Gayana 72(1): 31-35, 2008 ISSN 0717-652X

FINDING OF *GORDIUS AUSTRINUS* DE VILLALOBOS, ZANCA & IBARRA - VIDAL, 2005 (GORDIIDA, NEMATOMORPHA) IN THE STOMACH OF *SALMO TRUTTA* (SALMONIFORMES) IN PATAGONIA

HALLAZGO DE GORDIUS AUSTRINUS *DE VILLALOBOS, ZANCA & IBARRA - VIDAL, 2005 (GORDIIDA NEMATOMORPHA) EN LA DIETA DE* SALMO TRUTTA *(SALMONIFORMES) EN PATAGONIA*

Cristina de Villalobos[1,2], Juan J. Ortiz-Sandoval[3] & Evelyn Habit[3]

[1]Facultad de Ciencias Naturales y Museo. Paseo del Bosque S/N 1900 La Plata, Argentina.
[2]Comisión de Investigaciones Científicas Provincia de Buenos Aires. La Plata, Argentina.
E-mail for correspondence: villalo@fcnym.unlp.edu.ar
[3]Unidad de Sistemas Acuáticos, Centro de Ciencias Ambientales EULA-Chile, Universidad de Concepción, Concepción, Chile.

ABSTRACT

Field observations revealed, for the first time, cases of predation on *Gordius austrinus* by *Salmo trutta* in Risopatrón Lake, Aysén Region, Chile. Reinvestigation by SEM of the characteristics of the posterior end and of the cuticle of the specimens of horsehair worms collected inside the stomach of brown trout allow us to assign the specimens to the species *Gordius austrinus*. Also we could show that in some specimens the cuticle of mid body and terminal end presented structural alterations, due to the action of the digestive juices of the fish. This finding implies the extension of the distribution range of *G. austrinus*.

KEYWORDS: Nematomorpha, *Gordius austrinus*, predation, *Salmo trutta*, Patagonian Lakes.

RESUMEN

En trabajos de campo se pudo observar, por primera vez, casos de depredación de *Salmo trutta* sobre *Gordius austrinus* en el Lago Risopatrón, Región de Aysén, Chile. El análisis ultraestructural (MEB) realizado sobre los especímenes de gordiidos, colectados dentro del estómago de la trucha café, sobre las características del extremo posterior y la cutícula, permitieron asignarlos a la especie *Gordius austrinus*. Asimismo, mostró que en algunos especímenes la cutícula de la región media del cuerpo y el extremo posterior presentaban alteraciones en su estructura, probablemente debidas a la acción de los jugos digestivos del pez. Este hallazgo implica la ampliación del rango de distribución de *G. austrinus*.

PALABRAS CLAVES: Nematomorpha, *Gordius austrinus*, depredación, *Salmo trutta*, Lagos Patagónicos.

INTRODUCTION

Gordiida or horsehair worms, as they are commonly called, are worm-like organisms free-living in streams and other freshwater environments as adults, where they copulate and lay their eggs. The preparasitic larvae hatch from eggs in water (Zanca *et al.* 2007). Part of the life cycle is parasitic, in which larvae infect host that are usually arthropods (De Villalobos *et al.* 2003, De Villalobos & Ronderos 2003).

Previous studies reported several cases of predation on gordiids by freshwater fish (Cochran *et al.* 1999, Poinar 2001, Kinziger *et al.* 2002, Ruiz & Figueroa 2005). In this paper we report, for the first time, cases of predation on adult of *Gordius austrinus* (De Villalobos *et al.* 2006) in Chile and show by SEM the damage caused by the digestive juices of the fish on the cuticle of this species of horsehair worms. All the specimens studied corresponded with the descriptions of specimens from *Gordius austrinus* that were described by De

Villalobos *et al.* (2006). Also, this paper implies the extension of the distribution range of the species.

