Proposal for a SCOR Working Group on Lanternfishes in the Ocean

(Revision: 31 May 2006)

EXECUTIVE SUMMARY

Lanternfishes (family Myctophidae) are small but abundant fishes found in the midwaters of the entire world ocean. Due to their ubiquity, abundance and vertical migratory behavior, they undoubtedly play major roles in the oceanic food web. Not only are lanternfishes major predators on zooplankton, but they comprise a significant portion of the diet of pinnipeds, penguins and other marine birds.

It is proposed that a SCOR Working Group (WG) be convened to investigate the role of lanternfish in the ocean. The WG goals will be:

1) Summarize the state of knowledge of methods and techniques employed for determining myctophid population dynamics, and to summarize the state of knowledge about myctophid biology, especially as it pertains to an understanding of the role of lanternfishes in the world ocean ecosystem.
2) Assess ongoing research effort required in these areas, including and emphasizing the utilization of modeling techniques and approaches.
3) Target those myctophid species and those geographic areas in the world ocean that could benefit from a focus of these and other innovative research approaches in terms of biomass turnover rate.
4) Establish and maintain a web site for the exchange of information and ideas between mesopelagic fish specialists, marine biologists and physical oceanographers, as well as other interested groups such as fisheries scientists.
5) Produce a comprehensive report incorporating the results from the above activities for which we would seek appropriate publication, whether in a peer-reviewed journal or as a book.

The WG will bring together a group of scientists, including young investigators and senior scientists, from a variety of countries and subdisciplines. Over a four-year period the WG would have three meetings and sponsor an international conference of myctophid specialists, fishery biologists and related marine scientists. The final report of the WG will identify the critical knowledge gaps as well as suggest ways that those gaps might be addressed.

RATIONALE

The mesopelagic region of the world's ocean comprises 1.4 x 10^9 km^3 of the total ocean volume (Herring 2002:249) and mesopelagic fishes are the largest component of its biomass. These are small fishes, usually 2 to 10 cm in length and usually found at depths from 100 to 1000 meters below the surface. The family Myctophidae, commonly known as lanternfish, makes up about 65% of all mesopelagic fishes and has a global biomass estimated at 660 million tons (Hulley in Paxton & Eschmeyer 1995).

Most fish population dynamics studies have been directed toward more economically important fishery groups (such as sardines, rockfishes, cod or herring) or large species (such as tunas), or toward marine mammals (such as whales and dolphins). Preliminary research indicates that myctophids play a significant role in the marine food web, acting as both predator and prey. As predators, myctophids primarily feed on copepods, ostracods and euphausiids. In turn, lanternfishes are reported as prey of numerous fishes, sea birds and pinnipeds. While much data has been obtained, the details of various food chains involving myctophids need to be worked out.

The proposed Working Group will focus international attention on the most logical way to explore the dual problem of the lack of knowledge of the population dynamics and biology of these lanternfishes, together with a lack of understanding of the domino effect on the ecosystem due to changes in relative abundances of the various myctophid species. While the kind of research that must be conducted is basic research, it is clearly of practical importance to a more complete understanding of the marine ecosystem and role of myctophids.

Most lanternfishes are broadly tropical in distribution (Hulley, pers. comm.), and are influenced by changes in environmental factors as readily as nearshore fishes, such as being entrained by fronts or transported by currents (Backus et al., 1969; Backus & Craddock, 1982; Bekker, 1985; Brandt, 1981; Craddock et al., 1992; Figueroa et al., 1998; Gorbunova et al., 1985; Hulley, 1992; John et al., 2000; Konstantinova et al., 1994; Koubbi et al., 2003; Rodriguez-Graña & Castro, 2003; Rogachev et al., 1996; Rojas et al., 2002; Sameoto, 1981; The Ring Group, 1981; Zelck & Klein, 1995). This is further complicated by the vertical diurnal migration deep-sea fishes undertake. For example, Linkowski (1996), in looking at the myctophid genus *Hygophum*, determined three types of species-specific migratory patterns in relation to lunar cycles. Proximity to coastal areas also affects vertical distribution. Ropke (1993) found the larvae of four species of myctophids occurred on the average about 20 m deeper in the central oceanic region compared to the coastal areas off Oman and Pakistan. The structure and ecology of the deep-sea community and its relationship to epipelagic and nearshore communities is still largely unknown (Parin, 1986).

