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Helminths of the kelp gull, *Larus dominicanus*, from the northern Patagonian coast

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Abstract The helminth community of *Larus dominicanus* (Charadriiformes) is reported from Península Valdés, on the Patagonian coast, Argentina. From March 2000 to April 2004, 29 kelp gulls were collected and dissected. All the birds were parasitized by at least 2 of 18 parasite species: 2 cestodes (1 Tetrabothriidae, 1 Dilepididae), 10 trematodes (2 Echinostomatidae, 3 Microphallidae, 2 Gymnophallidae, 1 Philophthalmidae, 1 Dicrocoeliidae, 1 Diplostomatidae), 4 nematodes (2 Acuariidae, 1 Capillaridae, 1 Anisakidae), and 2 acanthocephalans (Polymorphidae). The mean intensity was 3,204 parasites per host, and all helminths parasitized the gastrointestinal tract or associated glands. The helminth community of *L. dominicanus* on the Peninsula Valdés coast seems to be richer than those reported by previous authors in other localities in Argentina. This could be due to a greater diversity in prey items available. Nine species are recorded for the first time from the kelp gull and seven species are recorded for the first time from Argentina.

Marine littoral and sublittoral zones harbour an abundant diversity of invertebrates and fishes and a great number of birds that prey on them, sustaining the complex life cycles of helminths in the area. Similarly, through their complex life cycles, helminths are coupled with the surrounding free-living diversity of vertebrate and invertebrate animals (Hechinger et al. 2007).

The knowledge of the richness and diversity of bird parasites in littoral areas may provide important knowledge about interactions, trophic webs, and compound community structure, mainly in those regions where the abundance of shorebirds (mostly gulls) is increasing as a result of human activities such as fishing ports (Galaktionov and Skirnisson 2000).

The kelp gull *Larus dominicanus* is one of the most abundant and widely distributed birds in the southern hemisphere (del Hoyo et al. 1996). Its reproductive areas on the coast extend from northern Peru in the west and south of Brazil in the east to Tierra del Fuego, Islas Malvinas, Sub-Antarctic Islands, and the Antarctic Peninsula (del Hoyo et al. 1996). In Argentina, kelp gull populations were estimated at more than 75,000 reproductive pairs (Yorio et al. 1998) distributed in a wide variety of environments along the Atlantic littoral and continental waters (del Hoyo et al. 1996). In the Patagonian region, this species is one of the main components of the bird marine assemblage in the intertidal zone and other coastal environments (Bertellotti et al. 2003).

In the northern hemisphere, species of *Larus* have been the focus of a large number of helminthological studies, most of them limited to single reports or descriptions of parasite species (e. g. Wong and Anderson 1982b; Kostadinova 1996). Parasitological knowledge of *L. dominicanus* in the southern hemisphere is limited to similar reports (e. g., Cremonte and Navone 1999; Cremonte et al. 2000; Diaz et al. 2004; Diaz and Cremonte 2004, 2010; Gonzalez Acuña et al. 2009).

The aim of this paper is to report and compare the helminth richness of the kelp gull *L. dominicanus* feeding in the intertidal zone of the Península Valdés coasts (Chubut Province, Argentina) with other populations in different areas and environments and with other diet

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behaviours. Considering the great diversity of invertebrates, fishes, and birds that inhabit this zone, we expected that kelp gulls from Península Valdés would show higher helminth richness than other populations. The diet of the host in the area was also evaluated.