MATERIAL AND METHODS

During summer 2006, 81 specimens of *Salmo trutta* (Linnaeus, 1758) were collected using gillnets of different mesh size (15, 20, 30, 50, 60, 70 and 120 mm bar mesh size) placed at different depth in six lakes of South Chile, Aysén Region. From north to south: Risopatrón Lake (44° 15´39"S - 72° 31´12"W, Palena River basin), Las Torres Lake (44°45´04´´S - 72°12´22´´W, Cisnes River basin), Thompson Lake (45°38´18´´S - 71°47´15´´W, Aysén River basin), La Paloma Lake (45°52´40´´S - 72°04´14´´W, Aysén River basin), Riesco Lake (45°29´56´´S - 72°40´40´´W, Aysén River basin) and Tranquilo Lake (46°37´49´´S - 72°47´13´´W, Baker River basin). Stomach contents were preserved in formalin 10% and then analyzed under stereomicroscope. Samples of nematomorphs were preserved for scanning electron microscopy.

To examine specimens by scanning electron microscopy (SEM), fragments of worms (mid-body and posterior end) were washed with distilled water, dehydrated in an increasing ethanol series prior to their study. They were critical point dried, mounted on bronze blocks and gold-sputter coated. Observations were performed using a JEOL JSM 6360 LV scanning electron microscope. Body measurements were made with outstretched worms using a ruler. Diameters were measured under dissecting microscope using a calliper ruler.

Material investigated by SEM was mid body and posterior end: 4 males (MZUC 33137, MZUC 33138, MZUC 33139, MZUC 33140) (inside stomach of *S. trutta*) from Risopatrón Lake in Aysen, Chile.

RESULTS

Only fishes collected in the Risopatrón Lake had nematomorphs in their stomachs. In three of the seven brown trout specimens (2 females, 37.6 and 38.6 cm total length; 1 male, 48.6 cm total length) collected in this lake, 4 whole specimens of nematomorphs belonging to *Gordius austrinus*, were found in the stomach contents (Figs. 1-3).

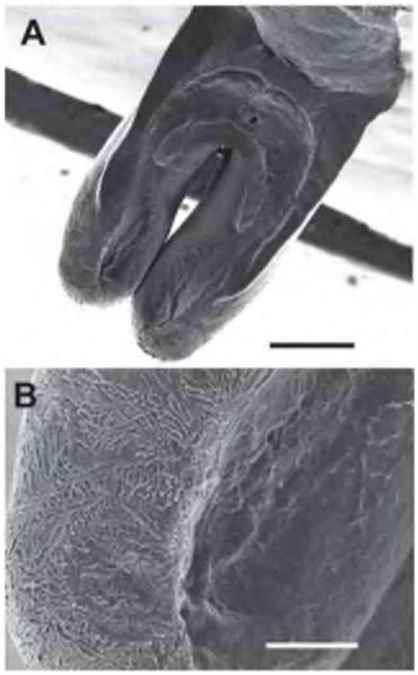

Figure 1. *Gordius austrinus*. Ventral view of the posterior end. (A) Lobes and semicircular postcloacal crescent; scale: 200 µm. (B) Detail of one lobe showing the cuticle partially modified; scale: 50 µm.

Figura 1. *Gordius austrinus*. Vista ventral del extremo posterior. (A) Lóbulos y cresta postcloacal; escala: 200 µm. (B) Detalle de un lóbulo mostrando la cutícula parcialmente modificada; escala: 50 µm.

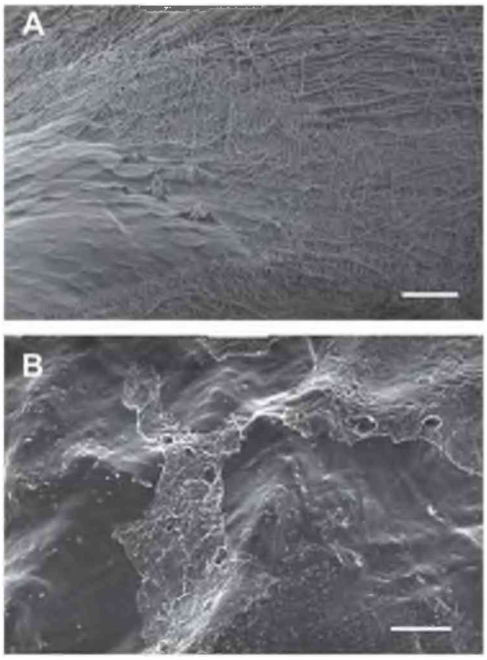

Figure 2. *Gordius austrinus*. (A) Cuticle of the medial region of the body showing the epicuticle partially destroyed; scale: 20 µm. (B) Mid body cuticle with some mucus secretion; scale: 20 µm.