With the hope of gaining a more detailed ecological understanding of mesopelagic fishes, the lanternfishes are an ideal study organism. The Myctophidae includes at least 250 species. It is the most speciose family of deepsea fishes, comprising at least 20% of the oceanic ichthyofauna (McGinnis, 1974). They are considered the dominant fishes in most midwater samples and the most abundant. Gjøsaeter and Kawaguchi (1980) estimated the biomass of all mesopelagic fish in the ocean to be at least 9.5×10^8 tons. Nair et al. (1999) estimated the biomass of mesopelagic fishes, mainly myctophids, in the Arabian Sea to be about 100 million tons, and Beamish et al. (1999) estimate the biomass of just the myctophid *Stenobrachius leucopsarus* in the Subarctic Pacific (including the Bering Sea and Sea of Okhotsk) to be approximately 21 million tons. Predation by this large biomass has an affect on the structure of the food web in the amount zooplankton biomass removed. Hopkins and Gartner (1992) estimated a nightly removal of 2% of the zooplankton biomass in the Gulf of Mexico by lanternfish. These fishes can also be the most speciose family present in a midwater collection. Klepadlo (pers. comm.) has typically found 20-40 myctophid species in midwater trawl samples in temperate to tropical Pacific waters. Hopkins and Gartner (1992) indicate some trawl collections could have over 50 myctophid species and suggest niche separation as a means to reduce competition. Lanternfish species interactions need to be better understood and more clearly defined.

The oceanic food web, as on land, is driven by the energy passed through the web (Longhurst & Harrison, 1988; Tanimata et al., 2005) as the organic matter of prey organisms passes to the predators. The meso- and bathypelagic zones of the deep-sea are generally regarded as those of low energy and productivity due to lower food availability at greater depth (Childress et al., 1980). However, migratory mesopelagic fishes are a key to the active transport of food energy to depth. Myctophids undergo diurnal migrations, feeding in the epipelagic (0-200 m) and upper mesopelagic (200-500 m) zones (Balanov et al., 1994), and bringing both nutrients and carbon dioxide to deeper layers (500-1000 m) in or near the oxygen minimum layer (Nair et al., 1999; Butler et al., 2001). The large biomass of myctophids is also a large forage mass for other predators, i.e., fishes, birds, mammals (see Appendix). The caloric content of lipid-rich myctophids has been shown to be a significant energy source for marine predators (e.g., Phleger et al., 1997; Lea et al., 2002). It has been found that during the breeding season for various sea birds and pinnipeds, myctophids can comprise up to 90% of their diets (Cherel et al., 2002; Croxall et al., 1988; Croxall & Lishman, 1987; Croxall & North, 1988; Guinet et al., 1996; Ridoux, 1994; Woehler & Green, 1992).

Mesopelagic fishes, particularly the lanternfishes, have an important and possibly critical role in rapid turnover and replacement of their prey populations (Haedrich, 1997). Hopkins and Gartner (1992) estimated that myctophids remove at least one-third of the daily production of zooplankton from the epipelagic zone in the eastern Gulf of Mexico. While feeding primarily on copepods and euphausiids, lanternfishes have been found to switch to phytoplankton when the availability of zooplankton is limited (Robison, 1984; Ishihara and Kubota, 1997; Sutton et al., 1998). Watanabe et al. (2002) examined three species of myctophid in the Kuroshio waters and found that the trophic competition is reduced by specializing in different food organisms. However, Watanabe and Kawaguchi (2003) have shown that *Myctophum nitidulum* seemed to change their diet composition according to changes in the composition of prey species in its habitat. It is unknown if other species of lanternfishes are specialist or generalist feeders in relation to their prey composition.

