Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Pseudopolydora cf. kempi*

Common Name *spionid worm*

Phylum	Annelida
Class	Polychaeta
Order	Canalipalpata
Family	Spionidae

Species Occurrence by Ecoregion

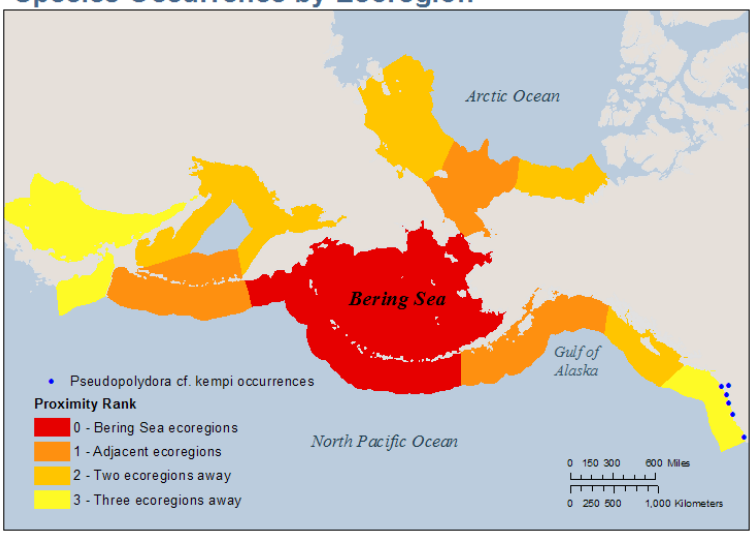

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Final Rank 47.40

Data Deficiency: 8.75

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	20	26	3.75
Anthropogenic Influence:	4.75	10	0
Biological Characteristics:	16	25	5.00
Impacts:	2.5	30	0
Totals:	43.25	91.25	8.75

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	NA	Minimum Salinity (ppt)	1.6
Maximum Temperature (°C)	29	Maximum Salinity (ppt)	37
Minimum Reproductive Temperature (°C)	NA	Minimum Reproductive Salinity (ppt)	31*
Maximum Reproductive Temperature (°C)	NA	Maximum Reproductive Salinity (ppt)	35*

Additional Notes

A species complex of tube-building polychaetes (segmented worms). Maximum reported length ranges from 6.5 to 22 mm. The worms are white to tan in color, with black pigments towards the front of their body, and sometimes with a pair of dorsal spots on the chaetigers. Populations from different localities show small differences in morphology. Populations from India, the Sea of Japan, and California differ in the number and size of nurse eggs providing food for developing embryos, and in the length of the planktonic larval stage (Blake and Woodwick 1975; Myohara 1979; Rdashevsky 1985; Blake and Ruff 2007). Pseudopolydora cf. kempi is a tube-building suspension and deposit feeder. Has been subdivided into several subspecies, which show differences in adult morphology and larval development. The status of these subspecies is unresolved. Its native range is believed to be the Indo-Pacific with introduced populations in Europe, Australia, New Zealand, Central America and the West Coast of the US (British Columbia to California). It is typically found in intertidal mudflats and shallow, muddy subtidal waters, often with low or variable salinity.

1. Distribution and Habitat

1.1 Survival requirements - Water temperature

Choice: C — Little overlap – A small area (<25%) of the Bering Sea has temperatures suitable for year-round survival

Score: 1.25 of 3.75

High uncertainty? ☑

Ranking Rationale:
The minimum temperature threshold is not known, but this species currently exists at northern latitudes in Russia. We therefore ranked this species as "Little overlap" with "High uncertainity".

Background Information:
Broad temperature range, from cold-temperate to tropical. Maximum Temperature: 29º C (Chollet and Bone 2007). Found at similar northern latitudes in Russia. A minimum temperature threshold was not found in the literature for P. cf. kempi.

Sources:
Chollet and Bone 2007

1.2 Survival requirements - Water salinity

Choice: A — Considerable overlap – A large area (>75%) of the Bering Sea has salinities suitable for year-round survival

Score: 3.75 of 3.75

Ranking Rationale:
Salinities required for year-round survival occur over a large (>75%) area of the Bering Sea.

