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On feeding and helminth fauna of neon flying squid *Ommastrephes bartramii* (Lesueur, 1821) (Cephalopoda: Ommastrephidae) in the southeastern Pacific

Alimentación y fauna de helmintos del calamar rojo *Ommastrephes bartramii* (Cephalopoda: Ommastrephidae) en el Pacífico sudeste

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Resumen.- Se analizó el contenido estomacal de 60 calamares *Ommastrephes bartramii* (160-392 mm mantle length, ML) recolectados en el Pacífico sudeste (entre 17° y 43°S), entre 1981 y 1984. Adicionalmente otros 22 calamares (165-365 mm ML) fueron examinaron por parásitos helmintos. Las principales presas fueron peces mictófidos (*Symbolophorus evermanni*, *Myctophum nitidilum*, *M. phengodes*, *Hygophum reinhardti*, *H. proximum*), *Diplospinus multistriatus*, *Argyropelecus affinis* y juveniles de Exocoetidae. Los calamares (principalmente *Onychoteuthis banksi* y *Abraliopsis affinis*) y los camarones, fueron presas secundarias, mientras que eufáusidos, anfípodos, moluscos octópodos y heterópodos fueron presas accidentales. El tamaño de las presas fue entre 8 y 440 mm, con un tamaño relativo de 3,2-77,2% de longitud absoluta (AL=ML + longitud de la cabeza y del brazo mas largo), mayoritariamente de 8-20% AL. El alimento en el estómago de las presas, principalmente mictófidos, se presentó en el 43,3% de los estómagos e incluyó copépodos, ostrácodos, anfípodos, eufáusidos, camarones, moluscos tecosomados, heterópodos y quetognatos. Se encontraron seis especies de helmintos parásitos en estado larval, con una prevalencia total de infección de 90,9%: los cestodos *Tentacularia coryphaenae* (prevalencia: 9,1%, rango de intensidad: 2-3), *Scyphophyllidium* sp. (4,5%, 12); el trematodo no identificado de Didymozoidae (86,4%, 6-1500); los nemátodos *Anisakis physeteris* (18,2%, 1-9), *Porrocaecum* sp. (36,3%, 1-21) y *Contracaecum* sp. (13,6%, 1-114). Sus ciclos de vida ocurren en cadenas tróficas de las comunidades pelágicas y los calamares se infectarían al comer crustáceos parasitados. *Ommastrephes bartramii* es un huésped transportador para las especies de helmintos estudiadas, cuyos huéspedes definitivos serían peces óseos (scombroideos y xifoideos), tiburones, mamíferos marinos y aves marinas.

Palabras clave: Hábitos de alimentación, fauna de helmintos

Introduction

The dominant oceanic nektonic squid *Ommastrephes bartramii* (Lesueur, 1821) is very widely distributed throughout the subtropical and lower-laltitude temperate zones of both hemispheres of the world ocean (Nesis, 1987). Its role in structure and functioning of the oceanic ecosystems is important, and has been the subject of study for the last three decades. However, geographical differences between feeding and parasitological characteristics of this species have not been extensively studied. The feeding ecology and helminth fauna was studied in the North Pacific (Shevtsov 1972, Wormuth 1976, Naito *et al*. 1977, Bower & Margolis 1991, Sinclair 1991, Seki 1993, Nagasawa *et al*. 1998, Watanabe *et al*. 2004, Bower & Ichii 2005, Young 2005, Parry 2006, 2008), the North and South Atlantic (Gaevskaya & Nigmatullin 1976, Nigmatullin & Pinchukov 1976[1], Gaevskaya *et al*. 1986, Lipinski & Linkowski 1988, Hernandez-Garsia 1995, Lordan 2001, Ivanovic & Brunetti 2004) and the Indian Ocean and Australian waters (Filippova 1974, Dunning 1998), but squids from the southeastern part of the Pacific Ocean have not been investigated. There are only very scanty and superficial data on food of this squid in the central and eastern parts of the South Pacific with food organisms identified to higher taxon level only (Polezhaev 1986, Alexeev 1994) and several preliminary brief publications (Gaevskaya *et al*. 1983, Nigmatullin *et al*. 1985). The goal of this paper is to describe the food and helminth compositions of neon flying squid in the subtropical open waters of the southeastern Pacific.

