1ST INTERNATIONAL WORKSHOP OF SQUIDS
2ND INTERNATIONAL SYMPOSIUM OF PACIFIC SQUIDS

NOVEMBER 25 - 29, 2002.
LA PAZ, BAJA CALIFORNIA SUR, MEXICO.

Presentación del 2o Simposium Internacional de Calamares del Pacífico.

Es un hecho irrefutable que las pesquerías en todo el mundo enfrentan retos de ordenamiento, en unas regiones más severos que en otras. En general, las capturas de recursos marinos están en el máximo que pueden rendir a las flotas pesqueras o más allá del mismo. En consecuencia, es cada vez más evidente que muchas flotas, tanto industriales como de pequeña escala, tienen un tamaño excesivo que atenta en contra del sostenimiento de la propia pesca como actividad económica.

Ante esta realidad, investigadores y administradores pesqueros por igual han tomado conciencia de que los recursos marinos son vulnerables y finitos. Ello ha provocado la adopción de medidas para promover que el uso de los recursos naturales se realice con el menor impacto posible a su capacidad productiva. Este conjunto de elementos estratégicos es lo que se conoce como pesca responsable, expresión que ha sido recogida en la Declaración de Cancún –en 1992–, incorporando de forma explícita el enfoque precautorio. Más recientemente, en Reykjavik –2001–, en el seno de FAO las economías pesqueras identificaron la necesidad y acordaron realizar el manejo pesquero en el contexto de los ecosistemas. Es por ello notorio que en este evento se consideren en específico el conocimiento de la estructura poblacional de los calamares, así como posibles relaciones con su ambiente natural.

El enfoque precautorio puede ponerse en marcha a nivel poblacional y ecosistema. Tiene este como elemento central el papel de la ciencia y del mejor conocimiento científico en el aprovechamiento de los recursos naturales. El reto, que generalmente constituye una gran dificultad, es adoptar políticas que permitan que la pesca sea económicamente óptima, ecológicamente sustentable y socialmente aceptada. Desde el punto de vista de la ciencia, lo anterior implica un esquema administrativo basado en investigaciones robustas, que lo orienten y le provean de sustento sólido. Esto es, en teoría, una meta que debiera orientar los eventos científicos para intercambio de experiencias y opiniones.

Tal como se declara en la invitación que se hiciera pública, el objetivo del presente simposium es mostrar y discutir los más recientes hallazgos sobre la biología, ecología y la pesca de calamares en el mundo entero. En línea con lo que se declara en los párrafos anteriores, se pretende que el simposium sirva de vínculo entre los participantes para concentrar esfuerzos y buscar fórmulas para que las pesquerías de calamares se desarrollen de manera sana.

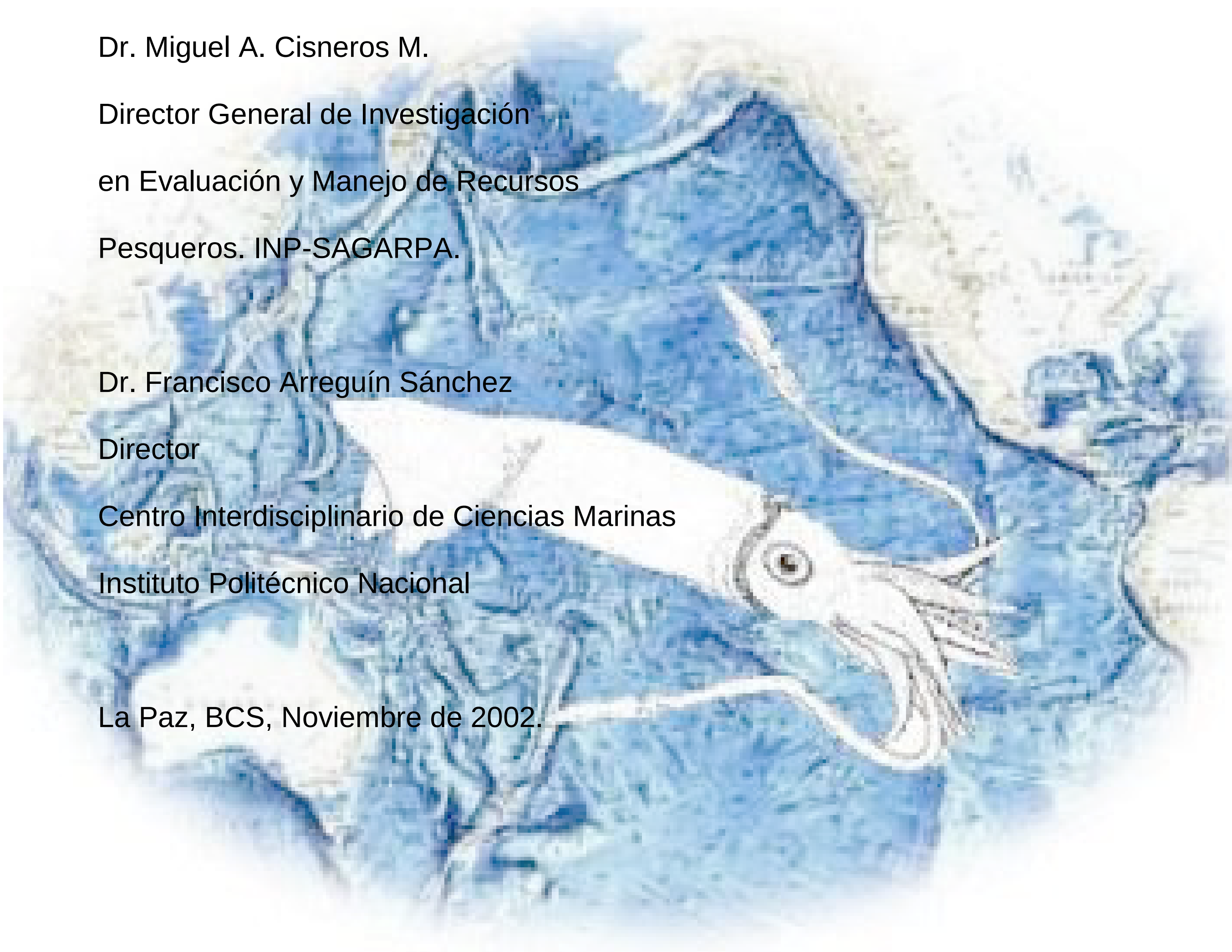
Constituye este evento una extensión de los trabajos iniciados en el Primer Simposium Internacional de Calamares del Pacífico, celebrado en Trujillo, Perú, bajo el auspicio del Instituto del Mar del Perú. Es para México una enorme satisfacción ser el anfitrión de este Segundo Simposium. Consideramos esta como una gran oportunidad para estimular y fortalecer la cooperación internacional para promover la explotación más racional de los calamares.

El INP se suscribe totalmente a la cooperación internacional, interdisciplinaria, y a las estrategias que favorezcan la explotación de recursos marinos en el marco del desarrollo sustentable. La ejecución de foros científicos especializados es una forma ideal mediante la cual el conocimiento, a través de la discusión, puede ser fortalecido con el concurso de especialistas. Esto es una condición sine qua non para generar prescripciones congruentes y robustas si se pretende lograr el manejo adecuado de las pesquerías y de los ecosistemas en donde se estas se desarrollan.

En la ciencia, la comunicación y difusión de los resultados de investigaciones es igual de importante que su hallazgo. Por ello es que resulta muy oportuno que las presentaciones que en este Segundo Simposium se discutirán serán sometidas para publicación en un número especial de la prestigiada revista Fisheries Research. Para ello habrán de conjuntar esfuerzos el Instituto Nacional de la Pesca (INP), el Centro Interdisciplinario de Ciencias Marinas, y el British Antarctic Survey.

Es por todo lo anterior que, a nombre del Dr. Guillermo Compeán Jiménez, Director en Jefe del INP, es menester felicitar a los participantes y organizadores de este Segundo Simposium Internacional del Calamares del Pacífico, así como a las instituciones que lo hicieron posible. No queda duda de que lo que habrá de resultar será de beneficio colectivo para economías, así como para las pesquerías mismas.

Bienvenidos a México y a La Paz, BCS, y enhorabuena.



Dr. Miguel A. Cisneros M.

Director General de Investigación

en Evaluación y Manejo de Recursos

Pesqueros. INP-SAGARPA.

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Instituto Politécnico Nacional

La Paz, BCS, Noviembre de 2002.