As in any marine organism, changes in oceanographic conditions affect the habitat of myctophid adults and larvae and play a role in the distribution, and survivorship and recruitment success (Field et al., 2006; Shannon et al., 2003). Herring (2002:253) pointed out that "Natural disturbance of deep-sea populations has not yet been identified, nor has it been attempted experimentally." For example, in a species with very wide distribution, Zelck and Klein (1995) found that the salinity characteristics of lower surface waters correlated better with distribution of *Ceratoscopelus maderensis* than did temperature. On the other hand, Rojas et al. (2002) determined that upwelling and cold plume dynamics were important factors affecting the survivorship of *Diogenichthys atlanticus* and *D. laternatus*. Nonaka et al. (2000) found significant seasonal variation for *Myctophum affine* larvae off eastern Brazil, and Tsarin (1985) found that *Myctophum asperum* substituted for *Myctophum lunatum* during the winter monsoon period in the western Indian Ocean. The response of the myctophid community structure to postulated climatic changes affecting the oceans may significantly alter the marine food web.

How the biodiversity of lanternfishes affects the ecosystem as a whole warrants further investigation and new study methods to predict the consequences of various types of disturbances.

STATEMENT OF WORK/TERMS OF REFERENCE

It will be the goal of this Working Group to:

1) Summarize the state of knowledge of methods and techniques employed for determining myvtophid population dynamics, and to summarize the state of knowledge about myctophid biology, especially as it pertains to an understanding of the role of lanternfishes in the world ocean ecosystem.
2) Assess ongoing research effort required in these areas, including and emphasizing the utilization of modeling techniques and approaches.
3) Target those myctophid species and those geographic areas in the world ocean that could benefit from a focus of these and other innovative research approaches in terms of biomass turnover rate.
4) Establish and maintain a web site for the exchange of information and ideas between mesopelagic fish specialists, marine biologists and physical oceanographers, as well as other interested groups such as fisheries scientists.
5) Produce a comprehensive report incorporating the results from the above activities for which we would seek appropriate publication, whether in a peer-reviewed journal or as a book. If the group decides to produce a book, it will also produce a summary article for a peer-reviewed journal.

MEETINGS

The WG will have a duration of 4 years with three meetings of the members over that period. The first WG meeting would take place within three to six months after the availability of funds. The primary task of the first meeting would be to develop a plan to achieve the terms of reference. The primary discussion would focus on how to produce the final report. This would include setting time-frames and allocating tasks to members most logically by their geographic areas of interest, in order to bring together the information for past and ongoing efforts. The secondary task of the first meeting will be determining the steps for the establishment of a web site for the exchange of information among myctophid specialists, and biological and physical oceanographers. Because the interests of this working group with those of IMBER will potentially intersect, we have been in contact with Julie Hall, Executive Director of IMBER, to determine how best to interact in order to benefit both organizations.

It is clear that a working group of ten Full Members, plus an indeterminate number of Associate Members, will have difficulty bringing together all the necessary knowledge of ongoing efforts, let alone addressing potential future efforts. Therefore, one of the activities at the first WG meeting will be the planning for an international conference of myctophid specialists and related marine scientists including fishery biologists in order to specifically spell out the state of our knowledge of all aspects of myctophid biology. It is expected that such a conference would occur 18-24 months after the first WG meeting and would bring together some 40-50 specialists from all parts of the world. Support for such a conference would be sought from various agencies and private foundations. The incorporation of results of a successful international myctophid conference will greatly enhance the Working Group's final report by making it more comprehensive and inclusive.

The second WG meeting would be held immediately after the international conference. The agenda will include a discussion of how to incorporate the results from the conference into the WG final report, i.e., those actions and activities that will need to be undertaken by the WG members in order to have the results ready for incorporation into the final report. This will result in an initial draft that would be circulated electronically to the members who would be free to solicit comments and inputs from other specialists. The contributions from the various WG members will be brought together electronically into a revised draft. This draft will be discussed and finalized at the third and last WG meeting, to be held approximately 12 months after the second WG meeting.