[1]Nigmatullin ChM & MA Pinchukov. 1976. The feeding of Bartram squid *Ommastrephes bartrami* Les. in the Atlantic Ocean and Mediterranean Sea. In: AtlantNIRO conference 'Problems of investigation of pelagic fish and invertebrates of the Atlantic Ocean'. Abstracts of communications. AtlantNIRO Press, Kaliningrad, p. 20. [In Russian]

Material and methods

Squids used for this study were collected during 1981-1984 aboard AtlantNIRO research vessels at night-lighting drift stations in the south part of the eastern Pacific (Fig. 1). The squids were caught with hand jigs. The squid were immediately frozen after capture and examined for food and helminths 4-6 months later. Squid were analyzed with identification of dorsal mantle length (ML), absolute length (AL), sex, stage of maturity and stomach fullness (six-point scale by Zuev *et al*. 1985).

Feeding

Squids used for the food composition study were collected in the area between 17-32°S and 79-95°W in April 1981, July and November-December 1982 and January 1984 (Fig. 1). Stomach contents were studied on 60 squids of ML 160-392 mm including 40 squids with full stomachs (fullness degree 3-5). From the total squids, 56 were males of ML 160-392 mm and 4 were females of ML 166-240 mm. Crustacean food items were identified by eyes, mandibles, maxillipeds, thoracic limbs and chitinous integuments; cephalopods were determined by beaks, horny rings of suckers and hooks; heteropods were identified by radular hooks; whereas fishes were identified by otoliths, scales and bony elements (Zuev *et al*. 1985). The identification of fish remains was based on published description according to the main diagnostic traits of osteological elements of pelagic fishes of the southeastern Pacific (Topal 1988). Estimate of fish body size were made from data on bony elements and otolith length against fish body size (Topal 1988). The body size reconstruction of crustacean and cephalopods were made by index of length of hard test elements relative to size of these animals. The relative prey size (RPS) was estimated as ratio (in %) of prey length to absolute squid length (%AL). AL is measured from mantle end to tip of longest arm (Zuev *et al*. 1985). AL of the studied *O. bartramii* of ML 160-392 mm was 170-175% ML.

Total number of prey by specific hard body elements was estimated in each stomach. In addition we distinguished a special food group – transit (secondary) food. It is not eaten directly by predator, but it get into predator's stomach after eating of the proper food organism with viscera (Nigmatullin & Toporova 1982, Nigmatullin 2005a,b). To estimate the role of each food component, the frequency of occurrence (percentage of stomachs containing food) and proportion of volume of full stomach contents (percentage of volume of stomach content) were calculated (Zuev *et al*. 1985).

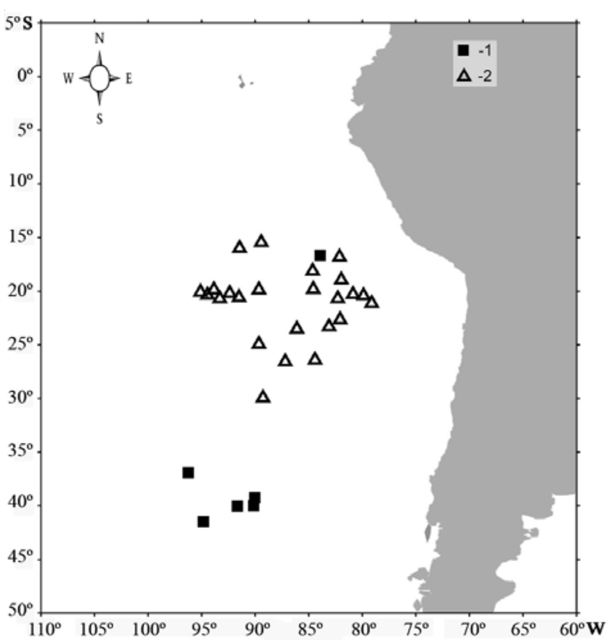

Figure 1

Distribution of stations in southeastern Pacific where *Ommastrephes bartramii* squids were collected for parasitological (1) and feeding (2) investigations