Acknowledgments

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Enrique Morales Bojórquez
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CICIMAR – IPN

PROGRAM

Hour	TITLE	AUTHOR
Wednesday		
08:00	REGISTRATION	
10:00	Opening ceremony and inauguration	
11:00	**Understanding the growth form of cephalopods: an evolutionary approach**	**Paul G. K. Rodhouse**
12:00	Coffee brake	
12:15	Sexual maturity of *Lolliguncula* (Loliolopsis) *diomedeae* (Hoyle, 1904) (Cephalopoda: Loliginidae) from the Gulf of Tehuantepec, Mexico.	**Alejo-Plata, M.C**, Salcedo-Vargas, M.A. & Sánchez-Cruz, A.Y.
12:45	Are *Loligunculla panamensis* (Berry) and *L. tydeus* (Brakoniecki) the same species?	Salcedo-Vargas, M.A. & **Alejo-Plata, M.C**.
13:05	Lunch	
15:20	SEM of Rhynchoteuthion stage and visceral photophores study of *Dosidicus gigas* (Ommastrephidae) from Mexican waters.	Salcedo-Vargas, M.A. & **Alejo-Plata, M.C**.
15:40	Distribution of squid paralarvae, *Loligo opalescens* (Cephalopoda: Myopsida), in the Southern California Bight in the four years following the 1997 El Niño.	**Zeidberg, L.D.** & W.H. Hamner
16:00	Behavior of juvenile *Loligo opalescens* squid as observed with a remote operated vehicle and the use of allometry measurements for scale.	**Zeidberg, L.D.** & W.H. Hamner
16:20	Coffee break	

16:35	The Yucatan-Campeche octopus fishery: Management and Modeling	**Solís-Ramírez, M.,** Fernández-Méndez, J.I. & Márquez-Farías, F.
17:05	Unusual presence of only one type of squid paralarvae in the Gulf of California, Mexico	**Alejo-Plata, M.C**. & M.A. Salcedo-Vargas
17:25	Oocyte development, egg size and fecundity of the large size females of jumbo squid *Dosidicus gigas*	**Nigmatulin, C.M**. & Markaida, U.
17:45	Reproductive biology of jumbo squid *Dosidicus gigas* in the Gulf of California, 1998-1999.	**Markaida, U.**
19:00	Welcome cocktail	Hotel "Los Arcos"
Thursday		
09:00:00 a.m.	Reproductive characteristics of the giant squid during the period 1996 – 2001.	**Tafur-Jiménez, R**.
09:20	Development of the darkening and morphometric of jumbo squid (*Dosidicus gigas*; D'Orbigny, 1835) (Mollusca: Omastrephidae) beaks and its relation to growth and sex maduration	**Mejía-Rebollo, A**. & Markaida U.
09:40	Abundance and behavior of the giant squid (*Dosidicus gigas*) in the Peruvian Sea	**Ganoza-Ch., F** & S. Peraltilla-N.
10:00	Feeding habits of Jumbo squid *Dosidicus gigas* in the Gulf of California and adjacent waters, 1998-1999.	**Markaida, U.**
10:20	Coffee break	

10:35	Cephalopods and pelagic fisheries at Oaxaca coast, México	**Alejo-Plata, M.C**., Cerdenares, G., Sánchez-Cruz, Y.& González-Medina, G.
10:55	Cephalopods predated by sharks in Baja California Sur.	Galván-Magaña, F., Aguilar-Castro, N.A., **Chávez-Costa, A.C.** & Bravo-Quezada, A.
11:15	Relationship between giant squid and sardine catch in the Gulf of California.	**Rivera-Parra, G.I.**
11:35	Coffee break	
11:50	Bites from jumbo squid (*Dosidicus gigas*) damage tuna purse-seine catches in the Eastern Pacific ocean.	Olson, R.J., **M. Román**-Verdesoto & Macias-Pita G.L.
12:10	Distribution and relative abundance of sperm whales in relation to environmental features, squid landings and the distribution of other cetacean species in the Gulf of California, Mexico	Jaquet, N. & **Gendron-Laniel, D.**
12:30	Biologic-fishing results from the catches of giant squid or pota *Dosidicus gigas* in Center - Eastern Pacific waters (August-December 1996).	**Mariátegui, L**., Aguilar, S. & Roque, C.
12:50	Lunch	
15:20	Fishery of the giant squid *Dosidicus gigas* (D'Orbigny, 1835) off the Peruvian coast during the period 1999-2002.	**Yamashiro, C**., Mariátegui, **L., Tafur, R**., Aguilar, S., Argüelles, J., Taipe, A. & Villegas, P.

15:40	Use of Leslie-De Lury modified model for the assessment of abundance of jumbo squid (*Dosidicus gigas*) in Peruvian water during 2000.	**Argüelles, J.**
16:00	Indices of relative abundance for jumbo squid (*Dosidicus gigas*), an estimation using Δ-distribution.	Morales-Bojórquez, E. & **Hernández-Herrera, A.**
16:20	Coffee break	
16:35	Is really the catchability a nuisance parameter?: an example with *Dosidicus gigas* fishery.	**Morales-Bojórquez, E.** & Hernández-Herrera, A., Cisneros-Mata, M.A & Nevárez-Martínez, M.O.
16:55	Unusual occurrence of giant squid *Dosidicus gigas* at the Southern coast of Baja California Sur in the spring and summer of 1998	**Gluyas-Millán, G**., Turrubiates-Morales, J., Trasviña-Castro, A. & Reineke-Reyes, M.A.
17:15	Analysis of the commercial captures of giant squid (*Dosidicus gigas*, D'Orbingny, 1835) in the state of Baja California Sur during event ENSO 1997-1998. Ecological implications and proposal of adaptation of the industry.	**Salinas-Zavala, C.A**, Dimate, N., Sánchez-Hernández, S. & Ponce-Díaz, G
17:35	**Fishing down coastal food webs in the Gulf of California**	**Luis Gerardo López Lemus**
Friday		
9:00	Spent females of *Gonatus madokai* (Teuthida: Oegopsida) from the Okhotsk Sea.	**Katugin, O. N**. & Merzlyakov, A. Yu
9:20	Distribution of *Berryteuthis anonychus* (Gonatidae, Oegopsida) in the North Pacific Ocean.	**Katugin, O. N**., Shevtsov, G.A., Didenko, V.D. & Slobodskoi, E.V

09:40	Lengths of *Dosidicus gigas* in central Gulf of California, Mexico.	**Montoya-Campos, M.**, Ramírez-Rodríguez, M. & Hernández-Herrera, A.
10:00	How many cohorts are there in the squid Mexican fishery. An overview from catchability analysis	**Martínez-Aguilar, S.**, Morales-Bojórquez, E. , Arreguín-Sánchez, F. & Hernández-Herrera, A.
10:20	Coffee break	
10:35	Growth, mortality and yield of the jumbo squid (*Dosidicus gigas*) of Guaymas, Mexico	**Nevárez-Martínez, M.O.**, Méndez-Tenorio, F.J., Cervántes-Valle, C., López-Martínez, J. & Anguiano-Carrasco, M.L.
10:55	Biomass distribution, size structure and maturity of the jumbo squid (*Dosidicus gigas*) in the Gulf of California, Mexico. June 2002.	**Nevárez-Martínez, M.O.**, Méndez-Tenorio, F.J., Cervántes-Valle, C. & Anguiano-Carrasco, M.L.
11:15	Preliminary results of tracking experiment for jumbo squid *Dosidicus gigas* in the Gulf of California, Mexico	**Markaida, U.**, Gilly W. F., and Rosenthal J. J. C.
11:35	Using lights to track squid fishing fleets from space.	**Waluda, C.M.**
11:50	Coffee break	
12:10	Conclusions and Closing Ceremony	
12:50	Lunch	

Sexual Maturity of *Lolliguncula (*Loliolopsis*) diomedeae* (Hoyle, 1904) (Cephalopoda: Loliginidae) from the Gulf of Tehuantepec, Mexico.

Ma. del Carmen Alejo-Plata*, M. Alejandro Salcedo-Vargas & A. Yazmín Sánchez-Cruz *

**Universidad del Mar, Pto. Ángel Oaxaca, México*

During the sampling season between October 1999 – November 2001, 603 specimens of *Lolliguncula diomedeae* were obtained using a shrimp bottom-trawl net on board the B/M UMAR. According to the macroscopic scale observed on specimens genitalia, the sexual maturity stages were typified into five phases for female and four for male specimens. Spawning peaks were identified using the method of variation of the nidamental gland index ((NGL/ML)x100). The observed maximum mantle length was 88 mm ML for females and 65 mm ML for males. The mean of the first maturity for females is 77 mm ML (Fig. 1) and for males is 49 mm ML (Fig. 2). Spawning occurs throughout the year, with an increase noted in January. The size interval for each phase showed overlapping in mantle length. The data do not show a positive correlation of the mantle length in relation to the gonadic phase. The best performing phases were III and IV, indicating that the Gulf of Tehuantepec is a breeding ground for this small species of *Lolliguncula*, which is endemic to the Eastern Tropical Pacific.

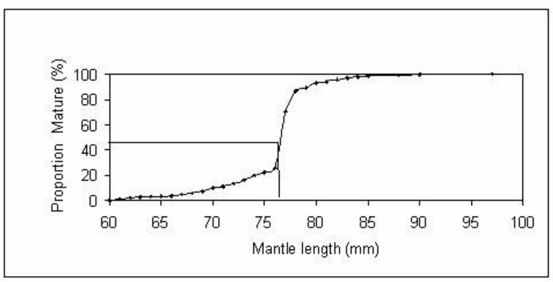

Fig. 1. Mean mantle length at first maturity in *L. diomedeae* females.

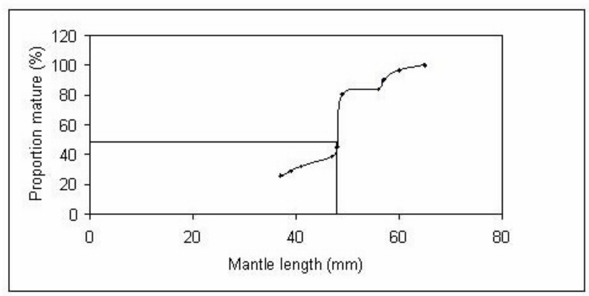

Fig. 2. Mean mantle length at first maturity in *L. diomedeae* males.

Are *Lolliguncula panamensis* (Berry) and *L. tydeus* (Brakoniecki) the same species?

Mario Alejandro Salcedo-Vargas & Ma. del Carmen Alejo-Plata*

**Universidad del Mar, Pto. Ángel Oaxaca, México.*

These two species of *Lolliguncula* from the eastern tropical Pacific were studied. The species in question are *Lolliguncula panamensis* (Berry) and *L. tydeus* (Brakoniecki), which are now considered synonyms. The discussion on the similarities within these species and variability between species to make *tydeus* a junior synonym have not been properly documented. The two species resemble each other in areas of sympatry and they overlap in most of their diagnostic characters. However, detailed studies on *panamensis* have never been done since its definition and its hectocotylus has never been described. Studies on *tydeus* are also very limited. The definition of *tydeus* was based on comparison with other species such as *Lolliguncula diomedeae* from the Eastern Pacific and *Lolliguncula brevis* from the Atlantic rather than *panamensis*. Comparison of characters such as fin L/W ratio, mantle with, head length using PCA Analysis, and visual comparison of their hectocotytli focusing on sucker size, number, and papillae indicated that this synonymy should be reconsidered until more detailed studies are made.