Figura 2. *Gordius austrinus*. (A) Cutícula de la región media del cuerpo mostrando la epicuticula parcialmente destruida; escala: 20 µm. (B) Cutícula de la región media del cuerpo con una secreción de tipo mucosa; escala: 20 µm.

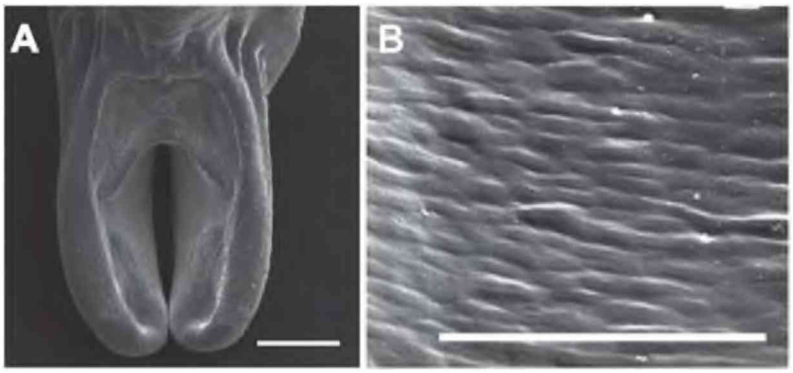

Figure 3. *Gordius austrinus*. (A) Ventral view of the posterior end showing at the apex of the lobes a spoon shaped cavity and the semicircular postcloacal crescent; scale: 200 µm. (B) Mid body cuticle without damage; scale: 100 µm.

Figura 3. *Gordius austrinus*. (A) Vista ventral del extremo posterior mostrando una cavidad en forma de cuchara en el ápice de los lóbulos y la cresta postcloacal semicircular; escala: 200 µm. (B) Cutícula de la región media del cuerpo sin daños; escala: 100 µm.

Description of the material investigated: The newly reported specimens, in spite of their cuticular alterations, corresponds with the descriptions of specimens from *Gordius austrinus* that were described by de Villalobos *et al.* (2006), being type locality Agüita de la Perdiz, Pozo de Vertiente, Concepción. The body color is dark brown. In the anterior end a white cap is absent. The Posterior end is bilobed. Lobes vary between 515.7 µm to 557.8 µm long and 210.5 µm to 252.6 µm wide. They are moderately

long and not diverging (Figs. 1A, 3A). The apex of the lobes forms a spoon shaped cavity. Posterior of the cloacal opening is a semicircular postcloacal crescent. Anterior to the postcloacal crescent there is a depression with a central cuticular protuberance where the cloacal opening lies (Figs. 1A, 3A). The cuticle in this depression is smooth. In the precloacal region there is a parabolic intergumentary ledge which bounds the cloacal depression. The cuticle of the terminal end and the body cuticle in three of the four specimens collected, showed modifications due to the action of the digestive juices of the predator (1A, 1B). The epicuticle is partially destroyed although the alternating layers of the fibres of the endocuticle can be observed (Fig. 2A) (De Villalobos & Restelli 2001). Likewise, some mucus secretion can be seen on the cuticle which possibly corresponds to the digestive of *S. trutta* (Fig. 2B). In the fourth specimen (223mm length/ 1.3mm wide) the cuticle of the body and posterior end (Figs. 3A, 3B) maintain the normal characteristics for this species (De Villalobos *et al.* 2006) and show the posterior end bilobed. Posterior of the cloacal opening is a semicircular postcloacal crescent. Anterior to the postcloacal crescent there is a depression with a central cuticular protuberance where the cloacal opening lies. The cuticle in this depression is smooth. In the precloacal region there is a parabolic intergumentary ledge which bounds the cloacal depression. The body cuticle with transverse oriented slender folds with scattered short bristles. This specimen had possibly been swallowed close to the moment of the fish capture and therefore the action of the digestive juices had not yet affected it.