Distribución de estaciones en el Pacífico sudeste donde se recolectaron los calamares *Ommastrephes bartramii* para las investigaciones parasitológicas (1) y de alimentación (2)

Helminths

Parasitic helminths were obtained from 22 squid of ML 165-365 mm that were collected in the area between 17-43°S and 78-95°W in April 1981, January and July-August 1984. This sample was subdivided into two sub-samples according two areas of catch (Fig. 1): 1) 17-20°S and 80-84°W (n=14 of ML 165-365 mm) and 2) 34-43°S and 78-95°W (n=8 of ML 240-360 mm). The helminthological investigation of squids followed the standard methods (Zuev *et al*. 1985). All worms were collected from defrosted squids. Trematodes and cestodes were fixed in 10% formalin and stored in 70% alcohol. These worms were stained in alum carmine after washing in distilled water, dehydrated in alcohol, cleared in oil cloves and mounted in Canada balsam. Nematodes were preserved in formalin and cleared in mixture of glycerol and lactic acid. The larvae of cestodes were identified following descriptions by Yamaguti (1959) and Palm (2004), didymozoid trematodes by Hochberg (1990) and anisakid nematodes by Berland (1961) and Smith (1983). The parasitological descriptors, such as prevalence and intensity were used in accordance to Margolis *et al.* (1982).

Results

Feeding

The food spectrum was wide. It included 2 species of amphipods, 2 euphausiids, 4 shrimps, 1 heteropod, 2 pelagic octopods, 12 squids and 29 teleosts including 17 species of Myctophidae and 10 species from 10 other families (Table 1).

The main foods were myctophids (*S. evermanni*, *M. nitidilum*, *M. phengodes*, *H. reinhardti*, *H. proximum*), *Diplospinus multistriatus*, *Argyropelecus affinis* and juveniles of Exocoetidae. Squids (mainly *O. banksi* and *Abraliopsis affinis*) and shrimps were secondary food. Euphausiids, amphipods, octopods and heteropod mollusks were accidental food. Of these, euphausiids and amphipods were found in stomachs of squids of ML < 200 mm only.

Table 1

Food items of *Ommastrephes bartramii* in open waters of SE Pacific (N=frequency of occurrence as percentage of stomachs containing food, V=proportion of volume of full stomach contents)

Ítems alimentarios de *Ommastrephes bartramii* en aguas oceánicas del Pacífico sudeste (N=frecuencia de ocurrencia como porcentaje de estómagos conteniendo alimento, V=proporción del volúmen de estómagos llenos de contenido)