SEM of Rhynchoteuthion stage and visceral photophores study of *Dosidicus gigas* (Ommastrephidae) from Mexican waters

M. Alejandro Salcedo-Vargas & Ma. del Carmen Alejo-Plata *

**Universidad del Mar, Pto. Ángel Oaxaca, México.*

Rhynchoteuthion stage ommastrephid larvae from waters of the Pacific coast of Mexico were obtained. A scanning electron microscope was used to study the proboscis and arm sucker morphology. Many specimens showed some degree of retraction of the proboscis, therefore the proboscis length was not considered a consistent character, but suckers were good for identification purposes together with other key characters. In all rhynchoteuthion specimens, the arm formula was consistent with arm IV being the least developed. The proboscis tip bears 8 suckers that are similar in size. The proboscis is usually longer than all arms until 5 mm DML, after that base starts to split. It was believed that these paralarvae may belong to *Sthenoteuthis oualaniensis*, but additional study of visceral photophores in specimens sizes from 3 to 225 mm DML, and comparison with other studies proved that the present specimens belong to *Dosidicus gigas*. Differences between rhychoteuthis stages of *D. gigas* from Peru and Mexico are also discussed.

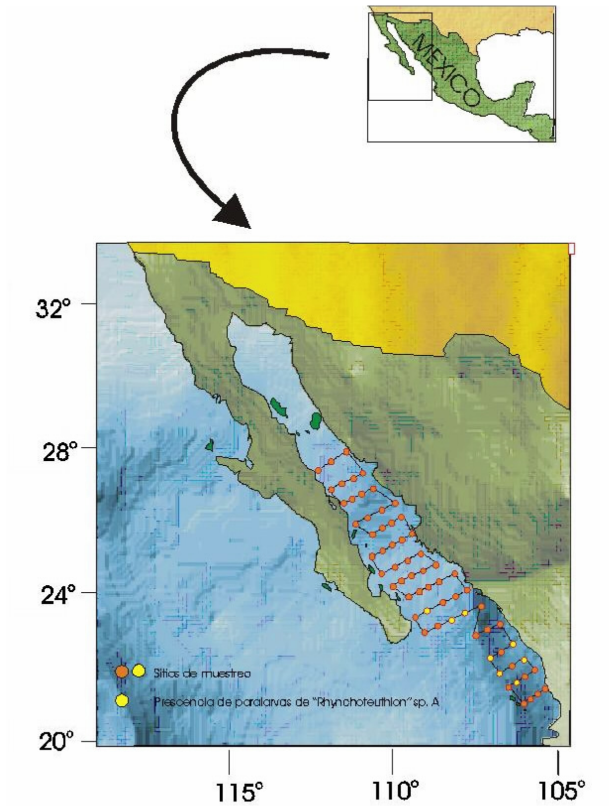

Figure 1. Sampling localities for Rhynchoteuthion squid paralarvae in the Gulf of California, Mexico.

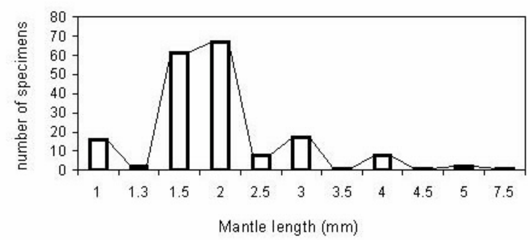

Fig. 2.- Size-frequency distributions for Rhynchoteuthions paralarvae

Distribution of squid paralarvae, *Loligo opalescens* (Cephalopoda: Myopsida), in the Southern California Bight in the four years following the 1997 El Niño.

Louis D. Zeidberg & William M. Hamner

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Large numbers of paralarvae of the California market squid, *Loligo opalescens* (10,560 paralarvae from 422 plankton samples) were collected in the Southern California bight in 1999, 2000, 2001, and 2002 during the spawning season. Paralarvae abundance increased dramatically (P<0.0041) from 1.5 squid/1000m^3 in 1999 to 77.9 squid/1000m^3 in 2000 and 73.6 squid/1000m^3 in 2001 following the El Niño of 1998. Paralarvae abundance dropped off in 2002 to 15.4 squid/1000m^3. The effects on the squid fishery of the 1997-1998 El Nino thus were extended for two years, with larval abundance reduced until the 1999-2000 spawning season. Paralarvae were abundant close to shore for up to a month after hatching in 2000 (P<0.003), with tidal surface currents adjacent to shore in the Channel Islands dramatically affecting paralarvae abundance. Tidally reversing currents within 1-3 kilometers of shore create a boundary layer of "sticky water" within which paralarvae remain entrained inshore immediately after hatching. Neritic currents further from shore disperse older paralarvae within the Southern California bight. The greatest change in paralarval abundance, for all transects, was observed within one kilometer of the transition between these two flow regimes. Age of paralarvae (from statolith increments) entrained within the Catalina Island boundary layer averaged 13 days and 16 days, but some individuals remained nearshore for up to a month. Paralarvae within the boundary layer occur above 80 meters both day and night and they exhibit a statistically significant pattern of vertical diel migration (P<0.01). Paralarvae at sea were disproportionately abundant adjacent to fronts associated with upwelling events.

Behavior of juvenile *Loligo opalescens* squid as observed with a remote operated vehicle and the use of allometry measurements for scale.

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Juvenile squid are the most under-represented age cohort in research literature. This is because they are fast, approaching the swimming capabilities of the adults, but spawning activities do not distract juveniles, as with adults, when fishermen attempt to catch them. Juvenile *Loligo opalescens* were captured opportunistically on the continental shelf with a 30-meter otter trawl during educational cruises in 50 meters of water 3 miles from Marina del Rey, California. We collected 138 individuals that ranged from 10.5 to 156 mm in mantle length from 8 March 1998 to 12 February 2002. Changes in size over time provide evidence of cohort development. For allometry purposes, we measured fin length, fin width, mantle width, 4th arm length, tentacle length, head width, head length, long eye diameter, and short eye diameters. Wet weights were also taken. Additionally, video of juveniles at sea was analyzed from footage taken in Monterey Bay, California by the ROV *Ventana* of the Monterey Bay Aquarium Research Institute (MBARI). Juvenile behavior was compared to that of the adults. Allometry measurements were used to provide scale for analysis of the video footage.

The Yucatan-Campeche octopus fishery: Management and Modeling

Manuel Solís-Ramírez , José Ignacio Fernández-Méndez & Fernando Márquez- Farías

Instituto Nacional de la Pesca, México

The octopus fishery is the ninth most important in volume of catch among Mexican fisheries and the fifth most important in the Gulf of Mexico. At the end of the 1990s as much as 98% of the catch came from Yucatan and Campeche in the Southeastern Gulf of Mexico. There, a wide continental shelf and shallow waters allow a substantial artisanal fleet to operate. This fleet catches mainly *Octopus maya,* (locally called "pulpo rojo", red octopus) a species native to the Campeche-Yucatan shelf. An industrial fleet that operates in deeper waters off Yucatan catches *O. maya* as well as *O. vulgaris* ("pulpo patón") that is not vulnerable to the artisanal fleet.

From the early 1980s until the late 1990s, the Yucatan catch rose around 100%, up to around 12,000 – 13,000 tons. Much of this increase came from growth of fishing effort caused by peasants becoming fishermen with the decadence of Yucatan henequen culture. Meanwhile, Campeche catch remained around 2,000 tons.

Since 1981 it has been observed that one year after a hurricanes strikes the zone where the fishery operates, catch rise noticeably coming back to normal the next year. This happened in 1996, when the catch broke the 20,000 t barrier at the same time that the fall of the North African octopus fishery and a strong Japanese economy drove demand and price up. A sudden surge in demand of fishing permits made the recommendation of regulating the effort (made many years before) more compelling.

Catch predictions of 9,000 to 15,000 tons for 1997 were made. Large investments in small vessels and processing plants were being made as the industry expected catch of 25,000-30,000 tons. The risk of overfishing and overinvestment was present. A Total Allowable Catch quota of 13,000 tons was set as a way to avoid the problems of restricting permits at that particular time, despite the quota being noticeably hard to enforce because no close real-time monitoring of catch existed and industrial vessels at sea for weeks on end could surpass the quota (as happened) before landing their catch. In the end, 14,500 tons were caught despite the fishing effort being greater than in 1996.

Since 1998, international market prices and interstate conflicts has determined catch and management more than resource availability. The recent conflict between Spain and Morocco is expected to drive prices up and Campeche's catch reached nearly 8,000 tons in 2001, maybe heralding a new rise in the demand for octopus in the world market.

The red octopus fishery has some interesting characteristics for modeling. Catch is dominated by one cohort, born at the beginning of the year. Adults get close to shore as they mature and they become vulnerable to the artisanal fishery. After they mate (during the fishing season), females hide into small caves to lay their eggs, which they take care of, stop eating, and thus are not vulnerable to the fishery. From the beginning of the year until the start of the fishing season the cohort is only affected by natural mortality. The nominal effort, number of artisanal and industrial vessels is known and, because they use the same kind of fishing gear, a rough equivalence between them can be found. The proportion of males and females in catch is known during the fishing season

An age-structured model that incorporates migration of females into caves is used to describe the dynamics of the fishery. Attempts are made to relate the estimated number of females at the end of the season with the number of recruits that would explain the catch of the next year. Fecundity and catch per unit effort in the recent seasons, previous natural mortality estimates, and considerations on the relationship between von Bertalanffy's K and natural mortality are used to construct priors for a Bayesian updating. Some remarks on the possible effects of the evolution of the fishery (like change in fishing power and new areas open to fishing) on the present and past assessments (mainly on mortality estimates and Stock- Recruitment assessments) are made.