Dimensions: 41mm, 125mm, 223mm, 260mm in length and 0.4mm, 0.51mm, 1.3mm and 1.51mm in diameter respectively.

Remarks: Although possibly by the action of the digestive juices, the distribution patterns of the bristles at the posterior end are not so evident, the analysis of the characteristics of the posterior end and of the cuticle allow us to assign the specimens collected in the stomach of *S. trutta* to the species *Gordius austrinus*.

Finding of *G. austrinus* in Risopatrón Lake, Chilean Patagonia, implies the extension of its distribution range. Previous record indicated a distribution range between 20° 21´to 41° 67´S and 70° 16´to 72° 30´W. Now, we extended its latitudinal distribution until 44° 27´S in Chile.

DISCUSSION

The amount of fish collected in different freshwater environments in Chile is high in comparison with the scarce incidence of gordiids as part of their diet (Ruiz & Figueroa 2005). This could be explained because gordiids are generally found rolled in the lower part of the aquatic vegetation or with vegetal debris (leaves, sticks, etc.) at the bottom of streams, places where they can easily camouflage and be protected from predators (Hanelt *et al.* 2005). However, there are times when horsehair worms are highly vulnerable to a predator like a fish: 1) when the gordiids adults emerge, in aquatic environments, from their insect host which they previously induced to suicide (Thomas *et al.* 2002, Ponton *et al.* 2006), 2) when they form the "Gordian knots" in order to reproduce (McLennan & MacMillan 1984, Cochran *et al.* 1999) or 3) when in calm waters gordiids swim with slow movements being easily detected by a predator (Hanelt *et al.* 2005).

There are previous reports on the predation of horsehair worms by *Salmo trutta*, in different countries, for the United States of America (Clemens 1928, Cochran *et al.* 1999, Kinziger *et al.* 2002), for Canada (Scott & Crossman 1964) and for New Zealand (McLennan & MacMillan 1984). For South America, Ruiz & Figueroa (2005) point out the presence of a specimen of nematomorph, not determined, inside the stomach of a brown trout in Chile, and also in native fishes like *Basilichthys australis* Eigenmann, 1928 and *Percichthys trucha* (Valenciennes, 1833). Common result for all these reports is that predation on horsehair occurs in oligotrophic aquatic systems. Salmonids we found with *Gordius austrinus* in theirs stomachs correspond to adults samples that have been described as highly piscivorous (Jonsson *et al.* 1999, Macchi *et al.* 1999). It is probable that *Gordius* is not an optimal prey since its biomass is low comparable to fishes or other prey items like decapods. The finding of *G. austrinus* only in 3 of 81 *S. trutta* analyzed, and only in one of 5 lakes studied, indicates trout are probably not selecting gordiids as prey, or maybe they are not abundant in the other analysed lakes (Risopatrón Lake, Las Torres Lake, Thompson Lake, Riesco Lake, Tranquilo Lake).

The results of our studies show that *G. austrinus* is part of the diet of the brown trout from Chile. Also we showed by SEM, that within the stomach of the fishes due to the digestive juices the cuticle of the horsehair worms was damaged or altered. The

presence of *G. austrinus* in Risopatrón Lake allows extending its distribution for Chile (De Villalobos *et al.* 2006).

ACKNOWLEDGMENTS

We thank Waldo San Martín for help with field work. Funding was provided under project DIUC-Patagonia 205.310.042-ISP of Universidad de Concepción. We also acknowledge an NSF-PIRE award (OISE 0530267) for support of collaborative research on Patagonian Biodiversity.

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Recibido: 15.10.07
Aceptado: 17.05.08