

Cohabitation of Ectosymbiotic Branchiobdellida (Annelida, Clitellata) and Scutarielloidae (Platyhelminthes, Rhabditophora, Temnocephalida) on Atyid Shrimps in Taiwan

台灣匙指蝦類體表兩種外共生蛭蚓目及切頭類之共棲

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Abstract

Occurrences of two ecologically similar but normally geographically separated ectosymbionts, branchiobdellidans (Annelida) and temnocephalidans (Platyhelminthes), were studied on 458 atyid shrimps collected from five localities in Taiwan. The shrimps, *Neocaridina* spp. and *Caridina*

pseudodenticulata, carried a scutariellid temnocephalidan, *Scutariella japonica*, at three localities, while a branchiobdellidan, *Holtodrilus truncatus*, was found at two of the three localities where it co-inhabited with *S. japonica*. No negative or positive interactions toward each other were observed. Statistically significant larger numbers of branchiobdellidans were found on larger shrimps, while such a tendency was not detected in *S. japonica*.

摘 要

在台灣 5 個樣站，共採集 458 隻匙指蝦類個體，其中，3 個樣站發現兩種生態上相似但通常具地理區隔的蛭蚓目 branchiobdellidans (Annelida)，*Holtodrilus truncatus* 及切頭類 temnocephalidans (Platyhelminthes)，*Scutariella japonica* 於匙指蝦體表上共生。這 3 個樣站中的 2 個樣站，其匙指蝦類同一檢體上共棲著該 2 種體表寄生的物種。觀察這 2 種體表寄生的物種彼此並無相互影響的現象。*H. truncatus* 之數量與宿主蝦體大小有統計上顯著正相關；但 *S. japonica* 則否。

Keywords: Branchiobdellida, Temnocephalida, atyid shrimp, cohabitation, Taiwan

關鍵詞：蛭蚓目、切頭類、匙指蝦、共棲、台灣

Received: February 6, 2015

Accepted: July 24, 2015

收件日期：2015 年 02 月 06 日

接受日期：2015 年 07 月 24 日

Introduction

Freshwater crayfishes show disjunct Holarctic Astacoidea and Gondwanan Parastacoidea distributions (Hobbs 1988). Both of these taxa have ectosymbionts with a very similar obligate biology consisting of the Holarctic Branchiobdellida (Annelida: Clitellata) (Gelder and Williams 2015) and Gondwanan Temnocephalida (Platyhelminthes: Rhabditophora) (Joffe *et al.* 1998, Kawakatsu *et al.* 2007). Branchiobdellidans, or crayfish worms,

are found on astacid and cambarid crayfishes in the Nearctic and northern Neotropical (North America), Euro-Mediterranean (Europe and western Asia) and East Asian regions. However, in North America besides crayfish, a few branchiobdellidan species have adopted crabs, isopods or shrimps (Gelder *et al.* 2002, Gelder and Messick, 2006), while in southern parts of both China and Japan branchiobdellidans are found on shrimps (Liang 1963; Ohtaka *et al.* 2012). In contrast, the more diverse Temnocephalida (Joffe *et al.* 1998) consists of

two superfamilies: Temnocephaloidea (composed of three families) found in Australasia, Southeast Asia, Madagascar (Kawakatsu *et al.* 2007) and Neotropics (Martinez-Aquino *et al.* 2014), and Scutarielloidea distributed along the Alpine-Himalayan massif's southern margin (Italy–Balkan countries–Azerbaijan–India), then through both southern China and Japan (Matjašič 1990; Gelder 1999).

Most East Asian branchiobdellidans are found on endemic crayfishes across northern China, the Korean Peninsula, southeast Russia and northern Japan (Yamaguchi 1934; Timm 1991; Gelder and Ohtaka 2000; Ohtaka and Gelder 2015). However, two species on atyid shrimps occur in the southern areas of China and Japan. *Caridinophilus unidens* Liang, 1963, on *Caridina yunnanensis* Yu, 1938, is only known from its type location in Yunnan Province, China, while *Holtodrilus truncatus* (Liang, 1963) is more widely distributed on *Neocaridina* spp. in Anhui, Guangdong, Henan and Zhejiang Provinces, China (Liang 1963, Liu 1984, Ohtaka *et al.* 2012). Recent shrimp collections have reported *H. truncatus* on *Neocaridina* spp. and *Caridina pseudodenticulata* Hung, Chan and Yu, 1993, in Taiwan (Ohtaka and Chen 2010), *Caridina rubella* Fujino and Shokita, 1975, *C. rapaensis* Edmonson, 1935, and *C. typus* Milne Edwards, 1937, on Miyako Island (Fujita *et al.* 2010) and *Neocaridina* spp. in central Japan (Ohtaka *et al.* 2012; Niwa *et al.* 2005).