Materials and methods

From March 2000 to April 2004, 29 kelp gulls, *L. dominicanus* (Aves: Laridae), were collected from Península Valdés coasts and adjacent areas (24 adults from Fracasso Beach, 42°25′ S–64°07′ W, San José Gulf, and five adults from Puerto Madryn Beach, 42°47′ S–65°02′ S, Nuevo Gulf) of Chubut Province, Argentina (permits from the Protected Areas and Tourism Subsecretary, General Direction of Protected Areas Conservation, Chubut Province). The birds were captured using a net, killed with ether, and transferred as soon as possible to the laboratory for dissection. The gastrointestinal tract was separated into oesophagus, stomach, and intestine; this last organ was divided into three equal sections. The body cavity, liver, pancreas, biliary vesicle, gall bladder, gonads, lungs, heart, bursa of Fabricius, and kidneys were also examined for parasites. The viscera were examined under a stereomicroscope. Helminths recovered from each section were counted, fixed in 5% hot formalin, and preserved in 70% ethanol. Cestodes were stained in Harris haematoxylin, and digeneans, with Semichon's carmine, dehydrated in a graded ethanol series, cleared in methyl salicylate, and mounted in Canada balsam. Some specimens of digeneans were embedded in paraffin, sectioned in transversal and sagittal views of 8–10 μm thickness, and stained in haematoxylin–eosin. Nematodes and acanthocephalans were cleared in lactophenol or in 25% glycerinealcohol. All species were studied using a light microscope. Some specimens of each species collected were dehydrated, dried by the critical point method, gold coated, observed, and photographed using a scanning electron microscope (JEOL/JSMT 6360 LV, Tokyo, Japan) from the Museo de La Plata, La Plata, Argentina. The terms prevalence (*P*), mean intensity (MI), and community were interpreted and calculated according to Bush et al. (1997). Specimens were deposited in the Helminthological Collection of the Museo de La Plata (MLP), La Plata, and in the Parasitological Collection of the Centro Nacional Patagónico (CNP-Par), Puerto Madryn, Argentina.

Stomach contents were collected from each bird and analysed, and prey items were identified.

Results

A total of 306,996 parasites were collected. Most of the parasite specimens (217,270 belonging to three helminth species) were found in one individual bird. Excluding this individual, the mean intensity was 3,204 parasites per host. All birds were parasitized by at least 2 of the 18 parasite taxa found (2 cestodes, 10 digeneans, 4 nematodes, and 2 acanthocephalans). After dissection of the tenth bird, no new parasite species was recorded. The helminths were found in the oesophagus, stomach, intestine, pancreas, biliary vesicle, bursa of Fabricius, and cloaca. No parasites were found in the body cavity or other viscera examined.

The species parasitizing the kelp gull in the northern Patagonian coast were the following:

Cestoda

Tetrabothriidea Baer 1954; Tetrabothriidae Linton, 1891

***Tetrabothrius cylindraceus* (Rudolphi, 1819)** (Fig. 1)

Site of infection: intestine, mainly the first section. *P*, 38%; MI, 50.

Deposited specimens: MLP no. 6304 and CNP-Par no. 7.

Remarks: Tetrabothriidean cestodes are widely distributed among marine mammals and seabirds with *Tetrabothrius* as the largest genus, including more than 40 species parasitizing seabirds (Baer 1954; Schmidt 1986; Hoberg 1994). Three species were reported from gulls of the genus *Larus* around the world, *Tetrabothrius erostris* (Lonnberg, 1899) found in the northern hemisphere (e. g. Schmidt 1986; Hoberg 1994), *Tetrabothrius argentinum* Szidat 1964 from *L. dominicanus*, *Larus maculipennis*, and *Larus cirrocephalus* in freshwater environments in Buenos Aires and Santa Fe Provinces, Argentina (Szidat 1964; Labriola and Suriano 2001), and *Tetrabothrius cylindraceus*, a cosmopolitan species reported in Europe and North and South America (Baer 1954; Threlfall 1968; Roca et al. 1999; Gonzalez Acuña et al. 2009). Odening (1982) also reported this last species in kelp gulls from Malvinas Islands.

Cyclophyllidea van Beneden in Braun, 1900; Dilepididae Raillet and Henry, 1909

***Anomotaenia dominicana* (Raillet and Henry, 1912)** (Fig. 2)

Site of infection: intestine, mainly the first section. *P*, 69%; MI, 73.

Deposited specimens: MLP no. 6305 and CNP-Par no. 8.

Remarks: Dilepidid cestodes are very common parasites of birds including more than 100 genera that exhibit host specificity at the order level of the host (Schmidt 1986; Bona 1994). *Anomotaenia dominicana* was recorded in *L. dominicanus* from South Shetland Islands (Antarctica) (Zdzitowiecki and Cielecka 1984). Among *Larus* species in South America, this species was reported from *L. dominicanus* and *L. maculipennis* in lakes from Chile and from *L. dominicanus* in landfills and Patagonian lakes in Argentina (Torres et al. 1991, 1993; Kreiter and Semenas 1997).