Food groups	N (%)	V (%)
Teleosts	100.0	83.7
Myctophidae	73.3	57.2
Symbolophorus evermanni	11.6	10.5
Myctophum nitidulum	16.6	7.0
Myctophum lychnobium	3.3	-
Myctophum aurolaternatum	1.7	2.0
Myctophum asperum	1.7	2.2
Myctophum phengodes	6.7	4.8
Myctophum sp.	1.7	0.5
Hygophum reinhardtii	18.3	6.2
Hygophum proximum	8.3	4.5
Hygophum hygomii	5.0	1.8
Notoscopelus resplendens	5.0	0.8
Ceratoscopelus warmingii	1.7	-
Gonichthys tenuiculus	1.7	0.8
Diaphus meadi	1.7	-
Benthosema suborbital	3.3	2.0
Lampanyctus parvicauda	1.7	-
Lampadena urophaos	1.7	-
Unidentified Myctophidae	15.0	13.5
Photichtyidae, *Vinciguerria lucetia*	6.7	1.2
Gonostomidae	5.0	0.3
Gonostoma sp.	3.3	0.3
Diplophos taenia	1.7	-
Chauliodontidae, *Chauliodus* sp.	5.0	0.3
Sternoptychidae, *Argyropelecus affinis*	8.3	4.0
Melanostomiatidae, *Bathophilus fillifer*	1.7	-
Tetragonuridae, *Tetragonurus atlanticus*	1.7	1.5
Gempylidae, *Diplospinus multistriatus*	15.0	6.2
Idiacanthidae, *Idiacanthus* sp.	5.0	-
Melamphaidae, *Melamphaes* sp.	6.7	2.2
Exocoetidae	8.3	6.5
Unidentified plankton-eating fishes	5.0	1.8
Unidentified predatory fishes	6.6	2.5
Cephalopoda	46.7	13.8
Octopoda	3.4	-
Ocytoe tuberculata	1.7	-
Argonauta argo	1.7	-
Teuthida	45.0	13.8
Ommastrephidae	3.3	3.7
Dosidicus gigas	1.7	2.0
Ommastrephes bartramii	1.7	1.7
Thysanoteuthidae, *Thysanoteuthis rhombus*	1.7	1.2
Onychoteuthidae, *Onychoteuthis banksi*	20.0	7.8
Enoploteuthidae	18.3	0.8
Abraliopsis affinis	8.3	0.8
Enoploteuthis sp.	1.7	-
Pterygioteuthis giardi	5.0	-
Ancistrocheirus alessandrinii	1.7	-
Histioteuthidae, *Histioteuthis* sp.	1.7	-
Cranchiidae	3.4	-
Liocranchia reinhardti	1.7	-
Teuthowenia megalops	1.7	-
Unidentified Teuthida	3.3	0.3
Mollusca, Heteropoda, *Carinaria* sp.	1.7	-
Crustacea	15.0	2.5
Decapoda	8.3	2.5
Sergestes sp.	3.3	-
Oplophorus spinosus	5.0	2.5
Acanthephyra sp.	1.7	-
Heterocarpus ensifer	1.7	-
Euphausiacea	6.6	-
Thysanopoda monocautha	3.3	-
Euphausia sp.	3.3	-
Amphipoda	1.7	-
Phronimella elongate	1.7	-
Parapronoe crusculum	1.7	-
Phronima stebbingi	1.7	-
Transit food items	43.3	-
Number of stomachs	60	40

Prey size ranged from 8 to 440 mm, and RPS from 3.2 to 77.2% AL. The mean values of absolute and relative prey size were 62 mm and 13.5% AL. RPS values were mainly 8-20% AL. Size of myctophid prey ranged from 17 to 112 mm (5.6-24% AL) with average length of 55 mm (11.4% AL). The size of other fishes in *O.bartramii* diet was larger: 17-440 mm (4.7-77.2% AL) with an average length 93 mm (21.5% AL). The largest fish consumed was *Diplospinus multistriatus* with length 260-440 mm (46.1-77.2% AL). This species has a narrow, fusiform body and squid of ML 280-320 mm may be capable of catching and eating them.

The AL of squid prey varied from 28 to 210 mm (4.3-61.7% AL) with mean value of 85 mm (18% AL). The two largest squid prey were *Dosidicus gigas* and *O. bartramii* of ML 130-140 mm (AL=210 mm) with RPS of 61.7 and 42.4% AL respectively. The AL of *Onychoteuthis banksi* were 28-150 mm (4.3-40% AL), *Thysanoteuthis rhombus* – 150 mm (40%AL) and Enoploteuthidae – 30-100 mm (6-16.1% AL). Crustaceans were the smallest prey: euphausiids – 6-35 mm (2.4-12.3% AL), amphipods – 0.9-1.9 mm (3.2-6.7% AL) and shrimps – 30-80 mm (9.3-13.1% AL).