Some considerations on the closed season, fishing effort, and the management scheme are made. A regulation of fishing effort is recommended as the quota is seen by these authors as severely limited as a management instrument in this fishery.

Unusual presence of only one type of squid paralarvae in the Gulf of California, Mexico.

Ma. del Carmen Alejo-Plata* & Mario Alejandro Salcedo-Vargas

Universidad del Mar, Pto. Ángel Oaxaca, México.

A plankton oceanographic survey was made in the Gulf of California in summer 1979. The search for cephalopods at the 20 stations sampled (Fig. 1) revealed that the diversity was not only extremely low but there was only one type of larvae found, namely the rynchoteuhtion form of *Dosidicus gigas*. The samples were gathered at the surface and with oblique dragging up to 100 m using net-type CalCOFI of 300 microns. Of the samples reviewed, 42% were positive for rhychoteuthion. In total, 183 paralarvae were obtained, their size ranging between 1.0 - 7.5 mm of LM, with modes at 1.5 and 2.0 mm LM (Fig. 2). It is commonly observed that because of the dynamics of vertical migration, the number of cephalopods are more abundant in the surface at night. However, the stations where their presence was more abundant coincided with sampling done in the daytime. The size-frequency analysis indicates this may be a result of surface currents at the entrance of the Gulf of California. It is not possible to prove that these are from a recent egg mass, but the positive samples coincide with the spawning grounds, according to fishery reports.

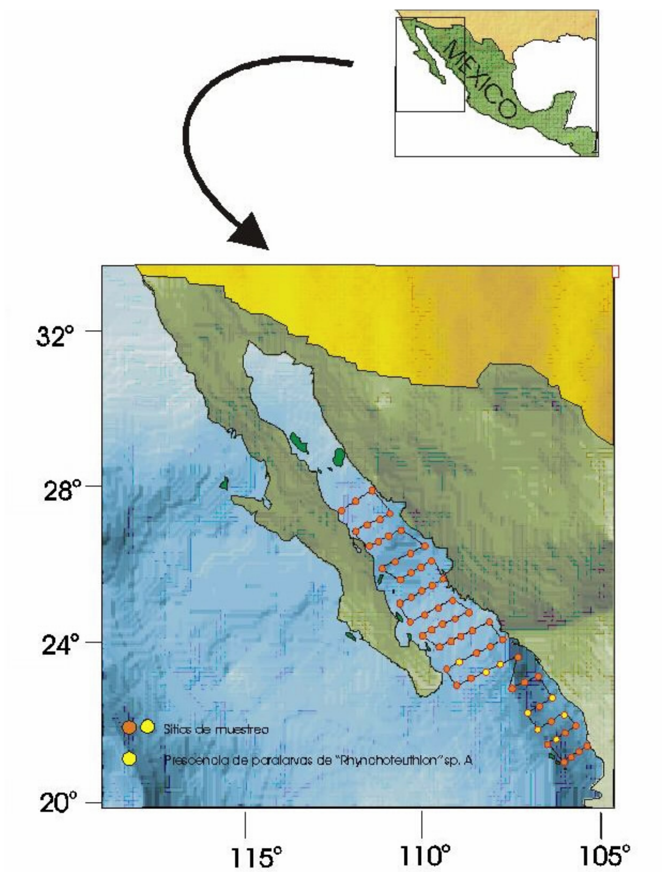

Figure 1. Sampling localities for Rhynchoteuthion squid paralarvae in the Gulf of California, Mexico.

Oocyte development, egg size, and fecundity of the large size females of jumbo squid *Dosidicus gigas*

Chingis M. Nigmatullin[1] and Unai Markaida[2]

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Ovaries of 31 large-size, maturing females of jumbo squid *Dosidicus gigas* (17.5 - 87.5 cm mantle length, ML) in different stages of maturity from the Gulf of California were analyzed (Table 1). During female ontogenesis, the oocyte development is asynchronic, with predominance (>85-90%) of small protoplasmatic oocytes 0.1-0.2 mm in diameter for all stages of maturity (Fig. 1). Potential fecundity (PF) is determined at late immature stages (up to 65 cm ML) with around 18 million oocytes (Table 1). However individual variation is high and PF reached 32 million oocytes in a 70-cm ML mature female. PF is closely related to female size.

Eggs were analyzed in oviducts of 7 mature females (67 - 87.5 cm ML) from the Gulf of California. Eggs measured 0.9×1.1 mm in diameter and weighed 0.45 mg. Oviducts held up to 1.2 million eggs, representing no more than 14% of all oocyte stock (Table 1). Variability in oviduct filling is high and unrelated to ovary weight. However a strong correlation was found between oviduct weight and nidamental gland development. These observations suggest that spawning is extended and intermittent. A female spawn is no less than half of the initial PF.

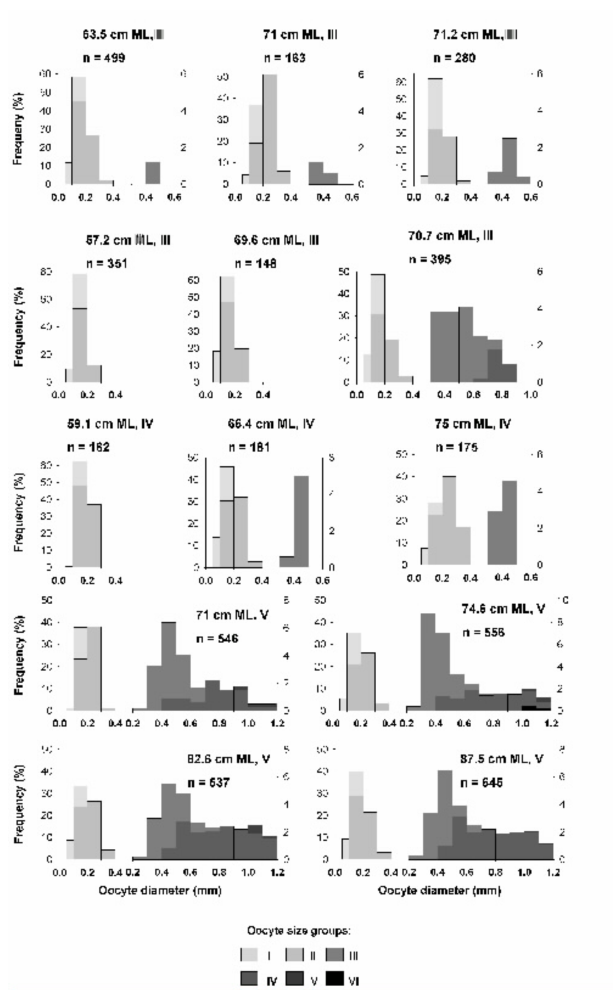

Figure 1. Oocyte size group frequency distribution for females of different stages of maturity, as related in Table 1. Frequency axis for oocyte size groups III-VI is shown at right.

Table 1. Potential fecundity (PF, in thousands), relative fecundity (RF), coefficient of viteline oocytes (CVO%), and oviductal load (CV, in thousands) of several females of jumbo squid from the Gulf of California.

Stage of maturity	ML, cm	Weight, kg	PF	RF	CVO %	CV
V	87.5	23.175	25,790	1,112	13.9	1,197
	85.5	19	23,157	1,218	5.8	395
	82.6	18.675	25,887	1,386	5.4	26
	82.5	20.175				
	74.6	15.075	14,782	980	12.6	531
	71	11.975	32,475	2,711	2.8	50
	69.6	10.3	15,862	1,540	8.1	148
	67	8.65	11, 529	1,332	10.1	213
IV	75	12.45	21,363	1,715		
	66.4	7.625	17,647	2,314		
	59.1	6.2	17,466	2,817		
III	71.2	12.425	20,333			
	71	13.05	22,818			
	70.7	14.5	16,258			
	69.6	11.05	23,000			
	67.4	10.7	19,419			
	63.3	8.85	23,437			
	57.2	5.25	16,100			
	49.1	2.175	8,900			
II	69.5	8.45	13,916			
	65.2	9.1	17,928			
	64	6.65	19,010			
	63.5	7.4	15,133			
	62	7.35	14,521			
	58	6.1	17,260			
	55.2	5.225	10,000			
	49.2	2.775	12,366			
	47.9	2.125	12,819			
	44.6	2.3	11,546			
	42.2	1.175	10,952			
	28.5	0.576	4,676			
I	17.5	0.135	813			

Reproductive biology of jumbo squid *Dosidicus gigas* in the Gulf of California, 1998-1999

Unai Markaida

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A large maturing form of jumbo squid *Dosidicus gigas* (40 - 80 cm mantle length, ML) supported a large fishery in the Gulf of California during 1995-1997. The jumbo squid fishery vanished in the Gulf Population because of an abundance drop following El Niño 1998. The aim of this paper is to record the population structure and reproductive aspects of jumbo squid after that event.

In May 1998, only a few females maturing at 24 - 27 cm ML were sampled (Fig. 1). A prospective fishery one year before showed abundant jumbo squid in the central Gulf of California, with females maturing at 38 cm ML and males at 31 cm ML, off Santa Rosalia (Fig, 1 and 2). This medium-size, maturing jumbo squid supported the fishery in that year in the Gulf of California. By August, maturing sizes for jumbo squid rose to 46 and 40 - 45 cm ML for females and males (Fig. 1 and 2). Additional information on size at maturity, sex proportions, copulation rates, and gonadosomatic indexes based on 733 individuals of medium-size maturing jumbo squid from the Gulf of California and adjacent waters is revealed.