Background Information:
P. cf. kempi has a salinity tolerance of 1.6 to 35 PSU (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

1.3 Establishment requirements - Water temperature

Choice: U — Unknown/Data Deficient

Score: of

Ranking Rationale:

Background Information:
No information is available in the literature for temperature thresholds for the reproduction of P. cf. kempi. Growth rates for this species depend upon temperature (Blake and Woodwick 1975)

Sources:
Blake and Woodwick 1975

1.4 Establishment requirements - Water salinity

Choice: A — Considerable overlap – A large area (>75%) of the Bering Sea has salinities suitable for reproduction

Score: 3.75 of 3.75

Ranking Rationale:
Although salinity thresholds are unknown, this species is a marine organism that does not require freshwater to reproduce. We therefore assume that this species can reproduce in saltwater (31 to 35 ppt). These salinities occur in a large (>75%) portion of the Bering Sea.

Background Information:
No information found.

Sources:
None listed

1.5 Local ecoregional distribution

Choice: D

Present in an ecoregion greater than two regions away from the Bering Sea

Score: 1.25 of 5

Ranking Rationale:
Washington is closest known occurrence of P. cf. kempi to the Bering Sea.

Background Information:
Found along the west coast of North America in California, Oregon and Washington (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

1.6 Global ecoregional distribution

Choice: A

In many ecoregions globally

Score: 5 of 5

Ranking Rationale:
Has a wide global distribution.

Background Information:
First described from Kolkata, India and has a wide global distribution. Its native range is believed to be the Indo-Pacific with introduced populations in Europe, Australia, New Zealand, Central America and the West Coast of the US (British Columbia to California). Also reported from Venezuela and Mozambique. Further molecular and morphological studies are needed to verify the identity of these

Sources:
NEMESIS; Fofonoff et al. 2003

1.7 Current distribution trends

Choice: A

Recent rapid range expansion and/or long-distance dispersal (within the last ten years)

Score: 5 of 5

Ranking Rationale:
Recent documentation of long-distance dispersal and range expansion.

Background Information:
Reported in numerous locations from 1975 to 2015. Long-distance dispersal due to anthropogenic vectors.

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	20
Section Total - Possible Points:	26.25
Section Total -Data Deficient Points:	3.75

2. Anthropogenic Transportation and Establishment

2.1 Transport requirements: relies on use of shipping lanes (hull fouling, ballast water), fisheries, recreation, mariculture, etc. for transport

Choice: B

Has been observed using anthropogenic vectors for transport but has rarely or never been observed moving independent of anthropogenic vectors once introduced

Score: 2 of 4

Ranking Rationale:
Has been observed using anthropogenic vectors but no information exists for movements independent of anthropogenic vectors once introduced.

Background Information:
The absence of Pseudopolydora cf. kempi in early polychaete surveys strongly supports introduced status for West Coast populations (Carlton 1979; Cohen and Carlton 1995). A likely source of these populations is northeastern Japan, from where the Miyagi strain of Pacific Oysters (Crassostrea gigas) was imported (Fofonoff et al. 2003). Ballast water discharge and ship fouling are also likely sources (Cohen 1998).

Sources:
Carlton 1979 Cohen and Carlton 1995 NEMESIS; Fofonoff et al. 2003 Cohen 1998

2.2 Establishment requirements: relies on marine infrastructure, (e.g. harbors, ports) to establish

Choice: B

Readily establishes in areas with anthropogenic disturbance/infrastructure; occasionally establishes in undisturbed areas

Score: 2.75 of 4

High uncertainty? ☑

Ranking Rationale:
In its introduced range, may be more common in anthropogenic areas due to its limited dispersal abilities. Information is lacking for this species.

Background Information:
Occurs on intertidal mudflats and soft sand or mud substrates (Blake and Woodwick 1975). Several specimens have been collected in harbors, on pilings, and in polluted areas (Barnard 1958; Blake and Woodwick 1975). This species lives in substrates and has limited natural dispersal abilities (Blake and Woodwick 1975).

Sources:
Blake and Woodwick 1975 Barnard 1958

2.3 Is this species currently or potentially farmed or otherwise intentionally cultivated?

Choice: B

No

Score: 0 of 2

Ranking Rationale:

Background Information:
P. cf. kempi is not currently farmed or intentionally cultivated.

