



A review knowledge of Chilean crayfishes (Decapoda: Parastacidae)

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Abstract

The Chilean crayfishes belong to family Parastacidae, and it included the genus *Parastacus* (*P. pugnax* and *P. nicoletti*), *Samastacus* (*S. spinifrons*), and *Virilastacus* (*V. araucanius*, *V. jarai*, *V. retamali*, and *V. rucapihuelensis*). This family is widespread from Central Chile to central southern Chile (33-46°S) specifically *P. pugnax* and *S. spinifrons*, whereas the other species are restricted between 38-40° S. It remarks that Parastacidae family is restricted to south of Chile and south of Brazil in subtropical latitudes. All species inhabits of *Parastacus* and *Virilastacus* in flooded plains in underground galleries, whereas *S. spinifrons* live in rivers. The species are endemic and endangered due habitats reduction and human exploitation as food in rural zones. The ecology of these species indicated that they fed mainly on vegetal matter, whereas their predators are mainly aquatic birds. There are not parasites reported, whereas it was reported the presence of ectocomensals, such as peritriches ciliates and temnocephalids. Within the reported species, only *P. pugnax* and *S. spinifrons* are important as human food in rural zones nevertheless there are not regulations for their extractions, and it was done initial studies for this aquaculture in southern Chile.

Keywords: Parastacidae, *Parastacus*, *Samastacus*, *Virilastacus*, fisheries, aquaculture.

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Introduction

The Chilean crayfishes include endemic species that are reported only for Chile (Rudolph, 2013a; Krandall & Rudolph, 2012), and *S. spinifrons* that it is reported also for south of Argentina, close to Chilean boundary. These situation involves marked genetic isolation of populations (Crandall *et al.*, 2020; Amador *et al.*, 2021, 2022; Ji *et al.*, 2020; De los Ríos-Escalante *et al.*, 2022a).

The Chilean crayfishes included species such as southern Chilean river crayfish *Samastacus spinifrons* (Phillippi, 1882) that inhabits between 33°-41° S, probably at 46°S, and Nahuelhuapi lake in Argentina (Rudolph, 2002, 2013a), *Parastacus pugnax* (Poepfig, 1835) that is located in flooded plains called “vegas” (Rudolph, 2013a,b), being these both species important for human consumption in local rural communities (Jara *et al.*, 2006; Rudolph, 2002, 2013a,b). Also, there are the presence of species of *Virilastacus* genus with the species *V. araucanius* Faxon, 1914, *V. retamali* Rudolph & Crandall 2007, *V. rucapihuelensis* Rudolph & Crandall, 2005, , and *V. jarai* Rudolph & Crandall 2012, (Rudolph, 2013a, 2015).

On this basis, the crayfish species reported in Chile are endemic and some of these are microendemic because are restricted in small localities (Rudolph, 2013b). These species are endangered due habitat reduction (Jara *et al.*, 2006). The aim of the present study is do a review of recent studies on Chilean crayfishes, with emphasis in study their

potential use as food resource for local communities.

Species reported for Chile

The crayfishes species reported for Chile on the basis of literature (Rudolph, 2013a,b; Rudolph & Crandall, 2005; 2007; 2012; De los Ríos-Escalante *et al.*, 2022a) are:

Parastacus nicoleti (Philippi, 1882).

Parastacus pugnax (Poepfig, 1835).

Samastacus spinifrons (Philippi, 1882).

Virilastacus araucanius (Faxon, 1914).

Virilastacus rucapihuelensis Rudolph & Crandall, 2005.

Virilastacus retamali: Rudolph & Crandall, 2007. Chile: Rucapihuel (40°35'S; 73°34'W) and Estaquilla (41°25'S; 73°46'W)(Rudolph & Crandall, 2007).

Virilastacus jarai Rudolph & Crandall, 2012.

Geographical distribution of Chilean crayfishes.

In according to Rudolph, 2013a,b; Rudolph & Crandall, 2005; 2007; 2012, De los Ríos-Escalante *et al.*, 2022a, the geographical (latitudinal) species distribution for each species is:

Parastacus nicoleti (Philippi, 1882): 39-40°S

Parastacus pugnax (Poepfig, 1835): 31-38°S

Samastacus spinifrons (Philippi, 1882): 33-46°S.

Virilastacus araucanius (Faxon, 1914): 36-40°S.

Virilastacus rucapihuelensis Rudolph & Crandall, 2005: 40°S.

Virilastacus retamali: Rudolph & Crandall, 2007: 40°S

Virilastacus jarai Rudolph & Crandall, 2012: 38°S.

More details are in fig. 1.