Such a timetable is reasonable. It allows for some slippage of the dates and times, but will still permit completion of the WG activities and the final report within the planned 4-year period.

Time 0 -- Availability of funds
3-6 months later – WG Meeting One
18-24 months later – International Myctophid Conference
1 day – 1 month later – WG Meeting Two
12 months later – WG Meeting Three
3 months later – Final report ready for publication

WORKING GROUP MEMBERSHIP

The Working Group membership will consist of 10 members from a variety of countries including both developed and developing countries. It will include both myctophid specialists, and biological and physical oceanographers already involved in, or with an interest in, mesopelagic fishes.

Potential Working Group Participants:

Bernard J. Zahuranec, Co-Chair; Myctophid systematics and biogeography
Smithsonian Institution, Division of Fishes, Washington, D.C., USA

M. M. Rabbani, Co-Chair; Director General of NIO, Biology of marine invertebrates
National Institute of Oceanography, Karachi, Pakistan

Cynthia Klepadlo; Assistant Curator, Taxonomy of deep-sea fishes worldwide
Scripps Institution of Oceanography, Marine Vertebrates Collection, Calif., USA

Samina Kidwai; Associate Research Scientist, Biology of marine invertebrates
National Institute of Oceanography, Karachi, Pakistan

John Paxton; Taxonomy, anatomy, biology, and relationships of myctophids; Australia and Indo-Pacific
Australian Museum, Sydney, N.S.W., Australia

P. Alexander Hulley; Systematics and biogeography of myctophid on worldwide basis
South African Museum, Cape Town, Republic of South Africa

S. A. Tsarin; Biology, systematics and life history of deep-sea fish, especially western Indian Ocean
Institute of Biology of the Southern Seas, Sebastopol, Ukraine

Padmini Dalpadado; Life history and biology arctic fishes; extensive life history work on a single myctophid species (*Benthosema pterotum*)
Institute of Marine Fisheries, University of Bergen, Norway

Chiuki Sassa; Ecology of mesopelagic fish, East China Sea and West Pacific
Seikai National Fisheries Research Institute, Nagasaki, Japan

Donald Olson; Physical oceanographer, interaction of marine fishes and physical and environmental variables
Department of Physical Oceanography, Rosensteil School of Marine and Atmospheric Sciences, University of Miami, Florida, USA

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Appendix

Taxon	Scientific name	Common name	Reference
Piscean	Apogonops anomalus		Blaber & Bulman 1987
Piscean	Apristurus microps		Ebert 1996
Piscean	Apristurus saldanha		Ebert 1996
Piscean	Auxis sp.	bullet mackerel	Sanchez-Velasco et al. 1999
Piscean	Bathyraja maculata		Orlov 1998
Piscean	Bathyraja matsubarai		Orlov 1998
Piscean	Bathyraja minispinosa		Orlov 1998
Piscean	Bathyraja papilionifera		Orlov 1998
Piscean	Bathyraja papilionifera		Stehmann & Schulze 1996
Piscean	Brama brama		Blaber & Bulman 1987
Piscean	Champsocephalus gunnari	mackerel icefish	Lee et al. 2002b
Piscean	Decapterus russelli	mackerel scad	Raje 1997
Piscean	Dissostichus eleginoides	Patagonian toothfish	de la Rosa et al. 1997
Piscean	Epigonus denticulatus		Matallanas 1982/83
Piscean	Etmopterus spinax	velvet-belly lanternshark	Relini Orsi & Wurtz 1976
Piscean	Etmopterus spinax	velvet-belly lanternshark	Wurtz & Vacchi 1981
Piscean	Eumegistus sp.		Parin & Prutko 1985
Piscean	Euthynnus lineatus	black skipjack	Sanchez-Velasco et al. 1999
Piscean	Galeus polli		Ebert 1996
Piscean	Gymnodraco acuticeps	Antarctic dragonfish	Pakhomov 1998