Digenea

Dicrocoeliidae Looss, 1899; Dicrocoeliinae Looss 1899

***Lyperosomum* Looss, 1899** (Fig. 3)

Site of infection: pancreas. *P*, 10.3%; MI, 5.7.

Deposited specimens: MLP no. 6306 and CNP-Par no. 16.

Remarks: A large number of species of *Lyperosomum* have been described as parasites of the bile ducts and gall bladder, several of them using birds as definitive hosts (Pojmanska 2008). In *L. dominicanus*, the only species of this genus reported is *Lyperosomum lari* from Brazil (Yamaguti 1971) which was later transferred to the genus *Brachylecythum* Shtrom, 1940. In Argentina, the only report of the genus is *Lyperosomum oswaldoi* (Travassos 1920) Travassos 1944 from the mammal *Molothrus bonariensis* (Lunaschi et al. 2007). This report constitutes the southernmost for the genus and the first for birds in Argentina.

Echinostomatidae Poche, 1926; Himasthlinae Odhner, 1910

***Stephanoprora podicipei* Etchegoin and Martorelli** 1997 (Fig. 4)

Site of infection: intestine, the last section. *P*, 20.7%; MI, 54.

Deposited specimens: MLP no. 6307 and CNP-Par no. 9.

Remarks: A large number of species of this genus have been described parasitizing mainly Charadriiformes (Yamaguti 1971). Previously, *Stephanoprora brachyrhynchus* Gupta, 1963; *Stephanoprora dogieli* Holcman-Spector and Olagüe, 1989; *Stephanoprora denticulata* (Rudolphi, 1809); and *Stephanoprora uruguayense* Holcman-Spector and Olagüe, 1989 were recorded in *L. dominicanus* (Ostrowski de Nuñez et al. 2004; Lunaschi et al. 2007). Ostrowski de Nuñez et al. (2004) reviewed the species of the genus reported for South American birds and considered *S. dogieli*, *S. podicipei* Etchegoin and Martorelli 1997, and *S. denticulata* (sensu Torres et al. 1983) as possible synonyms of *S. uruguayense*. Recently, the validity of *S. podicipei* was re-established on the basis of new surveys (Ostrowski de Núñez, personal communication). This is the first record of the species parasitizing *L. dominicanus*.

***Himasthla escamosa* Diaz and Cremonte** 2004 (Fig. 5)

Site of infection: intestine, mainly the last section. *P*, 3.4%; MI, 18.

Deposited specimens: MLP nos. 5 233 and 5234, and CNP-Par no. 6.

Remarks: Of the 14 species of *Himasthla* recorded in the western hemisphere, three have been reported from South America: *Himasthla alincia* Dietz, 1909 and *Himasthla piscicola* Stunkard, 1960 were reported in Brazil (Travassos et al. 1969), and *Himasthla limnodromi* Didyk and Burt 1997 in Venezuela (Didyk and Burt 1997). Diaz and Cremonte (2004) described *H. escamosa* parasitizing *L. dominicanus* in Patagonia. Later, this species was recorded from *Larus atlanticus* in Buenos Aires Province, Argentina (La Sala et al. 2009) and *L. dominicanus* in Talcahuano, Chile (Gonzalez Acuña et al. 2009).

Philophthalmidae Travassos, 1918; Parorchiinae (Lal, 1936)

***Parorchis* sp. Nicoll, 1907** (Fig. 6)

Site of infection: cloaca, rectum, and bursa of Fabricius. *P*, 41.4%; MI, 15.

Deposited specimens: MLP no. 6308 and CNP-Par no. 15.

Remarks: In South America, there are only two species described in this genus, *Parorchis pittacium* (Broun, 1901) Travassos, 1922, and *Parorchis proctobium* (Travassos, 1918) Travassos 1921, both from Brazil (Travassos et al. 1969). *Parorchis acanthus* parasitizes the cloaca and bursa of Fabricius of many species of shorebirds, mainly Charadriiformes, and has a wide geographical distribution in Europe and North and Central America (Dronen and Blend 2008). Specimens recovered from this study resemble *P. acanthus*. However, an ongoing molecular analysis suggests a difference of Argentinian worms from *P. acanthus* in North America (Tkach, unpublished data). Molecular and morphological comparisons of European, North American, and South American material will provide an adequate answer to this question. This finding constitutes the first report of the genus for Argentina.