The total number of prey items per stomach varied widely from 1 to 19 specimens (mean 6). The number of recently eaten prey (with undigested soft tissues) varied from 1 to 18 (3.1). The maximum number of consumed myctophid specimens was 11 (mean 3.8), and their recently eaten number was 10 (2.5). Mean number of all eaten fishes was 5.5 and their recently eaten representatives - 3.7. The number squid prey ranged between 1 and 4 (mean 1.6) with 1.2 being recently eaten. The number of crustacean prey did not exceed 4 with a mean 1.9.

Transit food items occurred in 43.3% of stomachs. As rule transit food organisms were introduced into the studied squid stomach from the stomachs of prey, mainly plankton-eating fishes. They included copepods (*Oithona* sp., *Oncea* sp., *Candacia* sp., *C. pachydactula*, *Calanus* sp., *Eucalanus* sp.), ostracods, amphipods (*Phrosina semilunata*, *Phronima stebbingi*, *Vibilia armata*, *Parapronoe crustulum*), euphausiids (*Euphausia* sp., *E.eximia, Stylocheiron* sp.), shrimps (*Sergestes* sp.), thecosomaths (*Peracle* sp.), heteropods and chaetognaths. The number of transit food organisms varied between 1 and 20 (mean 5). Their size were significantly smaller than the proper food organisms and varied between 0.7-22 mm (mean 5.4 mm), and their RPS were 0.2-6.5% AL with mean value 0.7% AL. There was some overlapping of maximal lengths of transit food organisms and minimal lengths of proper food, but this was infrequent and these organisms were very rare. Most of transit food organisms were from myctophid and other fish stomachs and, more infrequently, from squid stomachs.

The helminth fauna

Six species of parasitic helminths were found and all were in the larval stages (Table 2). The total prevalence of infection was 90.9%.

Table 2

Data on prevalence, (P, %) and range of intensity (I) of infections in *Ommastrephes bartramii* (n = 22)

Datos de prevalencia (P, %) y rango de intensidad (I) de infecciones en *Ommastrephes bartramii* (n = 22)

Parasites:	P (%)	I
Cestoda		
Tentacularia coryphaenae	9.1 (2.6-29.4)*	2-3
Scyphophyllidium sp.	4.5 (0.8-23.2)	12
Trematoda		
Didymozoidae (indetermined metacercariae)	86.4 (63.5-96.5)	6-1500
Nematoda		
Anisakis physeteris	18.2 (7.6-40.4)	1-9
Porrocaecum sp.	36.3 (20.4-59.8)	1-21
Contracaecum sp.	13.6 (12.9-27.1)	1-114

* - in brackets - confidence limits

Larvae of *Scyphophyllidium* sp. were found in the stomach cavity and caecum. The size range of 10 specimens was 0.31-0.70 mm. Bothridia (0.06-0.1 mm) are attached along the full length, suckers are absent.

Larvae of *T. coryphaenae* were found within the whole mantle cavity including the internal organs, occasionally penetrating into the mantle wall. These worms are very mobile and able to actively migrate within the mantle cavity. The size range of 10 specimens was 3.6-14.0 mm, maximum widths at the level of pars bothridialis 1.5-3.0 mm. Larvae possess four tentacles armed with hooks. Armature was homeoacanthous homeomorphous with characteristic tridentate basal hooks. Size of metabasal hooks: 0.031 mm, size of basal hooks: 0.01–0.014 mm. Pars bothridialis: 2.5-7.4 mm, pars vaginalis: 1.0-2.0 mm, pars bulbosa: 0.95–1.30 mm, pars postbulbosa: 0.9-7.2 mm, appendix: 0.7-4.78 mm and velum: 0.7-2.9 mm.