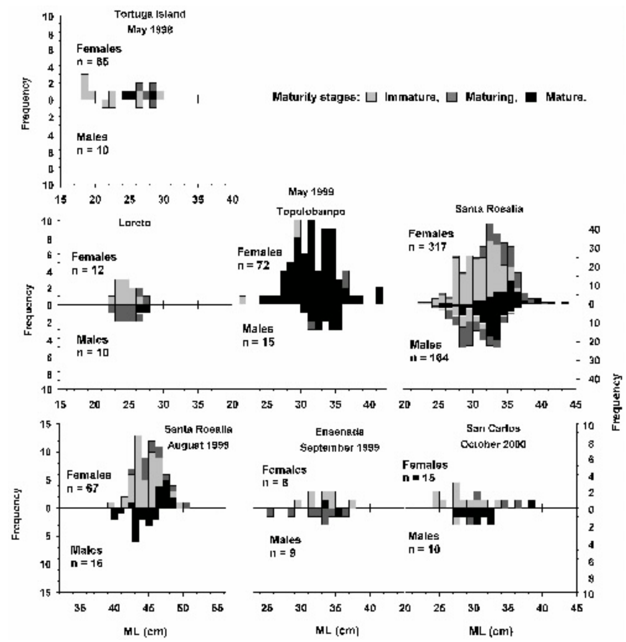

Figure 1. Mantle length distribution of jumbo squid by sex and stage of maturity for various samples from the Gulf of California and adjacent waters between 1998 and 2000.

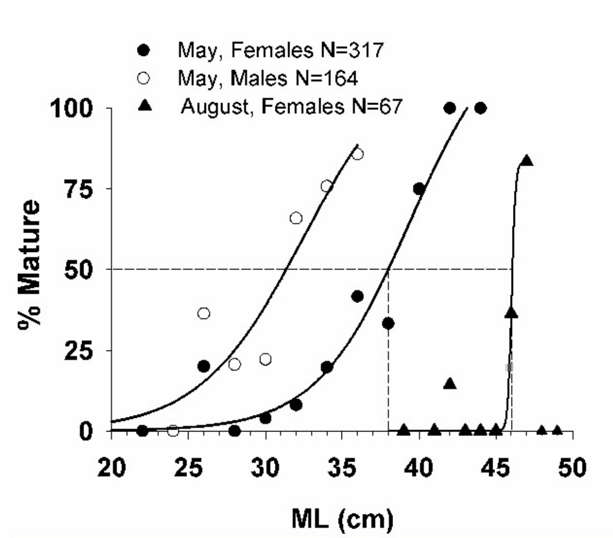

Figure 2. Distribution of mature jumbo squid percentage by mantle length during May and August 1998 off Santa Rosalia.

Reproductive characteristics of the giant squid during 1996 - 2001

Ricardo Tafur Jiménez

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Reproductive characteristics of the giant squid, *Dosidicus gigas*, in Peruvian waters are described on the basis of the analysis of 41 600 specimens from industrial fishing. Different maturity indexes of the resource were recorded during the period 1996 - 2001.

For females, a peak of spawning at the end of austral spring was observed, with the exception of 1997 when the main frequency appeared at the end of winter. For males, the reproductive cycle had similar spawning characteristics, but a with lack of coordination, and main spawning peaks were identified in autumn - winter.

A high concentration of spawner specimens was observed between 11° and 17°S in 2000 and 2001, whereas in other years there was little information of these areas. The major percentages were recorded between 5° and 6°S.

In 2000 and 2001, the presence of specimens longer than 50-cm ML was found. They were characterized by a high growth rate and slow maturity. They spawned principally in the north and central area during 2000 and in the area central and south in 2001.

During 1996 – 1997, the reproductive process was altered possibly by cold conditions (La Niña). The influence of the environmental changes on the reproductive process of this resource during the period of study (La Niña, ENSO) was discussed.

Development of the darkening and morphometrics of jumbo squid (*Dosidicus gigas*; D'Orbigny, 1835) (Mollusca: Omastrephidae) beaks and its relation to growth and sex maturation.

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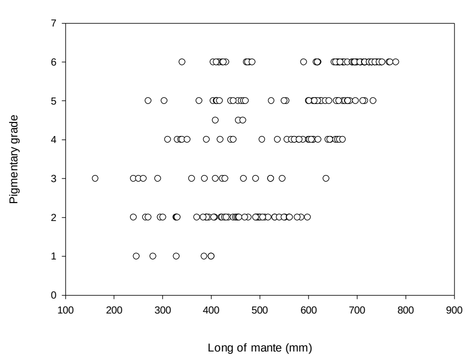
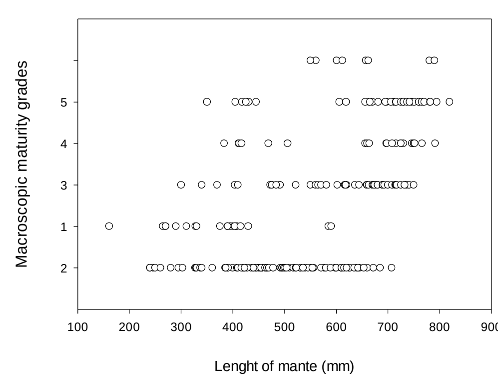
The beaks of 320 (186 females and 74 males) specimens of *Dosidicus gigas* caught in the Gulf of California, Mexico (Guaymas and Sta. Rosalia) during 1995 and 1996 were studied. Relationships between 9 measurements of the upper beak; L. Ros., L. Cap., L. Cre., L. wing. (Clarke, 1962); A. A. (Wolff and Wormunth, 1979; Wolff, 1984), AM-S., AltP-S., LH-C., L.RA. for this document; 11 measurements of lower beak: L. Ros., L. Cap., L. Cre., L. wing (Clarke, 1962); A. A (Ivanovic and Bruneti, 1997); AM., L. H-C., L. R-A., L. R-P. and L. H-E. for this document and dorsal mantle length and total weight were calculated. The development darkening of both beaks was definite and a qualitative scale of seven degrees of darkening development and related to histological maturity were recorded for 133 females and 69 males following the Lipinski and Underhill (1995) scale. Regression coefficients were calculated with a interval 95%. L. Cres of the female upper beak has the value higher for r^2 with DLM and total weight 0.975 and 0.952, therefore the results suggest that measurements of both beaks are related to growth of *D. gigas* . The maturity and grades of pigmentation likewise are connected.

Graph 1: Relationship between lenght of mante and pigmentary grades in *D. gigas* female



Graph 2: Relationship between the length of mante and the macroscopic maturity in *D. gigas* female



Graph 3: Relationship between the lenght of the mante and pigmentarity grades in D. gigas female. N=72; a= -3.8011934995, b= 0.1256527553; r ²= 0.6201664525

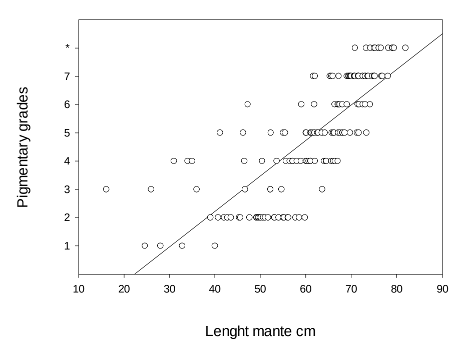
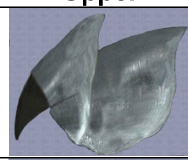
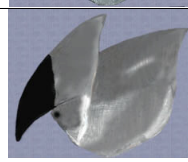
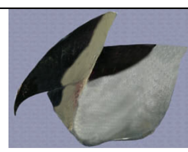
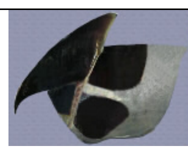
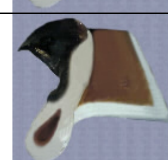
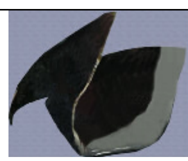
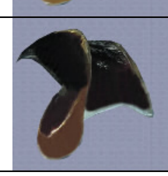


Table I: Regression coefficients of measurement with highest values

Variable	Beak	Sex	a	b	r^2
L.CRES.	Upper	Female	-7.427	0.107	0.975
L.ALA.L	Lower	Female	-2.508	0.042	0.956
WCL.	Upper	Male	-3.937	0.075	0.959
RPP.L	Lower	Male	-2.101	0.067	0.949
Ln L.CRES	Upper	Female	1.028	0.344	0.952
Ln RPP.L.	Lower	Female	0.746	0.339	0.947
Ln CRES.U.	Upper	Male	0.972	0.343	0.966
Ln RPP.L	Lower	Male	0.818	0.325	0.959

Stage of Pigmentation	Beaks	
	Upper	Lower
0		
1		
2		
3		
4		
5		
6		
7		

Abundance and behavior of the giant squid (*Dosidicus gigas*) in the Peruvian Sea

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The giant squid or pota (*Dosidicus gigas*) has a wide distribution from California to southern Chile, with the biggest concentrations located to the north of the Peruvian sea. The industrial fishery of this resource began in 1991, by means of the system of capture quotas and fishing permits to vessels of foreign flags (Japanese and Korean).