Scutarielloidea has one family, Scutarillidae, and only *Scutariella japonica* (Matjašič, 1990) (syn. *Cardinicola sinica* Matjašič, 1990) has

been reported on the atyid shrimps, *Caridina*, *Paratya* and *Neocaridina*, in southern China, Taiwan, Korea and Japan (Kawakatsu *et al.* 2007). Recent researches have revealed that *S. japonica* is more widely distributed than previously reported in southeast China (Ohtaka *et al.* 2012) and Japan (Kawakatsu *et al.* 2007). Although both *S. japonica* and *H. truncatus* had been reported independently on atyid shrimps in East Asia, it was not until our recent studies that both ectosymbiont species were found co-inhabiting the same shrimp host. Details of such cohabitation in southern China are given in Ohtaka *et al.* (2012), but a previous investigation in Taiwan (Ohtaka and Chen 2010) led to subsequent collections of these co-inhabiting ectosymbionts, which are now being reported here.

Material and methods

Atyid shrimps were collected from five lotic and lentic freshwater sites in Taiwan: 1) Guanyin, Taoguan County, 2) Longci, Tainan County, 3) Minchien, Nantou County, 4) Shihtan, Miaoli County and 5) Sinshe, Taichung County (Fig. 1) between 10th and 14th September 2008. *Neocaridina* spp. were found at sites 1, 3-5, and *Caridina pseudodenticulata* at sites 2 and 4, while 13 palaemonid shrimps, *Macrobrachium asperulum* (von Martens, 1868) were collected at site 4 along with the other two species. Dip-nets (mesh size, 0.5 mm) were dragged through aquatic vegetation and displaced shrimps were scooped up in the nets with the intention of

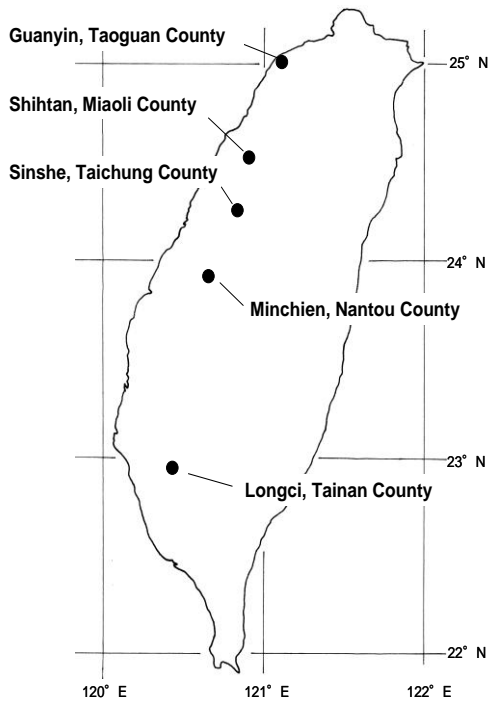


Fig.1. A map of Taiwan showing study sites.

obtaining about 100 atyids per site. Each living shrimp was placed into a 2.0 ml plastic tube filled with 5% formalin preservation solution following capture. The surface water temperature, electric conductivity (TOA CM14P) and pH (Narika α -Pack Test) were measured at each study site and recorded. Each shrimp was identified under a dissection microscope in the laboratory. Body length (from eye base to tip of telson), sex and brood condition in female *Neocaridina* spp. were recorded. All ectosymbionts on a shrimp and those in the tube's bottom debris were counted as well as the numbers and locations of attached branchiobdellidan cocoons. Scutariellids and branchiobdellidans recovered were identified

using Matjašič's (1990) key and Liang's (1963) description, respectively. Branchiobdellidans were separated into adults, where a clitellum was present, and juveniles.