Metacercariae of Didymozoidae were localized in cysts on the inner wall of the stomach mainly along blood vessels. The length range of 20 specimens was 0.43-0.71 mm, maximum widths 0.14–0.21 mm. Oral sucker almost terminal (0.02–0.05 x 0.03–0.06 mm). Ventral sucker (0.05-0.07 x 0.06-0.08 mm) larger than oral sucker. Ventral sucker situated just anterior to mid-body. Eighteen to twenty vesicular cells.

The third-stage larvae of *A. physeteris* were encysted in the stomach wall and mainly in gonad's coelomic membranes. The size range of 8 specimens was 6.4-7.8 mm, maximum body width 0.22-0.23 mm. Length from anterior end of body to nerve ring (position of nerve ring) 0.16-0.19 mm. Length of oesophagus 0.86-0.98 mm. Size of stomach 0.09-0.15x0.15-0.26 mm. Tail length 0.11–0.12 mm and length of tail mucron 0.004 mm.

Larvae of *Porrocaecum* were encysted in the stomach wall (length 3.5-6.4 mm) and into inner mantle wall (18.0-22.5 mm). Measurements of small larvae based on 20 specimens. Maximum widths 0.11–0.27 mm. Length from anterior end of body to nerve ring 0.10– 0.14 mm. Length of oesophagus 0.86-1.19 mm, size of stomach 0.05-0.07 x 0.11-0.17 mm and length of intestinal caecum 0.38-0.53 mm. Excretory pore situated at the level of nerve ring. Tail length 0.13–0.14 mm, length of tail thorn 0.01 mm. Measurements of large larvae also based on 20 specimens. Maximum width 0.7–1.0 mm. Length from anterior end of body to nerve ring 0.27– 0.38 mm. Length of oesophagus 2.54-3.02 mm, size of stomach 0.20-0.23 x 0.31-0.34 mm and length of intestinal caecum 1.53-2.29 mm. Excretory pore situated at the level of nerve ring. Tail length 0.16–0.20 mm and length of tail thorn 0.01 mm.

Larvae of *Contracaecum* were encysted in walls of stomach and caecum. The size range of 20 specimens was 2.5-7.3 mm, maximum widths 0.1–0.2 mm. Length from anterior end of body to nerve ring 0.06–0.1 mm. Length of oesophagus 0.44–0.98 mm, size of stomach 0.03–0.05 x 0.05–0.07 mm and length of intestinal caecum 0.24–0.8 mm. Length of ventricular appendix 0.04–0.07 mm. Tail length 0.09–0.17 mm, length of tail thorn 0.005 mm.

In the northern sampling area (17-20°S) squids were infected by four helminth species: Didymozoidae mtc (100%, 9-613), *T. coryphaenae* (15.4%, 2-3), *A. physeteris* (23.1%, 1-9) and *Porrocaecum* sp. (61.5%, 1-21). Squids of the southern area (34-43°S) were also infected by four species: Didymozoidae mtc (62.5%, 6-1500), *Scyphophyllidium* sp. (12.5%, 12), *A. physeteris* (12.5%, 2) and *Contracaecum* sp. (37.5%, 1-114). There were only two identical species between these two areas: Didymozoidae and *A. physeteris.* Small sample sizes from both areas prevent further investigation of the observed differences in helminth fauna composition.

Discussion

The main food of middle-sized *O. bartramii* in the southeastern Pacific included micronektonic fishes, squids, shrimps and to a lesser degree - macroplanktonic crustaceans and mollusks and nektonic squids that are the consumers of II-IV orders. The main fish group was micronektonic plankton-eaters that totaled 71% by volume. The families represented included Myctophidae, Photichtyidae, Gonostomidae, Sternoptychidae and Exocoetidae. Predatory fishes in the diet of studied *O. bartramii* were estimated to be 12.7% by volume, and they were mainly juvenile and sub-adult forms of the families Chauliodontidae, Melanostomiatidae, Gempylidae, Tetragonuridae, Idiacanthidae and Melamphaidae (division on feeding groups by Parin 1988). Cephalopods prey were represented by plankton-eating octopods and squids (Enoploteuthidae, Cranchiidae and partly juveniles of thysanoteuthid and onychoteuthid squids) as well as predatory squids (mainly consumers of myctophids: middle-sized ommastrephids and onychoteuthids) (Rodhouse & Nigmatullin 1996).