Microphallidae Travassos, 1920; Maritrematinae Belopol'skaia, 1952

***Maritrema* (*Maritrema*) Nicoll, 1907** (Figs. 7 and 8)

Site of infection: intestine. *P*, 45%; MI, >1,000.

Deposited specimens: MLP nos. 6087 and 6088 and CNP-Par nos. 11 and 13.

Two species of this genus were identified in this community, *Maritrema madrynensis* Diaz and Cremonte 2010 and *Maritrema* sp.

Remarks: *Maritrema* Nicoll, 1907 (Microphallidae) is a genus with numerous species parasitizing mainly shorebirds (Yamaguti 1971; Deblock 2008). Only two species of this genus had been previously reported from Argentinean waters, *Maritrema bonaerensis* Etchegoin and Martorelli 1997 from *L. atlanticus*, *L. maculipennis*, and *L. dominicanus* (Etchegoin and Martorelli 1997; La Sala et al. 2009) and *Maritrema orensensis* Cremonte and Martorelli 1998 from *L. dominicanus* and *L. atlanticus* (Cremonte and Martorelli 1998; La Sala et al. 2009). During this survey, two new species were found parasitizing *L. dominicanus* in Península Valdés. Both of them belong to the "eroliae group", *M. madrynensis* (Diaz and Cremonte 2010) (Fig. 7) and an apparently undescribed species (Fig. 8).

***Odhneria odhneri* Travassos, 1921** (Fig. 9)

Site of infection: intestine. *P*, 7%; MI, 67.

Deposited specimens: MLP no. 6309 and CNP-Par no. 10.

Remarks: This species is widely distributed in the western hemisphere, parasitizing several bird families (Anatidae, Ardeidae, Charadriidae, Laridae, Scolopacidae, and Phalacrocoracidae) (Sinclair 1971). In Argentina, it was reported from *Phalacrocorax brasilianus* (Phalacrocoracidae) and *L. dominicanus* on the Patagonian coast (Cremonte and Etchegoin 2002), and from *L. atlanticus* on the Buenos Aires coast (La Sala et al. 2009).

Gymnophallidae Odhner, 1905; Gymnophallinae Odhner, 1905

Site of infection: intestine, mainly the last section. *P*, 65%; MI, >1,000.

We found two species belonging to different genera, *Bartolius pierrei* Cremonte 2001 and *Gymnophallus australis* Szidat, 1962.

***Bartolius pierrei* Cremonte** 2001 (Fig. 10)

Deposited specimens: MLP no. 6310 and CNP-Par no. 12.

Remarks: This species was described based on specimens from *L. dominicanus* from Península Valdés and by the experimental development of the metacercariae in the clam *Darina solenoides*, the only known second intermediate host (Cremonte 2001, 2004). In spite of minimal morphometrical differences, the specimens found in this survey fully agree with those of the original description.

***Gymnophallus australis* Szidat, 1962** (Fig. 11)

Deposited specimens: MLP no. 6311 and CNP-Par no. 14.

Remarks: *Parvatrema australis* (Szidat, 1962) Szidat, 1965 was described based on larval stages found in one specimen of the mussel *Mytilus edulis* from the Buenos Aires Province, Argentina. Although Szidat (1965) later examined hundreds of mussels, this parasite has never been found again, because the mussels came from 60 m in depth, unavailable to birds that could act as a final host. Cremonte et al. (2008) found the same larval stages in mytilids from the intertidal zone of the Patagonian coast and obtained the adult form by in vitro cultivation; these authors redescribed the species and changed the generic assignation to *Gymnophallus*. Considering the present record, it appears that *G. australis* is distributed from Península Valdés to the Beagle Channel (F. Cremonte, unpublished data).

Nematoda

Spirurida (Diesing, 1861); Acuariidae (Seurat, 1913); Acuariinae Raillet, Henry and Sisoff, 1912

***Cosmocephalus obvelatus* (Creplin, 1825)** (Fig. 12)

Site of infection: oesophagus. *P*, 41%; MI, 8.5.