Population data for specific associations were expressed in percentages, and statistical methods were used to analyze comparisons of particular aspects of the ectosymbiotic associations: "prevalence" is the percentage of hosts carrying an ectosymbiont in a locality; "abundance" indicates the number of ectosymbionts on a single host regardless of whether or not the host was infected; "mean intensity" is the mean number of ectosymbionts per infected host; and "cohabitation ratio" indicates the percentage of hosts carrying both branchiobdellidans and scutariellids in a locality. Significance of correlation between the number of ectosymbionts and body length of the host, and between individual numbers of co-inhabiting branchiobdellidans and scutariellids on a common host were tested by Spearman's correlation coefficient. In addition, the differences in numbers of ectosymbionts in relation to the sex and brood condition of the host shrimps were tested using ANOVA.

Results

Physical characteristics of collection site waters

Among the five sites studied, water temperatures ranged from 24.9 to 30.7 °C. The pH value ranged from 6.9 to 8.3, and electric conductivity from 19 to 58 $\mu\text{S cm}^{-1}$ at the study sites. These sites were regarded as freshwater

with no significant differences between them.

Geographical distribution and habitat of the ectosymbionts

A total of 458 shrimps comprising of 300 *Neocaridina* spp. and 158 *Caridina pseudodenticulata* were collected from the five sites in Taiwan (Table 1). Their body length ranged from 8.0 to 22.5 mm in *Neocaridina* spp., and 7.5 to 23.5 mm in *C. pseudodenticulata*.

Holtodrilus truncatus was found on *Neocaridina* spp. at two sites, Sinshe and Shihtan,

and also on *C. pseudodenticulata* at the latter locality (Table 1); *Scutariella japonica* occurred at Sinshe, Shihtan and Minchien. However, neither *H. truncatus* nor *S. japonica* was found at Guanyin and Longci. Specimens of *H. truncatus*, when present, were found in the host's branchial cavities as well as the ventral abdomen on of both *Neocaridina* spp. and *C. pseudodenticulata*. In contrast, *S. japonica* was only observed in the host's branchial cavities, and no ectosymbionts were seen on *Macrobrachium asperulum*.

Table 1. Summary in occurrence of ectosymbionts on shrimps from Taiwan.

Locality	Host shrimps and number examined	<i>Holtodrilus truncatus</i>		<i>Scutariella japonica</i>		Cohabiting ratio	
		Prevalenc %	Mean intensity (range)	Prevalence %	Mean intensity (range)		
Sinshe, Taichung Co.	<i>Neocaridina</i> spp.	90	61.1	2.2(1-9)	43.3	1.7(1-5)	35.6
Minchien, Nantou Co.	<i>Neocaridina</i> spp.	10	0	0	12.0	1.1(1-2)	0
Shihtan, Miaoli Co.	<i>Neocaridina</i> spp.	12	8.3	1(1)	58.3	1.1(1-2)	8.3
"	<i>Caridina</i>	61	9.8	1.7(1-2)	88.5	5.0(1-16)	8.1
Guanyin, Taoguan Co	<i>Neocaridina</i> spp.	98	0	0	0	0	0
Longci, Tainan Co.	<i>Caridina</i>	97	0	0	0	0	0

Quantitative description of the host-ectosymbiont associations

Prevalence of *H. truncatus* on *Neocaridina* spp. in two localities was 61.1% and 8.3 %, respectively, and that on *C. pseudodenticulata* at one locality was 9.8% (Table 1). More than half of the infected *Neocaridina* spp. (N=56) carried only one branchiobdellidan (67.0%) and their highest abundance reached 9, while *C. pseudodenticulata* (N=6) carried one or two

branchiobdellidans. Body lengths of the 56 *Neocaridina* spp. supporting *H. truncatus* ranged from 9.5 to 22.5 mm, and a significantly larger number of branchiobdellidans were found on larger shrimps ($P < 0.001$). The combined populations of *H. truncatus* were 62% juveniles and 38% adult worms; there was no significant difference between the numbers of individuals on male and female *Neocaridina* spp. Each *Neocaridina* spp. (N=17) carried 1 to 13 cocoons

while *C. pseudodenticulata* (N=5) always had one. These cocoons were invariably found attached to the gills of both shrimps.

Prevalence of *S. japonica* was higher than those of *H. truncatus* at the two localities where both ectosymbionts were found, with 12% on *Neocaridina* spp. in Minchien and 88.5% on *C. pseudodenticulata* in Shihtan (Table 1). The maximum number of the scutariellids per host was found on *C. pseudodenticulata* in Shihtan with an abundance of 16 and no significant difference was found between shrimp body length and the number of *S. japonica* carried.