Ecological characterization

Only *Samatacus spinifrons* inhabits in lakes and rivers, whereas the remaining species inhabits mainly in swamps and flooded plains where excavate galleries (Rudolph, 2013a). The Chilean

crayfishes feed mainly with vegetal material and omnivorous diet, and their potential predators can be probably aquatic birds such as heron (*Casmerodiun albus*), and river otter (*Lontra provocax*) (Rudolph, 2013a), and probably native trouts (*Percichthys trutta*) and introduced salmonids (Encina *et al.*, 2017; Vega-Aguayo *et al.*, 2017, 2020).

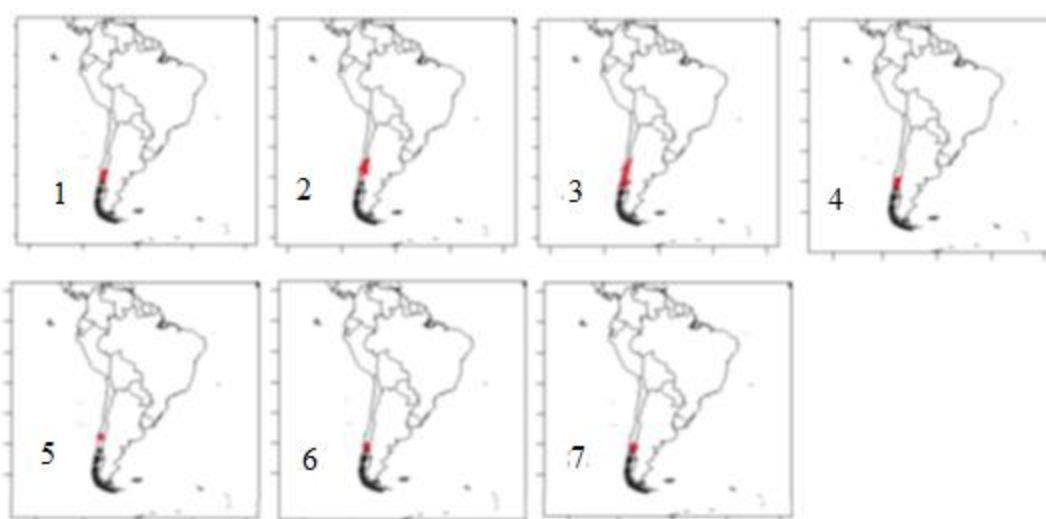


Fig. 1. Individual tracks of Chilean crayfishes: 1) *P. nicoletti*; 2) *P. pugnax*; 3) *Samastacus spinifrons*; 4) *Virilastacus araucanius*; 5) *V. jarai*; 6) *V. retamali*; 7) *V. rucapihuelensis*.

Reproductive behaviour and life cycle

S. spinifrons indicate low fecundity by female (< 200 eggs), and the maximum fecundity period is approximately between October to February (Spring and Summer), there is direct development without larval stages (Rudolph, 2002, Rudolph *et al.*, 2010). Similar results were described for *P. pugnax* (Rudolph, 2013b), the development time between embryonic

stages to juvenile liberation can late approximately 45 days (Rudolph, 2013b). There is not published information for other species of *Parastacus* and *Virilastacus* genus in Chile.

Parasites and commensals

The literature does not reveal the existence of parasites that affect Chilean crayfishes (Rauque & De los Rios-Escalante, 2013; Rudolph *et al.*, 2010; Rudolph, 2013b). Although, it is

possible found the existence of endoparasite *Psorospermium haeckeli* that affect ovarium of *P. pugnax* (Rudolph, 2013b).

The literature revealed the existence of ectocomensals, such as peritrich ciliates that inhabits in gills, such as genus *Operculigera* Kane, 1969 with the species *O. asymmetrica* Clamp, 1991, *O. insolita* Clamp, 1991, *O. parastaci* Jankowski, 1986, *O. seticola* Clamp, 1991, *O. striata*, Jankowski, 1986, and *O. taura* Clamp, 1991, whereas the genus *Lagenophrys* has the species *L. andos* Jankowski, 1986 and *L. antichos* Clamp, 1991 (Jankowski, 1986; Clamp, 1991; Fernandez-Leborans & Toto-Porto, 2000; De los Rios-Escalante *et al.*, 2022b, 2023).

Also, the literature review the presence of ectocomensals of *Temnocephala chilensis* (Platyhelminthes), and *Stratiodrillus pugnaxi* (Polychaeta) as ectocomensals for *Parastacus pugnax* and *Samastacus spinifrons* that inhabits in caparace and branchial cavity respectively (Rudolph, 2002, 2013b; De los Ríos-Escalante *et al.*, 2014; De los Rios-Escalante *et al.*, 2022b, 2023).