Deposited specimens: MLP no. 4811 and CNP-Par no. 17.

Remarks: *Cosmocephalus obvelatus* had been reported on all continents except Antarctica in a variety of families of fish-eating birds (Anderson and Wong 1981; Wong and Anderson 1982a). In species of *Larus*, this nematode had been found in Canada, Brazil, Spain, and New Zealand, among others (e. g. Krishna Rao 1951; Rodrigues de Olivera and Vicente 1963). Diaz et al. (2001, 2010) reported this species from Argentina in the Magellanic penguin. In spite of some minimal morphometrical discrepancies, this species seems to exhibit great morphological stability, indicating a wide adaptability to different hosts and localities.

***Paracuaria adunca* (Creplin, 1846)** (Fig. 13)

Site of infection: oesophagus. *P*, 62%; MI, 6.

Deposited specimens: MLP no. 5282 and CNP-Par no. 18.

Remarks: *Paracuaria adunca* is a frequent parasite of piscivorous birds of several groups (Laridae, Gaviidae, Podicipedidae, Diomedeidae, Anatidae, Alcidae, Pelecanidae, and Rynchopidae) and has been reported from many localities (North and Central America, Europe, and Asia) (Wong and Anderson 1982b). Diaz et al. (2004) reported the species for the first time in South America and from *L. dominicanus*. Later, the species was found from the same host in Chile (Gonzalez Acuña et al. 2009).

Acanthocephala

Echinorhynchidea (=Paleoacanthocephala); Polymorphidae Meyer, 1931

***Profilicollis chasmagnathi* (Holcman-Spector, Mañé-Garzón and Dei-Cas, 1977)** (Fig. 14)

Site of infection: intestine, mainly the middle section. *P*, 31%; MI, 4.5.

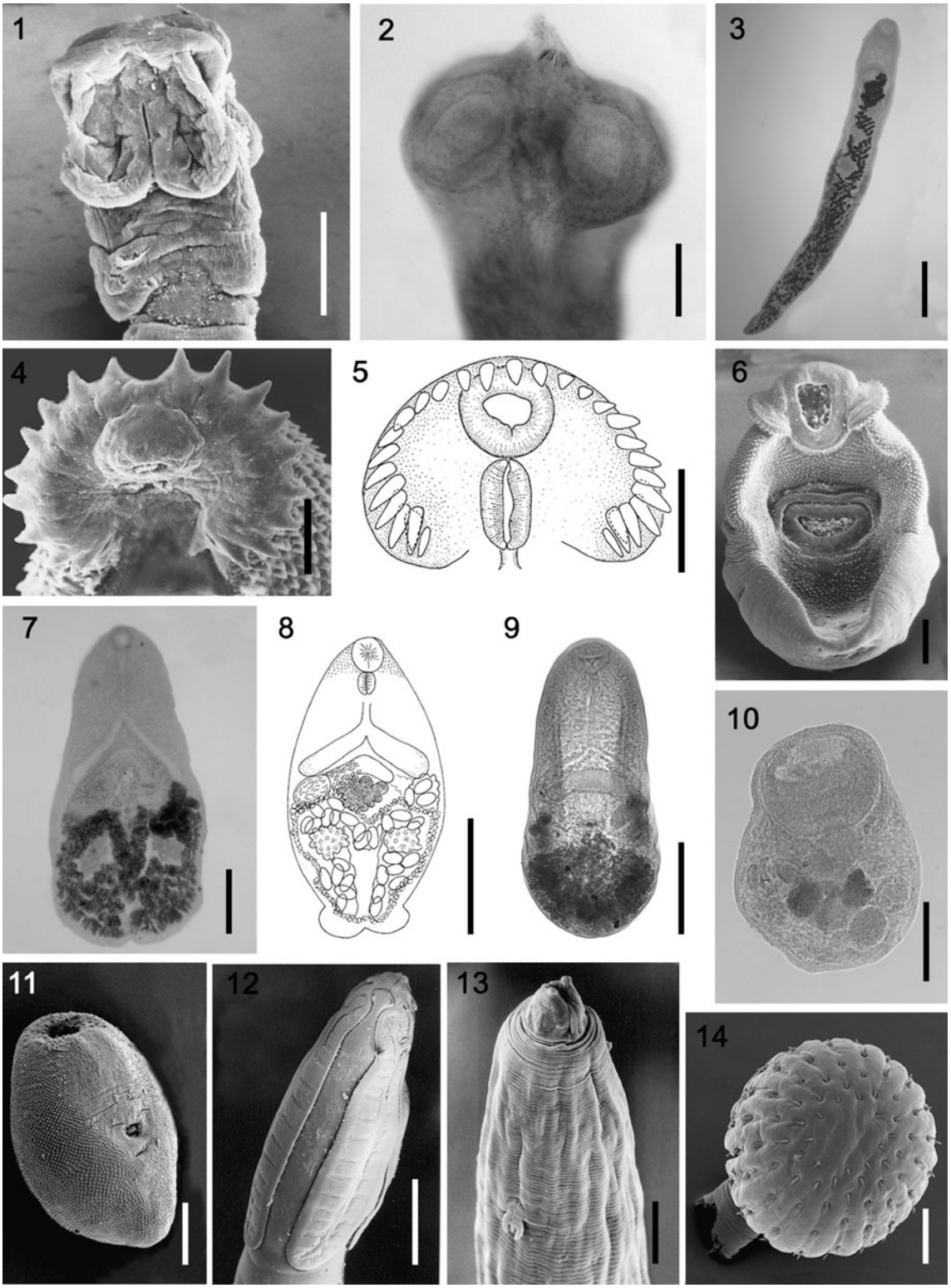
Deposited specimens: MLP no. 6312 and CNP-Par no. 19.