Cohabitation by *H. truncatus* and *S. japonica* was found at two locations, with ratios of about 8% at Shihtan and 36% at Shinshe (Table 1). As a total sympatry was found of 59% on *Neocaridina* spp. carrying *H. truncatus*, and 57% of those carrying *S. japonica*. Sympatry was found on 83% (5 out of 6) of *C. pseudodenticulata* carrying *H. truncatus* and 9% of those carrying *S. japonica*. No statistically significant difference was detected between the numbers of co-inhabiting *H. truncatus* and *S. japonica* on either shrimp species from any of the localities.

Discussion

Branchiobdellidans in the Palaearctic realm are restricted to the Euro-Mediterranean and East Asian regions, while scutariellids are distributed along the realm's southern border from Italy to Japan. Geographically the range of the two ectosymbionts overlap in the southern

Euro-Mediterranean, but their cohabitation on a host has never been reported. This could be due to a spatial separation resulting from endemic branchiobdellidans living only on crayfish hosts in surficial waterbodies while scutariellids are restricted to cave-dwelling shrimps (Gelder 1999). In contrast, the East Asian region has branchiobdellidans inhabiting atyid shrimp in the southern areas of China and Japan, which is south of the region's endemic crayfish range. Similarly, Matjašič (1990) reported and reviewed *Scutariella* species also on atyid shrimps in this southern area. However, the first sympatric occurrence in the region of *H. truncatus* and *S. japonica* was found on preserved *Neocaridina* spp. collected from Kinki District, central Japan (Niwa and Ohtaka 2006). Subsequently, the same ectosymbionts were found co-inhabiting seven localities in three southeast China Provinces (Ohtaka *et al.* 2012). These findings suggest that such a sympatric association might be more widespread in the southern part of East Asia than previously thought. Whether the same co-inhabiting association found in Japan is endemic or the result of ectosymbiont carrying hosts being translocated into the country is unknown at this time.

Based on observations (Ohtaka *et al.* 2012) in southeast China, a scutariellid-shrimp association is widespread, while that of a branchiobdellidan-shrimp combination is more restricted. Instances of co-inhabiting scutariellids and branchiobdellidans appear to be a combination of chance contacts by the hosts and other unknown factors endemic to southeast

China. The situation in Japan is more complicated as *S. japonica* (referred to as “the Temnocephaloid worm *Caridinicola*” by Kemp, 1917) on *Paratya compressa* (de Haan, 1844) was first reported at Komatsu in pools and back-waters around Lake Biwa, Japan, but no East Asian branchiobdellidans had been recorded in the area. Therefore, when *H. truncatus* and *S. japonica* were found on *Neocaridina* spp. in Kinki District, southern Honshu, Japan (Niwa *et al.* 2005; Niwa and Ohtaka 2006), the authors speculated that both ectosymbionts had been introduced from China. A similar situation appeared in Taiwan where *S. japonica* (syn. *Cardinicola indica*) on *Neocaridina denticulata sinensis* (Kemp, 1918) was reported at two localities by Lo and Wu (1991). Later, *H. truncatus* was found by Ohtaka and Chen (2010), and they suggested that this branchiobdellidan might also have been imported by shrimps from continental China. The present study is the first to report both ectosymbionts co-inhabiting shrimps in Taiwan, but like the Chinese observations (Ohtaka *et al.* 2012) sympatry was not seen at all collection sites. The first report of *H. truncatus* from Miyako Island, Japan, was made on three shrimp species (*Caridina rubella*, *C. rapaensis* and *C. typus*) from freshwater wells (Fujita *et al.* 2010), but there is no information to indicate infected shrimps were translocated from China. It is highly unlikely that phylogeographic connections of these ectosymbioses will be resolved until molecular sequencing is performed on the two ectosymbionts and hosts to demonstrate their coevolution.

Although some branchiobdellidans show a microhabitat preference on a host, the sites often change and contract or expand depending on environmental conditions. For example, *Xironogiton victoriensis* Gelder and Hall, 1990 are usually found on a signal crayfish’s chaelae but the attaching site will extend over the host’s body as its population increases (Gelder and Hall 1990; Oberkofler *et al.* 2002). A more accurate indication of microhabitat preference of branchiobdellidans is the location of their deposited cocoons. Ohtaka *et al.* (2012) found adults and cocoons of *H. truncatus* only on *Neocaridina* spp. gills in southeast China. Although similar in Taiwan, adults also congregated on the ventral abdomen of both *Neocaridina* spp. and *C. pseudodenticulata*. Niwa *et al.* (2014) found *H. truncatus* predominantly between the first pleopod and fifth pereopod, with cocoons exclusively in the branchial chambers of *Neocaridina* spp. from the Sugo River, central Japan. Specimens of *H. truncatus* on Miyako Island favored the first pair of antennae and ventral abdomen with cocoons only on the latter (Fujita *et al.* 2010). Whether these variations in microhabitat preferences are driven by some environmental forces or random behavioural traits is not known. Although *Macrobrachium asperulum* and atyid shrimps were collected from one site in Taiwan where they lived in close proximity to each other, none of the former species carried ectosymbionts. It seems clear that *M. asperulum* is an unsatisfactory host for the ectosymbionts, however, the reasons, *e.g.*, exoskeleton lacking