Piscean	Helicolenus dactylopterus	jacopever	Weilbach et al. 1998
Piscean	Hexanchus griseus	sixgill shark	Ebert 1994
Piscean	Holohalaelurus regani		Ebert 1996
Piscean	Hoplostethus atlanticus	orange roughy	Rosecchi et al. 1988
Piscean	Hoplostethus mediterraneus	silver roughy	Kerstan 1989
Piscean	Iago omanensis	bigeye houndshark	Waller & Baranes 1994
Piscean	Katsuwonus pelamis	Japanese skipjack tuna	Kikawa 1977
Piscean	Lepidopus c audatus		Blaber & Bulman 1987
Piscean	Macrourus holotrachys	South Atlantic grenadier	Dudochkin 1988
Piscean	Macruronus magellanicus	long-tailed hake	Bezzi 1984
Piscean	Macruronus novaezelandiae	hoki	Blaber & Bulman 1987
Piscean	Macruronus novaezelandiae	hoki	Bulman & Blaber 1986
Piscean	Macruronus novaezelandiae	hoki	Jay 1993
Piscean	Macrurus rupestris	round-nose grenadier	Savvatimskij 1985
Piscean	Merluccius albidus	offshore hake	Rohr & Gutherz 1977
Piscean	Merluccius capensis	shallow-water Cape hake	Chlapowski 1977
Piscean	Merluccius capensis	shallow-water Cape hake	Pillar & Wilkinson 1995
Piscean	Merluccius capensis	shallow-water Cape hake	Prenski 1986
Piscean	Merluccius capensis	shallow-water Cape hake	Roel & McPherson 1988
Piscean	Merluccius gayi peruanus	Peruvian hake	Alamo & Espinoza 1997
Piscean	Merluccius paradoxus	deep-water Cape hake	Chlapowski 1977
Piscean	Merluccius paradoxus	deep-water Cape hake	Roel & McPherson 1988
Piscean	Merluccius polli	Benguela hake	Kilongo 1998
Piscean	Merluccius polli	Benguela hake	Kilongo & Mehl 1998
Piscean	Merluccius productus	Pacific hake	Outram & Haegele 1972
Piscean	Micromesistius australis	polaca	Otero 1977
Piscean	Micromesistius australis	polaca	Perrotta 1982
Piscean	Micromesistius poutassou	blue whiting	Miller 1966
Piscean	Notolepis annulata	ringed barracudina	Skora & Balushkin 1994
Piscean	Oncorhynchus spp.	Pacific salmon	French et al. 1971
Piscean	Oncorhynchus spp.	Pacific salmon	Nagasawa et al. 1997
Piscean	Paradiplospinus antarcticus		Solyanik 1964
Piscean	Promethichthys sp.		Parin & Prutko 1985
Piscean	Reinhardtius hipplglossoides	Greenland halibut	Yang & Livingston 1988
Piscean	Salmo salar	Atlantic salmon	Hansen & Pethon 1985
Piscean	Salmo salar	Atlantic salmon	Hislop & Youngson 1984
Piscean	Salmo salar	Atlantic salmon	Jacobsen & Hansen 1997
Piscean	Salmo salar	Atlantic salmon	Jacobsen & Hansen 2001
Piscean	Salmo salar	Atlantic salmon	Thurow 1973
Piscean	Scomber japonicus peruanus		Alamo et al. 1996
Piscean	Scomber scombrus	mackerel	Walker & Nichols 1993
Piscean	Scopelosaurus adleri		Balanov 2001
Piscean	Scopelosaurus harryi		Balanov 2001
Piscean	Sebastes spp.	rockfishes	Dower & Perry 2001
Piscean	Sebastes borealis	short-raker rockfish	Orlov & Abramov 2001