Remarks: The family Polymorphidae includes at least ten genera (Amin 1992). There are two reports of the family in Argentina, *P. chasmagnathi* in birds from Buenos Aires Province (La Sala and Martorelli 2007) and *Profilicollis antarcticum* (Zdzitowiecki 1985) in freshwater birds from Patagonia (Torres et al. 1991, 1993; Kreiter and Semenas 1997). This is the southernmost report of *P. chasmagnathi* and the first for *L. dominicanus* in the Argentinean Sea.

In addition to the above-mentioned helminths, another four species were found parasitizing this kelp gull population: one trematode (*Diplostomum* sp., Diplostomatidae), two nematodes (*Eucoleus* sp., Capillaridae, and *Contracaecum* sp., Anisakidae), and one acanthocephalan (*Corynosoma* sp., Polymorphidae). However, they were not included in the preceding list because only a few immature specimens were recovered.

Diet analyses

Stomach analyses of gulls revealed a high consumption of molluscs (62%), fishes (31%), and crustaceans (14%).



Figs. 1–14 Helminth parasites of *L. dominicanus* from the northern coast of Patagonia. *1 T. cylindraceus*, scolex. *2 A. dominicana*, scolex. *3 Lyperosomum* sp., in toto. *4 S. podicipei*, anterior end showing head collar. *5 H. escamosa*, anterior end showing head collar. *6 Parorchis* sp., in toto. *7 M. madrynensis*, in toto. *8 Maritrema* sp., in toto. *9 O. odhneri*, in toto. *10 B. pierrei*, in toto. *11 G. australis*, in toto. *12 C. obvelatus*, anterior end. *13 P. adunca*, anterior end. *14 P. chasmagnathi*, proboscis. *Scale bars*: *13*=50 μm; *1–2*, *4–10*=100 μm; *11*, *14*=200 μm; *3*=500 μm

Among molluscs, bivalves showed the higher frequency (52%), followed by polyplacophorans (14%) (Table 1). The percentage of molluscs and crustaceans ingested was constant through the year, whereas that of fishes increased in summer months. No human or fishery discards were found.