attractive factors, efficient host grooming behavior, or others remain to be determined in a future study.

Acknowledgements

We would like to thank Hung-Po Chen of Endemic Species Research Institute, Nantou, Taiwan, for his help during the collecting trip. Thanks are also due to Shi-Kuei Wu of University of Colorado Museum, Boulder, USA, for his guidance in planning the survey. We thank Masaharu Kawakatsu of Sapporo, Japan, for his suggestions on the taxonomy of temnocephalidans. This work was partly supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (19310150).

References

- Fujita, Y., T. Kawahara, N. Niwa and R. S. Shokita. 2010. First record of *Holtodrilus truncatus* (Liang, 1963) (Annelida: Clitellata: Branchiobdellidae) from the Ryukyu Islands. *Biological Magazine Okinawa* 48: 25–33. (In Japanese with English abstract)
- Gelder, S. R. 1999. Zoogeography of branchiobdellidans (Annelida) and temnocephalidans (Platyhelminthes) ectosymbiotic on freshwater crustaceans, and their reactions to one another *in vitro*. *Hydrobiologia* 406: 21–31.
- Gelder S. R., and R. O. Brinkhurst. 1990. An assessment of the phylogeny of the Branchiobdellida (Annelida: Clitellata) using PAUP. *Canadian Journal of Zoology* 68: 1318–1326.
- Gelder, S.R., N. L. Gagnon and K. Nelson. 2002. Taxonomic considerations and distribution of the Branchiobdellida (Annelida: Clitellata) on the North American continent. *Northeastern Naturalist* 9: 451–468.
- Gelder, S.R. and L.A. Hall. 1990. Description of *Xironogiton victoriensis* n. sp. from British Columbia, Canada, with remarks on other species and a Wagner analysis of *Xironogiton* (Clitellata: Branchiobdellida). *Canadian Journal of Zoology* 68: 2352–2359.
- Gelder, S.R. and G. Messick. 2006. First report of the aberrant association of branchiobdellidans (Annelida: Clitellata) on blue crabs (Crustacea: Decapoda) in Chesapeake Bay, Maryland, USA. *Invertebrate Biology* 125: 51–55.
- Gelder, S. R. and A. Ohtaka. 2000. Description of a new species and a redescription of *Cirrodrilus aomorenensis* (Yamaguchi, 1934) with a detailed distribution of the branchiobdellidans (Annelida: Clitellata) in northern Honshu, Japan. *Proceedings of the Biological Society of Washington* 113: 633–645.
- Gelder, S. R. and B. W. Williams. 2015. Clitellata: Branchiobdellida. Pages 551–563 in J. Thorp and D. C. Rogers (editors), *Ecology and Biology: Thorp and Covich's Freshwater Invertebrates*. Academic Press,

New York.

Hobbs, H. H., Jr. 1988. Crayfish Distribution, Adaptive Radiation and Evolution. Pages 52 - 82 in D. M. Holdich and R. S. Lowery (editors), Freshwater Crayfish: Biology, Management and Exploitation. London: Croom Helm.

Joffe, B. I, L. R. G. Cannon and E. R. Schockaert. 1998. On the phylogeny of family and genera within the Temnocephalida. *Hydrobiologia* 383: 263-268.

Kawakatsu, M., S. R. Gelder, R. Ponce de León, O. Volonterio, S.-K. Wu, M. Nishino, A. Ohtaka, N. Niwa, Y. Fujita, M. Urabe, G.-Y. Sasaki, M.-y. Kawakatsu and T. Kawakatsu. 2007. An annotated bibliography of the order Temnocephalida (Plathelminthes, Rhabdocoela, "Turbellaria") from Japan, Taiwan, China and Korea, with other Far Eastern records of Temnocephalids. Kawakatsu's Web Library on Planarians (Mar. 10, 2007). <http://victorriver.com> (Temnocephalid).