Human exploitation of Chilean crayfishes

In Chilean crayfishes, the species *P. pugnax* is a seasonal human food source for rural populations between 34-38°S, that is captured mainly in winter when their habitats are flooded by winter rains (Rudolph, 2013a,b). A different situation occurs with *S. spinifrons* that is captured mainly between December

to April, and it is captured mainly at south of 40°S (Rudolph, 2013b; Rudolph *et al.*, 2010). There are not studies about fisheries captures of Chilean crayfishes, but in according to the literature many species are endangered or vulnerable due habitats reduction or excessive capture (Jara *et al.*, 2006; Rudolph 2013a,b; Rudolph *et al.*, 2010). Nevertheless there are initial studies about potential resource for local aquaculture for *P. pugnax* (Rudolph, 2013b) and *S. spinifrons* (Rudolph *et al.*, 2010; Salgado-Leu & Tacon, 2015).

On this view point it is necessary do more studies about ecology, specifically feed behaviour and life cycle, as well as experiments related with growth under laboratory and outdoors systems with proposal of generate basis information for Chilean crayfishes farming at small scale. Also it is necessary do more studies for estimate the abundance under natural conditions of crayfishes species, as well as fisheries capture volume for understand the population dynamics of populations.

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References

Amador, L., Victoriano P.F., and D'Elía, G., 2021. Molecular

- species delimitation reveals hidden specific diversity within a freshwater burrowing crayfish (Decapoda: Parastacidae) from southern Chile, *Systematics Biodiversity*, 19: 237-251. <https://doi.org/10.1080/14772000.2020.1865471>
- Amador, L., Leaché, A.D., Victoriano, P.F., Hickerson, M.J., and D'Elía, G., 2022.** Genomic scale data shows that *Parastacus nicoleti* encompasses more than one species of burrowing continental crayfishes and that lineage divergence occurred with and without gene flow. *Molecular Phylogenetic and Evolution*, 169: 107443. <https://doi.org/10.1016/j.ympev.2022.107443>
- Clamp, J.C., 1991.** Revision of the family Lagenophryidae Butschli, 1889 and description of the family Usconophryidae n. fam. (Ciliophora: Peritricha). *Journal of Protozoology*, 38: 353-377. doi: 10.1111/j.1550-7408.1991.tb01373.x
- Correa-Araneda, F., Núñez, D., Díaz, M.E., Gómez-Capponi, F., Figueroa, R., Acuña, J., Boyero, L., and Esse, C., 2021.** Comparison of sampling methods for benthic macroinvertebrates in forested wetlands. *Ecological Indicators*, 125: 107551. <https://doi.org/10.1016/j.ecolind.2021.107551>
- Crandall, K.A., Fetzner, J.W., Jara C.G., and Buckup, L., 2000.** On the phylogenetic positioning of the South American freshwater crayfish genera (Decapoda: Parastacidae). *Journal of Crustacean Biology*, 20: 530-540.
- De los Ríos-Escalante P, Salgado, I., Rauque, C., and González, N., 2014.** Probabilistic model for understand the presence of *Temnocephala chilensis* (Moquin-Tandon 1846) (Platyhelminthes: Temnocephalidae) on adults of a population of *Parastacus pugnax* (Poeppig 1835) (Decapoda: Parastacidae) in southern Chile. *Gayana* 78: 81-84. <http://dx.doi.org/10.4067/S0717-65382014000200001>
- Encina, F., Vega, R., Lara, G., and De los Ríos-Escalante, P., 2017.** Ecological role of benthic crustaceans in Chilean North Patagonian lakes and rivers (Araucania region, 39° S). *Crustaceana* 90: 437-447. <http://dx.doi.org/10.1163/15685403-3-00003643>
- De los Ríos-Escalante, P. P. Jara-Seguel, A. Contreras, M. Latsague, G. Lara, E. Rudolph, & K. Crandall, 2022a.** Distributonal patterns of the south American species of Parastacidae (Decapoda, Astacidea). *Crustaceana*, 95: 1123-1136. <https://doi.org/10.1163/15685403-bja10247>
- De los Ríos-Escalante, P. P. Jara-Seguel, A. Contreras, M. Latsague, G. Lara, & C. Leal-Bastidas, 2022b.** A review of