Piscean	Sebastes marinus		Gorchinski & Kiseleva 1992
Piscean	Sebastes marinus		Gorelova & Borodulina 1997
Piscean	Sebastes mentella		Gonzalez et al. 2000
Piscean	Sebastes mentella		Gorelova & Borodulina 1997
Piscean	Sebastes mentella		Shibanov et al. 1994
Piscean	Sebastes paucispinis	bocaccio	Phillips 1960
Piscean	Squalus sucklii		Hubbs 1917
Piscean	Theragra chalcogramma	walleye pollock	Yamamura et al. 2002
Piscean	Theragra chalcogramma	walleye pollock	Yoshida 1994
Piscean	Thunnus alalunga	albacore	Iverson 1971
Piscean	Thunnus alalunga	albacore	Kim et al. 1997
Piscean	Thunnus alalunga	albacore	Nihira 1988
Piscean	Thunnus albacares	yellowfin tuna	Bard & Pezennec 1991
Piscean	Thunnus albacares	yellowfin tuna	McPherson 1991
Piscean	Thunnus obesus	bigeye tuna	Kim et al. 1997
Piscean	Thunnus obesus	bigeye tuna	McPherson 1991
Piscean	Thyrsites atun	snoek	Negpen 1979
Piscean	Trachurus spp.	horse mackerel	Acevedo & Fives 2001
Piscean	Trachurus declivis		Blaber & Bulman 1987
Piscean	Trachurus picturatus murphyi		Alamo et al. 1996
Avian	Aptenodytes forsteri	emperor penguin	Kirkwood & Robertson 1997
Avian	Aptenodytes patagonicus	king penguin	Charrassin et al. 1998
Avian	Aptenodytes patagonicus	king penguin	Hindell 1988a
Avian	Aptenodytes patagonicus	king penguin	Jouventin et al. 1994
Avian	Aptenodytes patagonicus	king penguin	Klages & Bester 1998
Avian	Aptenodytes patagonicus	king penguin	Olsson & North 1997
Avian	Aptenodytes patagonicus	king penguin	Perissinotto & McQuaid 1992
Avian	Aptenodytes patagonicus	king penguin	Putz et al. 1998
Avian	Aptenodytes patagonicus	king penguin	Wilson et al. 1993
Avian	Catharacta antarctica lonnbergi	Antarctic skua	Reinhardt 1997
Avian	Catharacta maccormicki	South Polar skua	Montalti et al. 1997
Avian	Catharacta maccormicki	South Polar skua	Reinhardt 1997
Avian	Diomedea chrysostoma	grey-headed albatross	Reid et al. 1996
Avian	Diomedea melanophris	black-browed albatross	Reid et al. 1996
Avian	Eudyptes chrysolophus	macaroni penguin	Green et al. 1998
Avian	Fratercula arctica	Atlantic puffin	Falk et al. 1992
Avian	Halobaena caerulea	blue petrel	Cherel et al. 2002a
Avian	Hydrobates pelagicus	British storm petrel	D'Elbee & Hemery 1998
Avian	Larus argentatus atlanticus	yellow-legged herring gull	Hamer et al. 1994
Avian	Larus novaehollandiae hartlaubi	Hartlaub's gull	Morant 1987
Avian	Larus novaehollandiae hartlaubi	Hartlaub's gull	Walter 1985
Avian	Oceanodroma furcata	forked-tail storm-petrel	Vermeer & DeVito 1988
Avian	Oceanodroma leucorhoa	Leach's storm-petrel	Vermeer & DeVito 1988
Avian	Pagophila eburnea	ivory gull	Orr & Parsons 1982