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	4.75
Section Total - Possible Points:	10
Section Total -Data Deficient Points:	0

3. Biological Characteristics

3.1 Dietary specialization

Choice: A

Generalist at all life stages and/or foods are readily available in the study area

Score: 5 of 5

Ranking Rationale:
Deposit feeder that can shift to suspension feeding when the environment dictates a need.

Background Information:
P. cf. kempi is primarily a deposit feeder that consumes benthic microalgae, detritus, and phytoplankton (Gallagher and Wells 1983 as qtd. In Fofonoff et al. 2003;Hentschel 1998). Can shift to suspension feeding when water currents increase by forming palps in helical shapes (Hiebert 2015).

Sources:
NEMESIS; Fofonoff et al. 2003 Hentschel 1998 Hiebert 2015

3.2 Habitat specialization and water tolerances

Does the species use a variety of habitats or tolerate a wide range of temperatures, salinity regimes, dissolved oxygen levels, calcium concentrations, hydrodynamics, pollution, etc?

Choice: A

Generalist; wide range of habitat tolerances at all life stages

Score: 5 of 5

Ranking Rationale:
Tolerates a wide range of temperatures and salinities and utilizes numerous habitat types.

Background Information:
P. cf. kempi is typically found in intertidal mudflats and shallow, muddy subtidal waters, often with low or variable salinity. General habitats include: unstructured bottom mudflats, salt-brackish marshes and canals. B P. cf. kempi tolerates a broad temperature range, from cold-temperate to tropical. It has been reported from brackish estuaries and coastal waters in cold-temperate to tropical waters (Berkeley and Berkeley 1951; Srikrishnada and Ramamoorthi 1977; Light 1978; as qtd. In Fofonoff et al. 2003). It also exhibits a broad salinity range, from Mesohaline to Euhaline (1.6 -34.8 PSU) and seems fairly tolerant of contamination by industrial wastes in native ranges. It is an early successional species after a disturbance (Lu and Wu 2007).

Sources:
NEMESIS; Fofonoff et al. 2003 Lu and Wu 2007

3.3 Desiccation tolerance

Choice: U

Unknown

Score: of

Ranking Rationale:

Background Information:
No information available in the literature.

Sources:
None listed

3.4 Likelihood of success for reproductive strategy

i. Asexual or hermaphroditic ii. High fecundity (e.g. >10,000 eggs/kg) iii. Low parental investment and/or external fertilization iv. Short generation time

Choice: B

Moderate – Exhibits one or two of the above characteristics

Score: 3.25 of 5

Ranking Rationale:

P. cf. kempi have sexual reporduction, moderate fecudity, short generation time, and low parental investment.

Background Information:

P. cf. kempi occurs in estuarine habitats in constructed mud and mucus tubes. There are two sexes. The females lay 15-20 eggs in the tubes (Myohara 1979). The planktonic larval stage lasts from a few days to 4 weeks. The length of the larval stage varies by population. Populations in India hatch at an earlier stage and spend 2-4 weeks as larvae (Myohara 1979, Srikrishanda and Ramamoorthi 1977, Radshevsky 1985 as qtd. in Fofonoff et al. 2003). California populations hatch at a later stage and spend only a few days as larvae (Blake and Woodwick 1975).

Sources:

Myohara 1979 NEMESIS; Fofonoff et al. 2003 Blake and Woodwick 1975 Hiebert 2015

3.5 Likelihood of long-distance dispersal or movements

Consider dispersal by more than one method and/or numerous opportunities for long or short distance dispersal e.g. broadcast, float, swim, carried in currents; vs. sessile or sink.

Choice: C

Disperses short (< 1 km) distances

Score: 0.75 of 2.5

Ranking Rationale:

Natural dispersal occurs only at one life stage that lasts a short time.

Background Information:

P. cf kempi is more mobile during short larval phase as plankton, with adults and eggs being benthic. The mobile plankton stage exists for a only a short time before larvae settle into a benthic life (Blake and Woodwick 1975).

Sources:

Blake and Woodwick 1975

3.6 Likelihood of dispersal or movement events during multiple life stages

i. Can disperse at more than one life stage and/or highly mobile ii. Larval viability window is long (days v. hours) iii. Different modes of dispersal are achieved at different life stages (e.g. unintentional spread of eggs, migration of adults)

Choice: C

Low – Exhibits none of the above characteristics

Score: 0.75 of 2.5

Ranking Rationale:

Has only one short mobile phase as a larvae.