Discussion

A total of 18 helminth species were recovered from 29 *L. dominicanus* individuals in this study. It is interesting to note that after examination of gull number 10, no new helminth species were recorded. Szidat (1964) reported 13 species parasitizing *L. dominicanus* from several inland localities from the Buenos Aires, Santa Fe, and Neuquén Provinces (*n* not given); however, only digeneans and cestodes were reported. Kreiter and Semenas (1997) recorded nine species from landfills and freshwater Patagonian lakes ($n=13$), whereas Labriola and Suriano (2001) found only eight species in gulls from the Mar del Plata landfill, Buenos Aires Province ($n=9$). Also, Latham and Poulin (2002) reported nine species parasitizing this host ($n=9$) on the New Zealand marine coast, and Gonzalez Acuña et al. (2009) reported 11 species in Talcahuano City, Chile ($n=90$, environment not provided). Some of the previous reports included immature stages of parasites or accidental records.

Table 1 Stomach contents of the 29 kelp gulls *L. dominicanus* from the Península Valdés coast

Item prey presence (frequency)		
Molluscs (62%)	Bivalvia (52%)	*Darina solenoides*
		Brachidontes rodriguezi
		Perumytilus purpuratus
		Mytilus edulis
		Amiantis purpuratus
		Lasaea adansoni
	Polyplacophora (14%)	*Chetopleura* sp.
	Gastropoda (3.4%)	*Fissurella* sp.
	Siphonopoda (4%)	*Octopus tehuelchus*
Fishes (31%)		*Odontesthes* sp.
		Undetermined fishes
Crustaceans (14%)		*Idotea baltica*
		Cyrtograpsus altimanus
		Undetermined Brachiura
		Undetermined Isopod
Echinoderms (10%)		*Ophioplocus* sp.
Insects (10%)		Undetermined Coleoptera
Polychaeta (4%)		Undetermined

Frequencies of the presence (percentage) of each prey item in the total gulls analysed

The kelp gull population from Península Valdés feeds in the rich intertidal community, including in its diet different molluscs (Gastropoda, Bivalvia, and Polyplacophora), crabs, and fishes, among other items (Bertellotti et al. 2003). The stomach analysis of birds from the present work revealed a high consumption of molluscs, mainly bivalves. Among bivalves, the clam *D. solenoides* is a significant prey item, mainly between January and April and coincident with an increase in the population abundance of this clam from the end of the austral summer to the beginning of autumn (D'Amico et al. 2004). This increment also was coincident with both greater prevalences and intensities of *B. pierrei* for which *D. solenoides* is the intermediate host (Cremonte 2004). Among crustaceans, one of the stomach items was *Cyrtograpsus altimanus*, which was previously reported as the second intermediate host of *M. madrynensis* in the area studied (Diaz and Cremonte 2010). The ingestion of molluscs and crustaceans was more or less constant through the year, whereas that of fishes heavily intensified in summer, which is directly related to an increase in abundance of small- and medium-size fishes in this season (Cousseau and Perrota 2000). In concordance, Carballo et al. (2011) reported larvae (L3) of the nematode *C. obvelatus* parasitizing the silversides *Odontesthes smitti* and *Odontesthes nigricans* in the same study area, an important item prey for *L. dominicanus*. Thus, the kelp gull population from Península Valdés has an opportunistic diet, taking advantage of the varied resources that the coast offers through the year, without the necessity of resorting to human discards for food. Since these birds have high prey diversity, the probability of a higher number and abundance of helminths is also increased. Considering that most marine helminths have complex life cycles, the elevated helminth richness could be explained by the euryphagic diet of the kelp gull in Península Valdés, corroborating that most life cycles of their helminths develop in this littoral zone. The helminth richness of *L. dominicanus* in the Península Valdés coast is higher than in other regions studied (Kreiter and Semenas 1997; Labriola and Suriano 2001; Latham and Poulin 2002). This fact could suggest a more varied and natural diet of gulls from the marine coast, supporting greater helminth diversity than those of inland, Patagonian lakes, and landfills.

Also, the finding of several larval stages of helminth parasites of birds indicates that other life cycles develop in the same area, using other bird species as definitive hosts, which share food items with *L. dominicanus*. This supports the conclusion of Balech and Ehrlich (2008) that the

intertidal zone of Patagonian shores supports a rich fauna of invertebrates and birds, fostering a complex web of life cycles in the area.

Future studies of parasites over different components of the coastal fauna in the area could help to elucidate the relationships between parasites and prey items, allowing us to understand the life cycles of bird helminths.

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