Thus this squid occupied the niche of consumer from III-IV to V orders in the open waters ecosystems of the southeastern Pacific. It is important intermediate link between large oceanic top-predators and micronektonic plankton-eating fishes (especially myctophids) and squids. The main predators of this squid are lancet fishes (*Alepisaurus ferox*), different species of tunas, swordfish (*Xiphias gladius*), marlins, active species of sharks, sperm whale (*Physeter macrocephalus*) and other marine mammals (Gaevskaya & Nigmatullin 1976, Dunning 1998, Bower & Ichii 2005, Young 2005).

Almost all identified food organisms are diel vertical migrants and inhabit near-surface layers at night (Parin *et al*. 1977, Bekker 1983, Parin 1984, 1988, Nesis 1985). Most active feeding occurs during night time at near-surface layers (0-75 m), but squid also likely to feed during the day when their main prey migrates to depths in excess of 300-600 m. The daytime feeding at these depths was confirmed recently for *O. bartramii* in the North Pacific (Watanabe *et al*. 2004). In addition, this study identified the presence of the sternoptychid fish *Argyropelecus affinis* in diet of *O. bartramii*. This species is not involved in diel vertical migration and permanently inhabits depths of 200-600 m (Parin 1984, 1988).

Transit food organisms were relatively common but their role in squid energy metabolism is insignificant. However, their separate registration is very important for the accurate reconstruction of squid feeding behavior, size selectivity and real food relations. In order to correctly describe the taxonomy and size structure of 'proper' and transit food organisms this phenomenon requires consideration (Nigmatullin & Toporova 1982, Nigmatullin 2005a,b). It is possible that transit food organisms facilitate the transmission of helminths from one host to another. Moreover the transit food organisms that are infected by larval helminths may potentially act as transmitters of helminthes via one trophic level (Nigmatullin 2005a).

Relative size of food organisms varied in wide limits between 0.2-77.2% AL. But the transit food organisms occupied the minimal part of this range (0.2-6.5% AL, mainly 0.5-2%). Prey that eaten directly by studied squid («proper» food) had size ranged from 3.2 to 77.2% AL with optimal values between 8-25% AL. These data on size aspect of squid food relations are first real information with using AL as standard length. Thereupon here is important to stress that the correct analysis of size relations of predator and prey, especially its comparative aspect, possible when a realistic length of the studied predator and prey will be selected (Peters 1986). The basic measurement of cephalopods is the ML (Roper & Voss 1983, Nesis 1987). It is used as a standard length in biological investigations including studies of size relation of predator and prey. But AL is solely the natural size, and it has more veritable biological meaning than ML in special investigations of cephalopod trophic and behavioral relations including size-dependant predation. AL allows estimating real size of squid that perceives by predators, preys and other interacting animals in natural conditions.

The feeding spectrum of *O. bartramii* in this study was relatively wider in comparison with two similar-sized dominant ommastrephid squid *Dosidicus gigas* and *Sthenoteuthis oualaniensis* from open waters of the south-east Pacific, that were investigated in same period (Schetinnikov 1989, 1992, Nigmatullin *et al*. 1985, 2001, Nigmatullin, Shchetinnikov & Shukhgalter 2005[2]). These distinctions are probably due to differences in the level of bio-productivity. We estimated higher abundance of nektonic squid and micronektonic fishes in the post-upwelling tropical open waters (to the north of 18°S) than in the subtropical waters (to the south of 18-20°S) near Peruvian and Chilean EEZ boundaries (Nigmatullin *et al*. 1985, 1991, unpublished data). In upwelling and post-upwelling communities a relatively few species of plankton-eating fishes appear to dominate whereas in low-productivity communities the same dominance is not evident. It is likely that differences are reflected in the diet width of dominant predators in these communities (Cushing 1971, Valiela 1995).