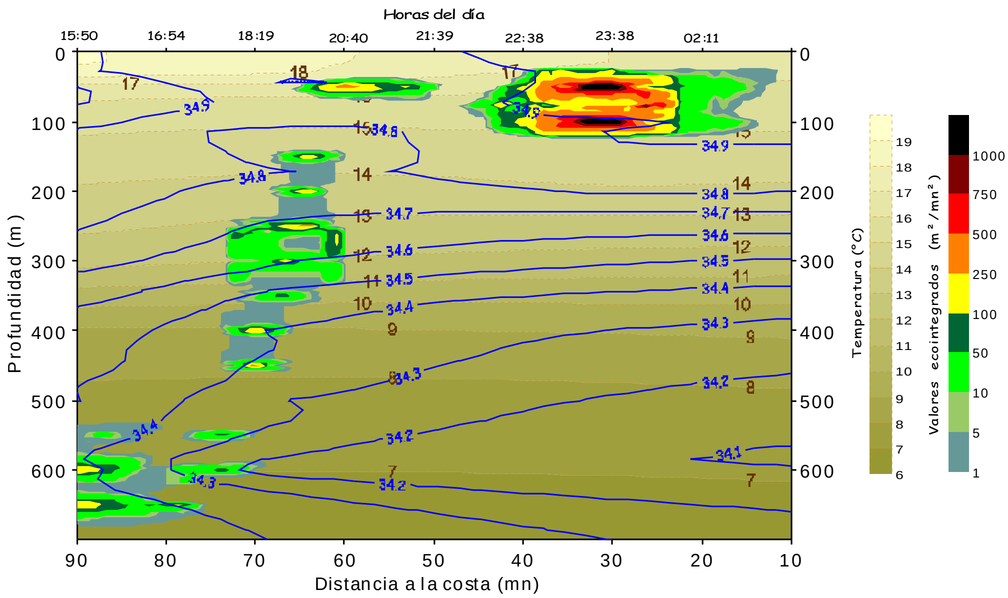
According to the analysis of the space distribution of the giant squid or pota, it was observed that the most important areas with high school concentrations, were between latitudes 4º to 6º S and 14º to 16º S during winter and spring of 2001 and 2002 and summer of 2002.

The echotraces with high values echointegrates are presented forming clouds with continuous points from the surface tol 650 m. During the day (0600 to 1800) they could be recorded to 650 m and near the surface at night (1800 at 0600).

During 1999 to 2002, a strong variation in the acoustic biomass of the giant squid, with the highest in spring 2001 with 863 000 t and in winter with 560 000 t.

In winter 2000, the highest concentrations of schools of giant squid were distributed in the north area between 4º to 6ºS influenced by the masses of Surface Subtropical Waters (SSW) with salinities of 35.1 ups and surface temperatures of 18 to 19 ºC. Vertically in the hydrographic profile of Punta Sal (4ºS), the echotraces was distributed from 15 to 90 mn from 20 to 650 m estdepth, observing the great distribution of this resource in the water column inside the isotherms from 7 to 19 ^{o}C and the salinity from 34.2 to 35.1 ups. The best concentrations were generally located in the night .

According to the studies made during the different cruises for evaluation of pelagic resources, we present an analysis of the variations of acoustic biomass, geographical and vertical distribution, and their relationship to the temperature and salinity period from 1999 to 2002.



Horas del día
15:50
16:54
18:19
20:40
21:39
22:38
23:38
02:11
Profundidad (m)
Distancia a la costa (mn)
Temperatura (°C)
Valores ecointegrados (m²/mn²)

Feeding habits of jumbo squid *Dosidicus gigas* in the Gulf of California and adjacent waters, 1998-1999

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Stomach contents of 254 medium-size maturing jumbo squid *Dosidicus gigas* (17 - 42.7 cm mantle length) were collected during 1998 and 1999 in the Gulf of California and adjacent waters. Fish prey were identified by their sagittal otoliths, cephalopods by their beaks, and crustaceans by their exoskeletal features. A detailed list of prey species is given showing their occurrence and numeric and gravimetric contribution to squid diet. The diet was dominated by the myctophids *Benthosema panamense,* 42%, and *Triphoturus mexicanus*, 23%, which were found in all stomachs, and accounted for almost half of all prey items. Pteropods accounted for 13% of all prey and occurred in 32% of all stomachs. Several crustaceans, micronektonic squid, and *Vinciguerria lucetia* played a secondary role in the jumbo squid diet. Cannibalism was noted in the contents in one fifth of stomachs. Differences for size, sex, or fishing ground in diet of jumbo squid were tested. Medium-size maturing jumbo squid feed on more pteropods and crustaceans than large maturing jumbo squid, whereas the dominance of *Benthosema panamense* in their diet decreased.

Cephalopods and pelagic fisheries at the Oaxaca coast, Mexico.

Ma. del Carmen Alejo-Plata, , Genoveva Cerdenares, Yazmín Sánchez-Cruz & Gabriela González-Medina.

Universidad del Mar, Puerto Ángel Oaxaca, México

To determine the incidence of cephalopods in the feeding habitat of pelagic fish, the stomach contents of 400 pelagic fish, *Istiophorus platypterus* (sailfish), *Coryiphaena hippurus* (dolphin fish), *Euthynnus lineatus* (bonito), and *Thunnus albacares* (yellow fin tuna), where examined (Table 1) from January 2001 to January 2002. Biologic material was obtained from the artisanal fisheries at Puerto Angel, Puerto Escondido, and Santa Cruz Huatulco in Oaxaca, México. From the total of the examined stomachs, 55% contain cephalopods. The ones found at an advanced digestion condition, were identified through their hard structures, as beaks, which are resistant to chemical and mechanical action, so that are conserved in predator stomachs for a long time. Beaks where identified to species by structural and biometric differences and by their pigmentation patterns.

The upper or lower mandible rostral length were considered to estimate the mean weight of each cephalopod. For sailfishs, fish and crustaceans are the principal feeding component and cephalopods are a secondary group. For dolphin fish and bonito, the principal feeding components are fish and cephalopods, especially Ommastrephidae family squids. Yellow fin tuna consumes the highest diversity and abundance of cephalopod species. We found 7 cephalopod families (Fig. 1), by order of occurrence Ommastrephidae (3 species); Argonautidae (1 specie); Octopodidae (3 species); Loliginidae (1 species); Onychoteuthidae (1 species); Enoploteuthidae (1 species), and Cranchiidae (1 specie). From the founded species, *Dosidicus gigas*, *Lolliguncula diomedeae, Octopus bimaculatus*, *Octopus hubbsorum*, *Ommastrephes bartramii*, *Sthenoteuthis oualaniensis* and *Onychoteuthis banksii* are fisheries potential resources. To species unreported for Mexican South Pacific are present: *Euaxoctopus panamensis* and *Octopus bimaculatus.*

Table 1. Number of reviewed stomach, by species, and % of stomachs containing cephalopods.

Fish species	# Reviewed Stomachs	% Stomachs containing cephalopods
Istiophorus platypterus (sailfish)	120	17
Coriphaena hippurus (dolphin fish)	100	30
Euthynnus lineatus (bonito)	80	38
Thunnus albacares (yellow fin tuna)	100	76

The presence of oceanic cephalopod remains in stomach contents of fish captured near the coastline are evidence of their recent migrations from deep ocean waters. This kind of work makes it possible to infer aspects related to cephalopod distribution, ecology and relative importance, and about their migration and that of their predators.

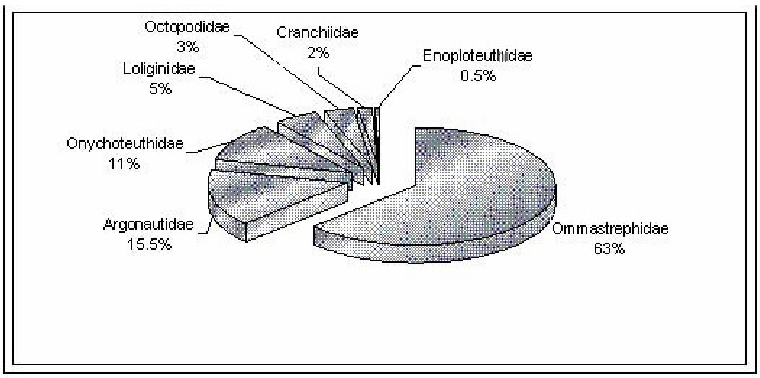

Fig. 1. Porcentual representation of cephalopod families from the feeding component of pelagic fishes at the coast of Oaxaca, México during 2001.

Cephalopods predated by sharks in Baja California Sur

Felipe Galvan-Magaña[1], Nallely Ariadna Aguilar-Castro, Alejandra Cabrera Chavez-Costa & Alejandro Bravo-Quezada

Centro Interdisciplinario de Ciencias Marinas
Apartado Postal 592. La Paz, Baja California Sur, Mexico
[1]COFAA-IPN fellowship

Stomach contents of silky shark (*C. falciformis*), blue shark (*Prionace glauca*), and scalloped hammerhead (*Sphyrna lewini*) were analyzed from 2000-2002 along the western coast of Baja California and Gulf of California. Cephalopods were the main prey in blue shark and secondary prey in silky shark and scalloped hammerhead. We identified 18 cephalopod species based in beak items (*Vampyroteuthis infernalis*, *Vitreledonella richardi*, *Japetella heathi*, *Argonauta* spp., *Haliphron atlanticus*, *Octopus* spp., *Histioteuthis heteropsis*, *Histioteuthis* spp., *Gonatus* spp., *Dosidicus gigas*, *Stenoteuthis ovalaniensis*, *Pholidoteuthis boschmai*, *Abraliopsis affinis*, *Onychoteuthis banksii*, *Thysanoteuthis rhombus*, *Ancistrocheirus lesueuri*, *Mastogoteuthis* spp., and Familiy Loliginidae. Silky shark mainly preyed on jumbo squid *Dosidicus gigas*; whereas Blue shark preyed on *Onychoteuthis banksii* as main species, and *Histioteuthis heteropsis* and *Gonatus* spp. as secondary species. The main cephalopod prey for the Scalloped hammerhead was *Dosidicus gigas*, *Onychoteuthis banksii*, and *Abraliopsis affinis*. Epipelagic and mesopelagic habitat of cephalopods indicated the probable depth where the sharks consumed their prey. Blue shark prey in deeper waters than the silky shark and scalloped hammerhead. In table 1, we show the squid as prey consumed by silky shark, scalloped hammerhead, and blue shark. Also in figure 1 we included the percentage in number of squid consumed by the skark species off the western area of Baja California Sur and southwestern area of the Gulf of California.