Background Information:

Benthic for majority of its life. Mobile for a very short period as planktonic larvae.

Sources:

Blake and Woodwick 1975

3.7 Vulnerability to predators

Choice: **D**

Multiple predators present in the Bering Sea or neighboring regions

Score: **1.25** **of** **5**

Ranking Rationale:

Numerous predators, many of which exist in the Bering Sea.

Background Information:

P. cf. kempi is a potential prey item for fishes, shorebirds and other predators (Tomiyama et al. 2007).

Sources:

Tomiyama et al. 2007

Section Total - Scored Points:	16
Section Total - Possible Points:	25
Section Total -Data Deficient Points:	5

4. Ecological and Socioeconomic Impacts

4.1 Impact on community composition

Choice: D — No impact

Score: 0 of 2.5

Ranking Rationale:
Has few, minor impacts.

Background Information:
In native ranges, facilitates recruitment of other invertebrates and provides forage for vertebrates. No evidence of declines detected.

Sources:
NEMESIS; Fofonoff et al. 2003

4.2 Impact on habitat for other species

Choice: B — Moderate – Causes or has potential to cause changes to one or more habitats

Score: 1.75 of 2.5

Ranking Rationale:
Alters the structure of the benthic habitat which facilitates the recruitment of other invertebrates.

Background Information:
Tube building invertebrates including P. cf. kempi have impacts on mudflats and other soft substrates through their burrowing behaviors. This adds structure to relatively soft and homogenous environments and aids in the recruitment of other invertebrate taxa (Gallagher et al 1983).

Sources:
Gallagher et al. 1983 NEMESIS; Fofonoff et al. 2003 Hiebert 2015

4.3 Impact on ecosystem function and processes

Choice: C — Limited – Causes or potentially causes changes to food webs and/or ecosystem functions, with limited impact and/or within a very limited region

Score: 0.75 of 2.5

Ranking Rationale:
Is a potential prey item. It's burrowing activities facilitate recruitment of other invertebrates.

Background Information:
The impacts of exotic polychaetes are varied, with many having no reported impact, but some species can reach high densities and are known to increase erosion or foul aquaculture species and maritime equipment. The ecological impacts of Pseudopolydora cf. kempi are not well known.

Pseudopolydora cf. kempi is frequently abundant in subtidal brackish waters in Asian waters and the West Coast of North America. It is a potential prey item for fishes and other predators (Tomiyama et al. 2007). Together with other tube-building invertebrates, this worm has an ecological impact in mudflats and soft-substrate habitats by adding structure to relatively homogeneous environments, facilitating the recruitment of other invertebrates (Gallagher et al. 1983).

Sources:
Tomiyama et al. 2007 Gallagher et al. 1983 NEMESIS; Fofonoff et al. 2003

4.4 Impact on high-value, rare, or sensitive species and/or communities

Choice: D — No impact

Score: 0 of 2.5

Ranking Rationale:
To date, no impacts on high-value, rare, or sensitive species have been reported for P. cf. kempi.

Background Information:
No information available in the literature.

Sources:
NEMESIS; Fofonoff et al. 2003

4.5 Introduction of diseases, parasites, or travelers

What level of impact could the species' associated diseases, parasites, or travelers have on other species in the assessment area? Is it a host and/or vector for recognized pests or pathogens, particularly other nonnative organisms?)

Choice: D — No impact

Score: 0 of 2.5

Ranking Rationale:
To date, no known diseases or parasites have been reported for P. cf. kempi.

Background Information:
No information available in the literature.

Sources:
NEMESIS; Fofonoff et al. 2003 Hiebert 2015

4.6 Level of genetic impact on native species

Can this invasive species hybridize with native species?

Choice: D — No impact

Score: 0 of 2.5

Ranking Rationale:
No evidence exists for hybridization with native species.

Background Information:
No evidence of hybridization with native species detected. Genetics of this species still poorly understood. Pseudopolydora cf. kempi has been subdivided into several subspecies, which show differences in adult morphology and larval development. The status of these subspecies is unresolved, due to scanty descriptions and the absence of type specimens. With future work, this taxon may be split into several cryptic species (Radashevsky and Hsieh 2000; Sato-Okoshi 2000).

