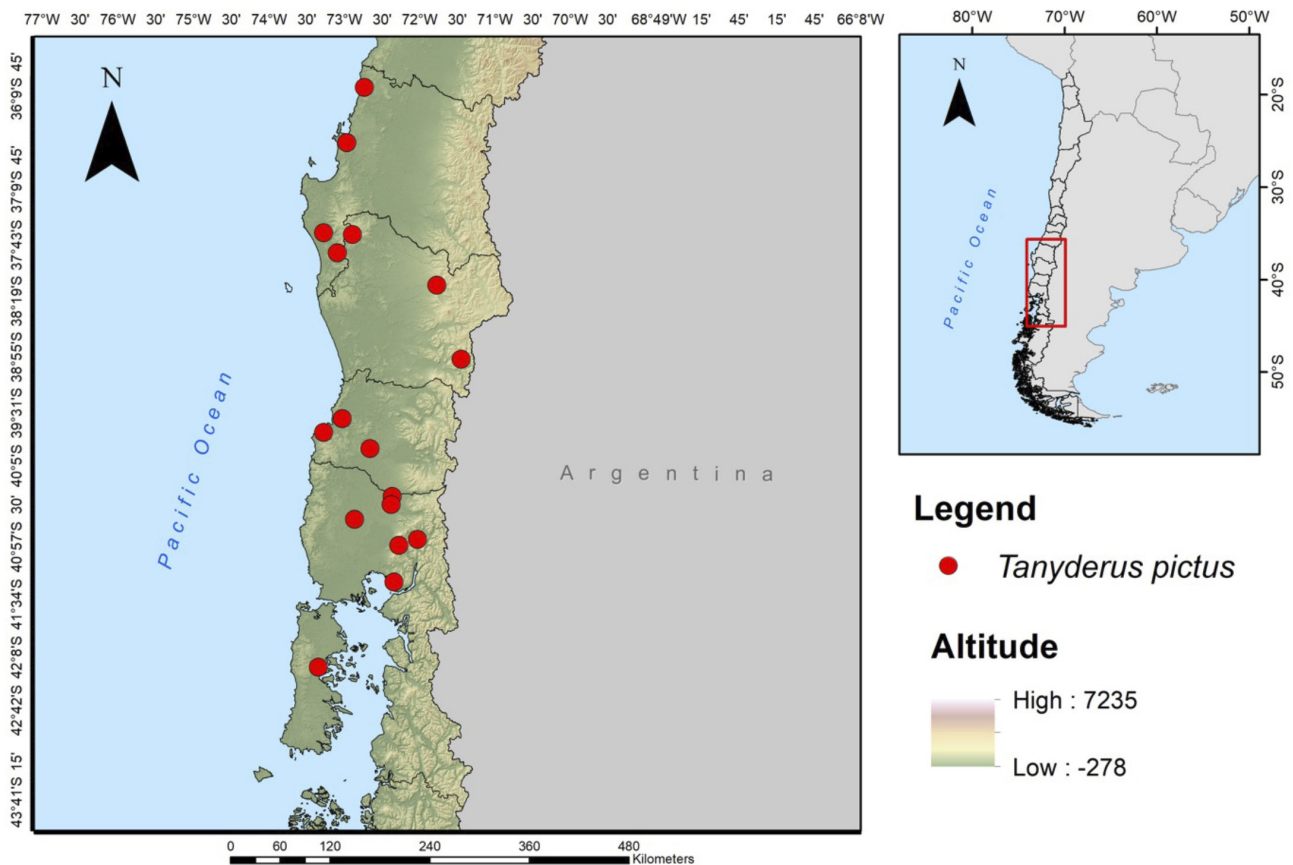


FIGURE 2. Updated distribution of *Tanyderus pictus* Philippi, 1865, along central-south Chile. / Distribución actualizada de *Tanyderus pictus* Philippi, 1865, a lo largo del centro-sur de Chile.

poor dispersal abilities of *T. pictus*, it is plausible that the old locations such as Concepción and Contulmo, no longer have adequate conditions for the survival of the species. In addition, some natural history notes describe that tanyderids usually maintain some type of fidelity to the habitat surrounding their larval substrate (Lukashevich & Shcherbakov 2014, 2016; Madriz & Courtney 2016; Madriz 2017a, 2017b). We suggest maintaining the conservation status previously proposed because of the high habitat fragmentation generated mainly by forestry and the loss of native forests and their associated streams.

Finally, Maulino Forest is considered the northern limit of fauna with Valdivian origins, such as the “Murciélago orejudo del sur” *Histiopus magellanicus* (Philippi) (Rodríguez-San Pedro et al. 2015); the “ratón topo valdiviano” *Geoxus valdivianus* (Philippi), the “monito del monte” *Dromiciops gliroides* Thomas, and the “rata arborícola chilena” *Irenomys tarsalis* (Philippi) (Saavedra & Simonetti 2000, 2001); the “caracol de árbol araucano” *Plectostylus araucanus* Valdovinos & Stuardo (Barahona-Segovia et al. 2019), and the “rana moteada” *Batrachyla leptopus* Bell (Cuevas & Cifuentes 2010). The new record in the Maulino Forest suggests some resilience of *T. pictus* to habitat fragmentation and its potential presence in other localities of this ecosystem type. Therefore, it is necessary to evaluate which ecological parameters (e.g., decaying wood type, physical-chemical parameters of the water) are sufficient for the species to continue its life cycle and maintain viable populations over time. Native forests will play a key role in the maintenance of *T. pictus* populations in the future. However, habitat restoration and biological corridors can provide suitable conditions for moving through the landscape, providing resources for this species (and others), maintaining the genetic pool, and avoiding the potential negative consequences of fragmentation on the populations of this tanyderid species.

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