- ectocommensals and parasites of Chilean crayfishes (Decapoda, Parastacidae), with emphasis on *Temnocephala chilensis* (Moquin-Tandon, 1846). *Crustaceana*, 95: 1137-1144.
<https://doi.org/10.1163/15685403-bja10240>
- De los Ríos-Escalante, P. R., Jara-Seguel, P., Contreras, A., Latsague, M., & Lara, G. 2023.** An update and review of commensals on Chilean inland water Decapoda, *Crustaceana*, 96(3), 271-280.
<https://doi.org/10.1163/15685403-bja10278>
- Fernández-Leborans, G. and Tato-Porto. M.L., 2000.** A review of the species of protozoan epibionts on crustaceans. I. Peritrich ciliates. *Crustaceana*, 73: 643-683.
<https://doi.org/10.1163/15685400-0504705>
- Jankowski, A., 1986.** New and little known genera of ciliated Protozoa (phylum Ciliophora). *Proceedings Zoological Institute Leningrad*, 144: 72-88. [In Russian with English abstract]
- Jara, C.G., Rudolph E., and González, E., 2006.** Estado de conocimiento de los malacostráceos dulceacuícolas de Chile. *Gayana*, 70: 40-49.
<http://dx.doi.org/10.4067/S0717-65382006000100008>
- Ji, S-J., Ahn D-H., and Min, G-S., 2020.** The complete mitochondrial genome of the South American freshwater crayfish, *Parastacus nicoleti* (Crustacea, Decapoda, Parastacidae), *Mitochondrial DNA Part B*, 5: 208-209. doi: 10.1080/23802359.2019.1699457
- Rauque, C., and De Los Ríos-Escalante, P., 2013.** Patagonian inland water malacostracans as host for parasites. *Crustaceana* 86: 1520-1526.
<https://doi.org/10.1163/15685403-00003262>
- Rudolph, E.H., 2002.** Sobre la biología del camarón de río *Samastacus spinifrons* (Philippi, 1882)(Decapoda, Parastacidae). *Gayana*, 66: 147-159.
<http://dx.doi.org/10.4067/S0717-65382002000200009>
- Rudolph, E.H., and Crandall, K.A., 2005.** A new species of burrowing crayfish, *Virilastacus rucapihuelensis* (Crustacea: Decapoda: Parastacidae), from southern Chile. *Proceedings of the Biological Society of Washington*, 118: 765-776.
[http://dx.doi.org/10.2988/0006-324X\(2005\)118\[765:ANSOBC\]2.0.CO;2](http://dx.doi.org/10.2988/0006-324X(2005)118[765:ANSOBC]2.0.CO;2)
- Rudolph, E.H., and Crandall, K.A., 2007.** A new species of burrowing crayfish *Virilastacus retamali* (Decapoda, Parastacidae) from the southern Chile peatland. *Journal of Crustacean Biology*, 27: 502-512.
<http://dx.doi.org/10.1651/S-2681.1>

- Rudolph, E., F. Retamal & A. Martínez, 2010.** Cultivo de camarón de río *Samastacus spinifrons*: ¿una nueva alternativa para la diversificación de la acuicultura chilena? *Latin American Journal of Aquatic Research*, 38: 254-264. <http://dx.doi.org/10.3856/vol38-issue2-fulltext-10>
- Rudolph, E.H., and Crandall, K.A., 2012.** A new species of burrowing crayfish *Virilastacus jarai* (Crustacea, Decapoda, Parastacidae). *Proceedings of the Biological Society of Washington*, 125: 258–275. <https://doi.org/10.2988/11-39.1>
- Rudolph, E.H., 2013a.** Freshwater malacostracans in Chilean inland waters: a checklist of the Chilean Parastacidae (Decapoda, Astacidea). *Crustaceana*, 86: 1468-1510. <https://doi.org/10.1163/15685403-00003257>
- Rudolph, E.H., 2013b.** *Parastacus pugnax* (Poeppig, 1835) (Crustacea, Decapoda, Parastacidae): conocimiento biológico, presión extractiva y perspectivas de cultivo. *Latin American Journal of Aquatic Research*, 41: 611-632. <http://dx.doi.org/103856/vol41-issue4-fulltext-1>
- Salgado-Leu, I., and Tacon, A.G.J., 2015.** Effects of different protein and carbohydrate contents on growth and survival of juveniles of southern Chilean freshwater crayfish, *Samastacus spinifrons*. *Latin American Journal of Aquatic Research*, 43: 836-844. <http://dx.doi.org/10.3856/vol43-issue5-fulltext-4>
- Vega, R., De los Ríos-Escalante, P., Encina F., and Mardones, A., 2017.** Ecology of benthic crustaceans in the Cautin river (38°S, Araucania region, Chile). *Crustaceana* 90: 709-719. <http://dx.doi.org/10.1163/15685403-00003689>
- Vega, R., De los Rios, P., Encina, F., Norambuena, J.A., Barile, J., and Mardones, A., 2020.** First report of inventory and role of macroinvertebrate and fish in Cautin river (38° S, Araucania region, Chile). *Brazilian Journal of Biology*, 80: 215-228. <https://doi.org/10.1590/1519-6984.203511>