Sources:
Hiebert 2015 NEMESIS; Fofonoff et al. 2003

4.7 Infrastructure

Choice: D — No impact

Score: 0 of 3

Ranking Rationale:
To date, no impacts on infrastucture have been reported for P. cf. kempi.

Background Information:
No information available in the literature.

Sources:
None listed

4.8 Commercial fisheries and aquaculture

Choice: D — No impact

Score: 0 of 3

Ranking Rationale:
Is an important prey species in it's native range, impact in introduced ranges unknown.

Background Information:
P. cf. kempi may be important to fish and benthic invertebrates as prey. In Japan, predators (particularly flounders) engaged in sublethal predation of this species. The predators bite off chunks of the worms that the worms would then regenerate (Tomiyama et al. 2007). This has helped maintain the near optimal conditions for the high growth rates of stone flounders observed in Japan. Information not known in non-native regions.

Sources:
Tomiyama et al. 2007 NEMESIS; Fofonoff et al. 2003

4.9 Subsistence

Choice: D — No impact

Score: 0 of 3

Ranking Rationale:
To date, no impacts on subsistence have been reported for P. cf. kempi.

Background Information:
No information available in the literature.

Sources:
NEMESIS; Fofonoff et al. 2003

4.101 Recreation

Choice: D — No impact

Score: 0 of 3

Ranking Rationale:
To date, no impacts on recreation have been reported for P. cf. kempi.

Background Information:
No information found in the literature.

Sources:
NEMESIS; Fofonoff et al. 2003

4.11 Human health and water quality

Choice: D — No impact

Score: 0 of 3

Ranking Rationale:
To date, no impacts on human health or water quality have been reported for P. cf. kempi.

Background Information:
No information available in the literature.

Sources:
NEMESIS; Fofonoff et al. 2003 Hiebert 2015

Section Total - Scored Points:	2.5
Section Total - Possible Points:	30
Section Total -Data Deficient Points:	0

5. Feasibility of prevention, detection and control

5.1 History of management, containment, and eradication

Choice: C — Attempted; control methods are currently in development/being studied

Score: [ ] of [ ]

Ranking Rationale:

Background Information:
Increased awareness and regulation of transportation methods of exotic species (oyster farming and ship ballast water discharge are primary sources of Pseudopolydora cf. kempi), global efforts to identify non-native polychaetes but no direct efforts to manage or eradicate Pseudopolydora cf. kempi found.

Sources:
Hiebert 2015 NEMESIS; Fofonoff et al. 2003

5.2 Cost and methods of management, containment, and eradication

Choice: U — Unknown

Score: [ ] of [ ]

Ranking Rationale:

Background Information:

Sources:
None listed

5.3 Regulatory barriers to prevent introductions and transport

Choice: C — Regulatory oversight and/or trade restrictions

Score: [ ] of [ ]

High uncertainty? ☑

Ranking Rationale:
Regulations exist for oyster seed to be certified diesase free, but it is not clear if the presence of P. cf. kempi is included in this restriction.

Background Information:
The distribution and release of the hatchery products (including oysters) are a matter of state regulations and control as well as the practices outlined in the National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish – Section II, Chapter VI (FDA 2011). In 1989 the State of Alaska passed legislation permitting the farming of approved shellfish species in coastal waters. The state of Alaska requires oyster seed sources to be certified disease free, but it is not clear if species like Pseudopolydora kempi could still be present in certified seed or spat (ADF&G 2016). Alaska does not have a formal program for the management of aquatic species in ballast water discharges. It relies on the U.S. Coast Guard to enforce national standards (ADF&G 2016).

Sources:
NEMESIS; Fofonoff et al. 2003 ADF&G 2016

5.4 Presence and frequency of monitoring programs

Choice: **A** No surveillance takes place

Score: _____ **of** _____

Ranking Rationale:

Background Information:
No specific efforts for Pseudopolydora kempi found.

Sources:
NEMESIS; Fofonoff et al. 2003

5.5 Current efforts for outreach and education

Choice: **A** No education or outreach takes place

Score: _____ **of** _____

Ranking Rationale:

Background Information:
No specific efforts for Pseudopolydora kempi found.