Kemp, S. 1917. Notes on Crustacea Decapoda in the Indian Museum. XI. Atyidae of the genus *Paratya* (= *Xiphocaridina*). Records of the Indian Museum 13: 293-306.

Liang, Y- L. 1963. Studies on the aquatic Oligochaeta of China. I. Descriptions of new naids and branchiobdellids. *Acta Zootaxa Sinica* 15: 560-570. (In Chinese)

Liu, S. 1984. Descriptions of two new species of the genus *Stephanodrilus* from Northeast China and notes on *St. truncatus* Liang from Guangdong Province (Oligochaeta:

Branchiobdellidae). *Acta Zootaxa Sinica* 9: 351-355.

Lo, C.-T. and S.-K. Wu. 1991. New records of two temnocephalids from Taiwan. The 7th Annual Meeting of the Chinese Society of Parasitology, 1991, p. 28 (In English with Chinese title).

Martinez-Aquino, A., F. Brusa and C. Damborenea. 2014. Checklist of freshwater symbiotic temnocephalans (Platyhelminthes, Rhabditophora, Temnocephalida) from the Neotropics. *Zoosystematics and Evolution* 90: 147-162.

Matjašič, J. 1990. Monography of the family Scutariellidae (Turbellaria, Temnocephalidea). Slovenska Akademija Znanosti in Umetnosti, Razred za Naravoslovne Vede Classis IV: *Historia Naturalis*, 28, Znanstvenoraziskovalni Center Sazu, Biološki Inštitut Jovana Hadžija 9: 1-166 (+pls. 1-29), Ljubljana.

Niwa, N., J. Ohtomi, A. Ohtaka and S. R. Gelder. 2005. The first record of the ectosymbiotic branchiobdellidan *Holtodrilus truncatus* (Annelida, Clitellata) and on the freshwater shrimp *Neocaridina denticulata denticulata* Caridea, Atyidae) in Japan. *Fisheries Science* 71: 685-687.

Niwa, N. and A. Ohtaka. 2006. Accidental introduction of symbionts with imported freshwater shrimps. In Koike, F., M. N. Clout, M. Kawamichi, M. De Poorter and K. Iwatsuki (eds), Assessment and Control of Biological Invasion Risk. IUCN, Gland,

- Switzerland: 182–186.
- Niwa N., M. V. Archdale, T. Matsuoka, A. Kawamoto and H. Nishiyama. 2014. Microhabitat distribution and behaviour of Branchiobdellidan *Holtodrilus truncatus* found on the freshwater shrimp *Neocaridina* spp. from the Sugo River, Japan. Central European Journal of Biology 9: 80–85.
- Oberkofler, B., F. Quaglio, L. Füreder, M. L. Fioravanti, S. Giannetto, C. Morolliand G. Minelli. 2002. Species of Branchiobdellidae (Annelida) on freshwater crayfish in South Tyrol (northern Italy). Bulletin Francais de la Pecheet de la Pisciculture 367: 777-784.
- Ohtaka, A. and R. T. Chen. 2010. New records of a branchiobdellidan and four microdrile oligochaetes (Annelida: Clitellata) from inland waters of Taiwan. Taiwan Journal of Biodiversity 12: 97–110.
- Ohtaka A. and S. R. Gelder. 2015. Description of a new species of Branchiobdellida (Annelida : Clitellata) and comparison with other *Cirrodrilus* species in northern Honshu, Japan. Species Diversity 20 : 67-71.
- Ohtaka A., S. R. Gelder, M. Nishino, M. Ikeda, H. Toyama, Y.-D. Cui, X.-B. He, H.-Z. Wang, R.-B. Chen and Z.-Y. Wang. 2012. Distributions of two ectosymbionts, branchiobdellidans (Annelida: Clitellata) and scutariellids (Platyhelminthes: “Turbellaria”: Temnocephalida), on atyid shrimp (Arthropoda: Crustacea) in southeast China. Journal of Natural History 46: 1547–1556
- Timm, T. 1991. Branchiobdellida (Oligochaeta) from the farthest South-East of the U.S.S.R. Zoologica Scripta 20: 321–331.
- Yamaguchi, H. 1934. Studies on Japanese Branchiobdellidae with some revisions on the classification. Journal of the Faculty of Science, Hokkaido University, Series VI, Zoology 3: 177–219.