Food composition of the mid-sized squid in this study differed from *O. bartramii* found in other parts of this species vast range on both the species and to a lesser degree the genera levels of prey identification. But preys species of *O. bartramii* by family and order levels and by their ecological characteristics are similar for all ranges. Moreover, the diet of squid ML 160-390 mm over the entire species range is dominated by the myctophids, other small plankton-eating fishes, juveniles of predatory fishes and squids with fewer numbers of large crustaceans, pelagic octopods and heteropod mollusks (Shevtsov 1972, Filippova 1974, Gaevskaya & Nigmatullin 1976, Nigmatullin & Pinchukov 1976, Wormuth 1976, Naito *et al.* 1977, Lipinski & Linkowski 1988, Sinclair 1991, Seki 1993, Hernandez-Garcia 1995, Dunning 1998, Lordan 2001, Watanabe *et al*. 2004, Ivanovic & Brunetti 2004, Bower & Ichii 2005, Young 2005, Parry 2006, 2008).

Six species of helminths observed in *O. bartramii* from this study were at larvae stages and they have very broad specificity. They use various planktonic invertebrates, small fishes and squids at same stages of life cycles (Hochberg 1990) as intermediate and transport hosts. Their life cycles are realized on trophic chains of the pelagic communities and squids are infected by eating

[2]Nigmatullin ChM, AS Shchetinnikov & OA Shukhgalter. 2005. Food and parasite relationships and role of mass ommastrephid squids in oceanic ecosystems of southeast Pacific. In: Libro de resumenes III Simposio Internacional sobre calamares del Pacifico y II Taller Internacional sobre calamares (28 noviembre - 2 diciembre 2005, Lima, Peru). Resumen 25: 1-3. IMARPE, Callao.

infected prey - intermediate and transport hosts. The most important sources for squid infestation with larvae of cestodes, nematodes and trematodes are myctophids and other plankton-eating fishes, squids, euphausiids and shrimps (Zuev *et al*. 1985, Hochberg 1990). It is likely that *O. bartramii* is a transport host for these helminths, with scombroid and xiphoid fishes, sharks, marine mammals and sea birds as the definitive hosts: they are common consumers on this squid (Gaevskaya & Nigmatullin 1976, Nigmatullin *et al*. 1985, Gaevskaya *et al*. 1986, Zuev *et al*. 1985, Bower & Margolis 1991, Shukhgalter & Nigmatullin 2001, Young 2005).

The helminths recorded in *O. bartramii* in proper open waters of the southeastern Pacific far off shelf and slope zones are the representatives of oceanic helminthes complex (Gaevskaya & Nigmatullin 1978). *Scyphophyllidium* sp. is only one representative of the shelf-slope complex.

Detail comparison of our data on helminth fauna with similar data for ommastrephid squid *D. gigas* and *S.oualaniensis* from the southeastern Pacific (Gaevskaya *et al.* 1983, Shukhgalter & Nigmatullin 2001, Nigmatullin & Shukhgalter 2001) and *O. bartramii* from other parts of species range (Gaevskaya & Nigmatullin 1976, Gaevskaya *et al*. 1986, Bower & Margolis 1991, Nagasawa *et al*. 1998) is impossible due to small sample sizes in the current study. However we conclude that in general the helminth fauna composition and the levels of infestation observed in this study do not significantly differ from those other ommastrephids or *O. bartramii* populations. The differences on the level of helminth species, their number and rate of infestations are mainly due to geographical and habitat variability and influence of sample size factors.

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