Sources:
None listed

Section Total - Scored Points:
Section Total - Possible Points:
Section Total -Data Deficient Points:

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Literature Cited for *Pseudopolydora cf. kempi*

- Blake, J. A. and K. H. Woodwick. 1975. Reproduction and larval development of Pseudopolydora paucibranchiata (Okuda) and Pseudopolydora kempi (Southern) (Polychaeta: Spionidae). Biological Bulletin 149: 109-127.
- Carlton, J. T. 1979. History, biogeography, and ecology of the introduced marine and estuarine invertebrates of the Pacific Coast of North America. PhD Thesis, University of California, Davis, CA, U.S.A. 904 pp.
- Chollett, I., and D. Bone. 2007. Effects of heavy rainfall on polychaetes: Differential spatial patterns generated by a large-scale disturbance. Journal of Experimental Marine Biology and Ecology 340(2):113-125. doi: 10.1016/j.jembe.2006.07.009
- Cohen, A. N. 1998. Ships' ballast water and the introduction of exotic organisms into the San Francisco Estuary: Current status of the problem and options for management. San Francisco Estuary Institute, Richmond, CA. 84 pp.
- Gallagher, E. D., P. A. Jumars, and D. D. Trueblood. 1983. Facilitation of soft-bottom benthic succession by tube builders. Ecology 64:1200-1216.
- Hiebert, T. C. 2015. Pseudopolydora kempi. In Hiebert, T.C., Butler, B.A., and A.L. Shanks, editors. Oregon Estuarine Invertebrates: Rudys' Illustrated Guide to Common Species, 3rd ed. University of Oregon Libraries and Oregon Institute of Marine Biology,
- Hiebert, T.C. 2015. Nippoleucon hinumensis. In: Oregon Estuarine Invertebrates: Rudys' Illustrated Guide to Common Species, 3rd ed. T.C. Hiebert, B.A. Butler and A.L. Shanks, eds.. University of Oregon Libraries and Oregon Institute of Marine Biology, C
- Hiebert, T. C. 2015. Limnoria tripunctata. In Hiebert, T.C., Butler, B.A., and A.L. Shanks, editors. Oregon Estuarine Invertebrates: Rudys' Illustrated Guide to Common Species, 3rd ed. University of Oregon Libraries and Oregon Institute of Marine Biology,
- Lu, L., and R. S. S. Wu. 2007. A field experimental study on recolonization and succession of subtidal macrobenthic community in sediment contaminated with industrial wastes. Marine Pollution Bulletin 52:195-205. doi: 10.1016/j.marpolbul.2006.10.004
- Fofonoff, P. W., G. M. Ruiz, B. Steves, C. Simkanin, and J. T. Carlton. 2017. National Exotic Marine and Estuarine Species Information System. http://invasions.si.edu/nemesis/. Accessed: 15-Sep-2017.
- Tomiyama, T., Omori, M., and T. Minami. 2007. Feeding and growth of juvenile stone flounder in estuaries: Generality and the importance of sublethal tissue cropping of benthic invertebrates. Marine Biology 152:365-376. doi: 10.1007/s00227-006-0491-1
- ADF&G. 2016. Invasive Pike in Southcentral Alaska: What Can be Done about Unwelcome Pike? Alaska Department of Fish & Game. Available from: http://www.adfg.alaska.gov/index.cfm?adfg=invasivepike.options Accessed 03-November-2016.
- Barnard, J. L. 1958. Amphipod crustaceans as fouling organisms in Los Angeles-Long Beach Harbors, with reference to the influence of seawater turbidity. California Fish and Game 44: 161-170
- Cohen, A. N., and J. T. Carlton. 1995. Nonindigenous aquatic species in a United States estuary: A case study of the biological invasions of the San Francisco Bay and Delta. SFEI Contribution No. 185. U.S. Fish and Wildlife Service, Washington, D.C.
- Hentschel, B. T. 1998. Intraspecific variations in ?13C indicate ontogenetic diet changes in deposit-feeding polychaetes. Ecology 79(4):1357-1370.
- Myohara, M. 1979. Reproduction and development of Pseudopolydora kempi japonica (Polychaeta: Spionidae), with special reference to the polar lobe formation. Journal of the Faculty of Science Hokkaido University Series VI, Zoology 21(4):355-364.