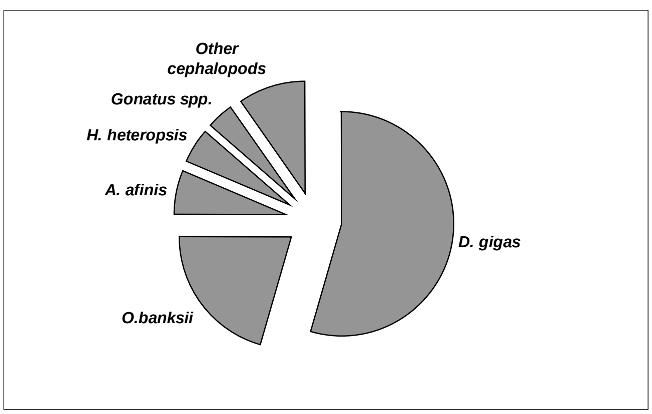

Figure 1. The most important cephalopods preyed on by sharks in Baja California Sur during 2000-2002.

Table 1. Percentage of cephalopod species preyed on by sharks in Baja California Sur

Cephalopod Species Shark Species	*C. falciformis*	*S. lewini*	*P. glauca*
Ancistrocheirus lesueuri	3.6		
Dosidicus gigas	87.4	49.3	8.8
Stenoteuthis oualaniensis	0.6		
Gonatus spp.	0.6	0.9	14.7
Onychoteuthis banksii	7.2	24	34.3
Histioteuthis spp	0.6		
Histioteuthis heteropsis		2.3	18.6
Abraliopsis afinis		14.3	
Pholidoteuthis boschmai		1.4	5.9
Loliginidae		2.3	
Mastigoteuthis sp.		3.2	1
Thysanoteuthis rhombus		1.4	
Octopus sp.		0.5	
Vitreledonella richardi		0.5	
Japetella heathi			4.9
Argonauta spp			4.9
Haliphron atlanticus			2
Vampiroteuthis infernalis			4.9
Total	100	100.1	100

Relationship between giant squid and sardine catch in the Gulf of California.

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Mazatlán, Sinaloa, México

The relation between the giant squid biomass estimated through six research cruises covering the central part of the Gulf of California (May and October 1996, November 1997, May and November 1998 and May 1999) and squid landings in Guaymas, Sonora, Mexico, sardine landings in the same location, and surface sea temperature anomalies recorded in Guaymas Bay from 1952-2000.

The results indicated that the correlations between survey-estimated biomass and squid landings was 0.58 ($P< 0.1$); estimated biomass against sardine landings was 0.78 ($P< 0.05$), and between estimated biomass and water surface temperature anomaly the correlation index was –0.27 ($P> 0.25$) (Table 1).

Between survey-estimated biomass squid and sardine landings, the correlation was 0.58 ($P = 0.10$) and that between squid catch and water surface temperature anomaly was the lowest, with a value of 0.21.

The greater relation between survey-estimated biomass and sardine landings and squid landings against sardine landings seem to indicate a higher dependence on food availability than with surface temperature alone.

Therefore, it would seem that squid responded to the lack of enough food or to food quality emigrating towards temperate conditions, which at that time prevailed along the costs of Baja California and the State of California, USA.

Even under the most adverse conditions caused by El Niño , squid were caught in the region, indicating that the giant squid is a permanent resident of the Gulf of California although with low population levels and with small individual sizes (Figure 1)

Table 1.- Coefficients of correlation between survey-estimated biomass of squid, squid landings (F squid), sardine landings, and sea surface temperature anomaly.

	Biomass	**F squid**	**Sardine**	**Temperature anomaly**
Biomass	1	0.58	0.78	-0.27
F squid		1	0.53	0.21
Sardine			1	0.14
Anomaly				1

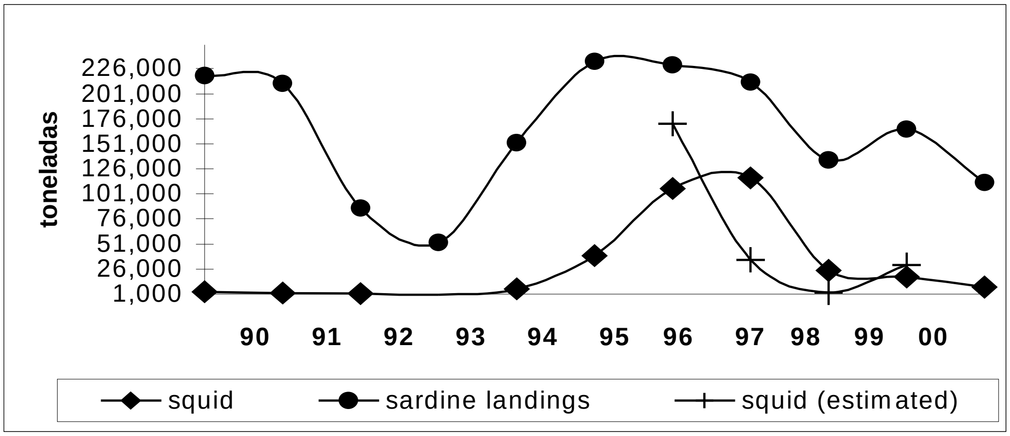

Figure 1.- Tendency of yearly squid and sardine landings and survey-estimated squid biomass.

Bites from jumbo squid (*Dosidicus gigas*) damage tuna purse-seine catch in the Eastern Pacific Ocean

Robert J. Olson, Marlon Román-Verdesoto, and Glenthon L. Macías-Pita

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Squid are described as short-lived, ecological opportunists. A variety of opportunities in the pelagic tropical seas derive from a vast, heterogeneous biological and physical environment. The jumbo squid (*Dosidicus gigas*) is a pelagic ommastrephid endemic to the eastern Pacific Ocean (EPO). Important fisheries for this species are centered off the Peruvian coast and in the Gulf of California, Mexico. Jumbo squid aggressively pursue their prey, and large *D. gigas* are thought to prey on small schooling fish, mainly lanternfish, and squid. Jumbo squid are thought to feed throughout the night, but most actively at dawn and dusk. In offshore areas, adult *D. gigas* typically occur in shallow layers at night and at depths of 800-1000 m during the day. Adult *D. gigas* (>400 mm) typically school in groups of 2-12 animals.

The purpose of this brief communication is to describe recent incidental catch of large schools of *D. gigas* by purse-seine vessels fishing for tuna near Peru. Catching large squid associated with schools of tuna is rare in the EPO purse-seine fishery, and squid attacks on live tuna swimming inside the net have not been reported. This anecdotal account demonstrates the plasticity of several aspects of the life history and behavior of *D. gigas*.

Scientific observers record the fishing operations of most of the tuna purse-seine fleet in the EPO. In April and May 2002, sets were made by vessels fishing within 120 nautical miles of the Peruvian coast on schools of primarily skipjack tuna (*Katsuwonus pelamis*). Incidental catches of *D. gigas*, ranging from a few individuals to an estimated 100 metric tons (t), were made in some of these sets. The sets were made during daylight hours, but most were late in the day (Table 1). The average size of the squid was estimated to range from 10 to 70[1] kg. In twelve sets (Table 1), $\geq$ 10 t of *D. gigas* were caught.

One vessel encircled an estimated 100 t of jumbo squid along with 50 t of skipjack in a set at 1817 on 5 May 2002 (Table 1). The squid were estimated to average 30 kg each and the skipjack averaged 51 cm fork length and 2.7 kg. Sometime during pursing and net retrieval, the squid attacked the skipjack and took bites from the fish over much of their bodies. The fishermen dumped 48 of the 50 t of skipjack at sea because they were damaged severely and unfit for human consumption. The squid were also discarded at sea.

We have no evidence to suggest that *D. gigas* prey on tuna in nature, when not confined in

[1] This is larger than the maximum size of *D. gigas* reported by Nesis (1983. *Dosidicus gigas*. *In* Boyle, P.R. (ed.), Cephalopod Life Cycles. Vol. 1 Academic Press, London: 215-231). We consider our size estimates unreliable because on-board observers made only visual estimates, and they do not normally encounter large squid.

a net. This account demonstrates, however, that jumbo squid are capable of imposing predation mortality on large fish if they can catch them. These events also imply that jumbo squid form large multispecies aggregations with skipjack tuna (possibly for feeding) in surface layers during daylight hours.

Table 1. Tuna purse-seine sets off the coast of Peru in which ten t or more of squid were incidentally caught with skipjack tuna.

Date	Time	Latitude	Longitude	Catch (metric tons)		Est. average size (kg)	
				Skipjack	Squid	Skipjack	Squid
April 12, 2002	16:46	5º 51' S	81º 53' W	117	15		12
April 15, 2002	15:14	4º 45' S	81º 29' W	3	12		25
April 15, 2002	17:11	4º 48' S	81º 31' W	0	20		13
April 16, 2002	16:48	4º 35' S	81º 30' W	100	20		20
April 16, 2002	17:45	4º 33' S	81º 30' W	80	10		25
April 17, 2002	7:34	4º 36' S	81º 31' W	0	20		20
April 17, 2002	10:13	4º 35' S	81º 32' W	15	10		25
April 17, 2002	17:29	4º 39' S	81º 35' W	60	15		22
April 25, 2002	18:08	4º 59' S	82º 04' W	5	10		25
May 5, 2002	18:06	4º 34' S	82º 01' W	0	10		40
May 5, 2002	18:17	4º 33' S	81º 58' W	2	100	2.7	30
May 14, 2002	13:54	4º 46' S	82º 41' W	40	10	2.7	70[1]

Distribution and relative abundance of sperm whales in relation to environmental features, squid landings and the distribution of other cetacean species in the Gulf of California, Mexico

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Sperm whales (*Physeter macrocephalus*) feed predominantly on meso- and bathypelagic cephalopods for which effective sampling methods have not been developed. The Gulf of California is one of the few areas where sperm whales might feed on a commercially fished species of squid (jumbo squid, *Dosidicus gigas*), presenting a unique opportunity to investigate the impacts of variations in jumbo squid abundance in relation to the distribution of *D. gigas*, other cetacean species, and key environmental features over spatial scales ranging from a few kilometers to a several hundred kilometers. Data were collected during two field seasons in spring-summer 1998 and 1999 using noninvasive techniques. Landing statistics show that the jumbo squid fishery collapsed in 1998 and started recovering in early 1999. Despite this collapse in 1998, sperm whales remained abundant during both years, but there were strong differences in their aggregative behavior. In 1998, sperm whales were roughly evenly distributed, whereas in 1999 there were three super-aggregations (~55 X 75 km across), which were stable for over a month. During both 1998 and 1999, sperm whales were uniformly distributed with respect to mean depth, slope, and sea surface temperature over spatial scales of ~ 10, 19, and 37 km segments and over areas of ~70 X 90 km. There was no close association between sperm whale distribution and the distribution of jumbo squid landings in 1998. In 1999 about two-thirds of the individuals were found in areas of possibly high jumbo squid biomass. There was a significant correlation between the occurrence of sperm whales and that of bottlenose dolphins (*Tursiops truncatus*), though they usually inhabit different water depths. This is the first study which was able to relate sperm whale distribution and relative abundance to the abundance of their main prey items. It suggests that sperm whales change their distribution in response to a decline in jumbo squid but that they do not leave the Gulf of California. However, this study encompassed only 2 years and further investigations are needed to gain and understanding of what may trigger large-scale movements.