Avian	Phalacrocorax capensis	Cape cormorant	Walter 1985
Avian	Phoebetria palpebrata	light-mantled sooty albatross	Thomas 1982
Avian	Procellaria aequinoctialis	white-chinned petrel	Croxall et al. 1995
Avian	Procellaria aequinoctialis	white-chinned petrel	Jackson 1985
Avian	Puffinus griseus	sooty shearwater	Jackson 1985
Avian	Puffinus tenuirostris	short-tailed shearwater	Gould et al. 2000
Avian	Pygoscelis antarctica	chinstrap penguin	Jansen et al. 1998
Avian	Pygoscelis papua	gentoo penguin	Leseroel et al. 2004
Avian	Rissa brevirostris	red-legged kittiwake	Lance & Roby 1998
Avian	Rissa tridactyla	black-legged kittiwake	Lance & Roby 1998
Avian	Sterna dougallii	roseate tern	Ramos et al. 1998
Avian	Sterna fuscata	sooty tern	Surman & Wooller 2003
Avian	Sterna hirundo	common tern	Granadeiro et al. 2002
Mammalian	Arctocephalus forsteri	New Zealand fur seal	Fea et al. 1999
Mammalian	Arctocephalus gazella	Antarctic fur seal	Daneri 1996
Mammalian	Arctocephalus gazella	Antarctic fur seal	Daneri & Carlini 1999
Mammalian	Arctocephalus gazella	Antarctic fur seal	Daneri & Coria 1993
Mammalian	Arctocephalus gazella	Antarctic fur seal	Green et al. 1989
Mammalian	Arctocephalus gazella	Antarctic fur seal	Klages & Bester 1998
Mammalian	Arctocephalus gazella	Antarctic fur seal	Lee et al. 2002a
Mammalian	Arctocephalus gazella	Antarctic fur seal	North et al. 1983
Mammalian	Arctocephalus philippii	Juan Fernandez fur seal	Acuna & Francis 1995
Mammalian	Arctocephalus pusillus	Cape fur seal	Bester et al. 2002
Mammalian	Arctocephalus tropicalis	Subantarctic fur seal	Klages & Bester 1998
Mammalian	Balaenoptera edeni	Bryde's whale	Gallardo & Pastene 1983
Mammalian	Balaenoptera edeni	Bryde's whale	Kawaguchi & Kawamura 1981
Mammalian	Delphinus delphis		Chou et al. 1995
Mammalian	Globicephala melas	long-fined pilot whale	Gannon et al. 1997
Mammalian	Lagoenorhynchus obscurus	dusky dolphin	Wuersig et al. 1997
Mammalian	Lissodelphis borealis		Chou et al. 1995
Mammalian	Stenella attenuata	pantropical spotted dolphin	Robertson & Chivers 1997
Molluscan	Dosidicus gigas	jumbo squid	Markaida & Sosa-Nishizaki 200
Molluscan	Dosidicus gigas	jumbo squid	Nigmatullin et al. 2001
Molluscan	Illex argentinus	short-finned squid	Santos & Haimovici 1997
Molluscan	Moroteuthis ingens	deepwater squid	Jackson et al. 1998
Molluscan	Moroteuthis ingens	deepwater squid	Phillips et al. 2001
Molluscan	Moroteuthis ingens	deepwater squid	Phillips et al. 2003
Molluscan	Ommastrephes bartramii	neon flying squid	Araya 1983
Molluscan	Ommastrephes bartramii	neon flying squid	Lipinski & Linkowski 1988
Molluscan	Ommastrephes bartramii	neon flying squid	Watanabe et al. 2004
Molluscan	Pterygioteuthis gemmata		Nesis 1993
Molluscan	Pyroteuthis margaritifera		Nesis 1993
Molluscan	Sthenoteuthis oualaniensis		Shchetinnikov 1992

Molluscan	Sthenoteuthis oualaniensis		Tsarin & Chesalin 1983
Molluscan	Sthenoteuthis oualaniensis		Zuyev et al. 2002
Crustacean	Acanthephyra pelagica	oplophorid shrimp	Cartes 1993
Crustacean	Plesionika spp.	pandalid shrimp	Cartes & Fanelli 2004
Crustacean	decapods		Cartes et al. 1994
Crustacean	euphausids		Cartes et al. 1994
Crustacean	mysids		Frank et al. 1984