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Biologic-fishing results from the catches of giant squid or pota *Dosidicus gigas* in Center -Eastern Pacific waters (August-December 1996)

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The results of the biological - fishing monitoring of the gigantic squid or pota *Dosidicus gigas* are presented from 41 jigging vessels (37 Korean and 4 Japanese), with the participation of a scientist of the Institute of the Sea of the Peru (IMARPE) on each of these vessels.

A total of 134 946 individuals were measured of which 93 352 were female and 41 594 males. A subsample of 27 909 individuals, 14 408 female and 13 501 males, was taken trying to cover the whole size-range for the analysis of sexual maturity; and another of 27 841 individuals, 13 957 female and 13 884 males, for the analysis of the stomach contents.

The vessels (41) operated between August and December 1996, during 2 244 effective work days in which 5 522 fishing operations were made. The catch was calculated on the basis of the number of produced blocks per day, and to the drained fresh weight average of the total campaign by vessel.

The fishing operations were made in the area between 04°59-10°59N and 92°59-100°59W off Central America, and the best concentrations were between 06°23-07°58N and 93°59-96°37W (Fig. 1). The indices of relative abundance, expressed in catch per unit effort values (CPUE), had meaningful values (Table 1).

As a rule, the size range ranged between 6 and 61 cm mantle length (ML), with mode at 34 cm and a mean length of 33.7 cm (Fig. 1).

Spent specimens prevailed in both sexes (67%), with 58% female and 77% males. In smaller percentage, the mature stage was recorded with 21% females and 18% males.

The analysis of the stomach content showed that the squid were 30%, fish items 29%, and crustaceans 5.5%.

During the study period, the resource was concentrated in the waters of the Center - Eastern Pacific (off Costa Rica and Mexico), where there was found a high abundance associated with the divergence zones, as mentioned in Koronkiewicz (1988). In the same work, Koronkiewicz finds three modes with the immature female individuals predominance, whereas we found a greater percentage of spent individuals in both sexes, coinciding with Sato (1976) in the same period.

The values of CPUE found in waters of the Pacific Center - Eastern, during the study period, were smaller than the historical monthly averages obtained by the jigging fleet that operated off Peru between April 1991 and December 1994 (Mariátegui and Taipe, 1996).

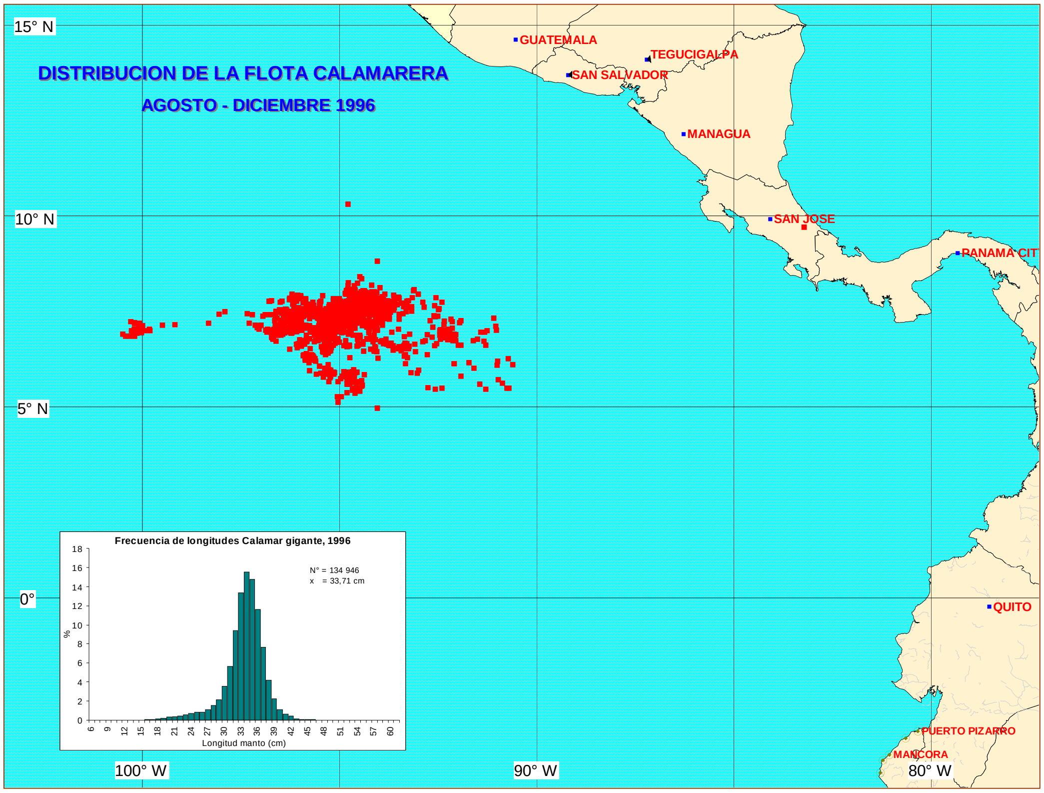

Figure.1 Catch distribution of the jumbo squid (*Dosidicus gigas*) from August to December 1996.

Table 1. Jumbo squid catch per unit of effort (CPUE) from August to December 1996

Month	**Catch (kg)**	**CPUE**				
		kg/day	kg/hour	kg/lin	kg/lin/h	kg/pot/h
August	796077.0	13268.0	1271.7	90.1	17.9	0.853
September	5062914.7	5984.5	552.5	34.1	7.5	0.373
October	4251849.3	5730.3	518.5	32.9	7.1	0.338
November	3030533.7	5189.3	461.0	25.4	6.1	0.303
December	46030.5	3835.9	434.3	14.1	5.2	0.258
Average	13187405.2	5876.7	534.6	32.2	7.1	0.339

Fishery of the giant squid *Dosidicus gigas* (D'Orbigny, 1835) off the Peruvian coast during 1999-2002

Yamashiro, C., Mariátegui, L, Tafur, R., Aguilar S., Argüelles, J., Taipe, A. & Villegas, P.

Instituto del Mar del Peru, PO Box 22, Callao - Peru

The principal biological - fishing indicators of the giant squid Dosidicus gigas (D'ORBIGNY, 1835) are analyzed during 1999-2002, to determine the changes in its availability and abundance as well as the characteristics of its size structure, reproductive cycle, and food spectrum in relationship to some environmental variables.

The annual catch was between 36 000 t in 1999 and 133 450 t in 2001, of which about 77% was extracted by the squid industrial fleet. The values of CPUE showed an increase from 17.6 t/day/ship and 0.8 t/trip in 1999 to 32.8 t/day/ship and 2.3 t/trip in 2001, in the industrial and artisanal fisheries. Between January and July 2002 catch of 90 900 t (preliminary)was recorded, with CPUE average of 21 t/day/ship and 2.66 t/trip (Figure 1).

The fishing areas were located off the north Peru coast during 1999 and 2000, but in November 2000 the industrial fleet moved southward staying in these areas during 2001 and 2002. The artisanal fleet operated mainly along the north coast.

The size of the giant squid ranged between 10 and 106 cm of ML (Figure 2), with means between 29.9 and 70.1 cm, being predominantly larger from the 50 cm in the years 2000 to 2002, with growth rates from 2 to 6 mm/day (preliminary estimates). The spawning peaks were in autumn - winter for males and in spring - summer in females. For diet, it was found that the individuals smaller than 50 cm of ML showed a preference for fish and the larger were characterized by a high cannibalism index.

During the study period, the marine environment was characterized by wide areas of a mixture of Surface Subtropical Waters and Cold Coastal Waters, which favored the presence of high concentrations of the gigantic squid.

The management strategy was based on the analysis of the indices of relative abundance, which permitted us to estimate the levels of yield and optimum effort.

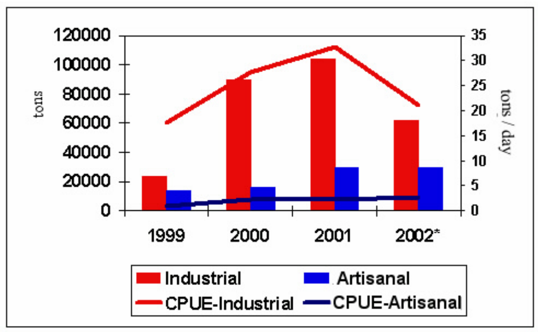

Figure. 1 Jumbo squid catch and CPUE variations by fleets during 1999-2002.

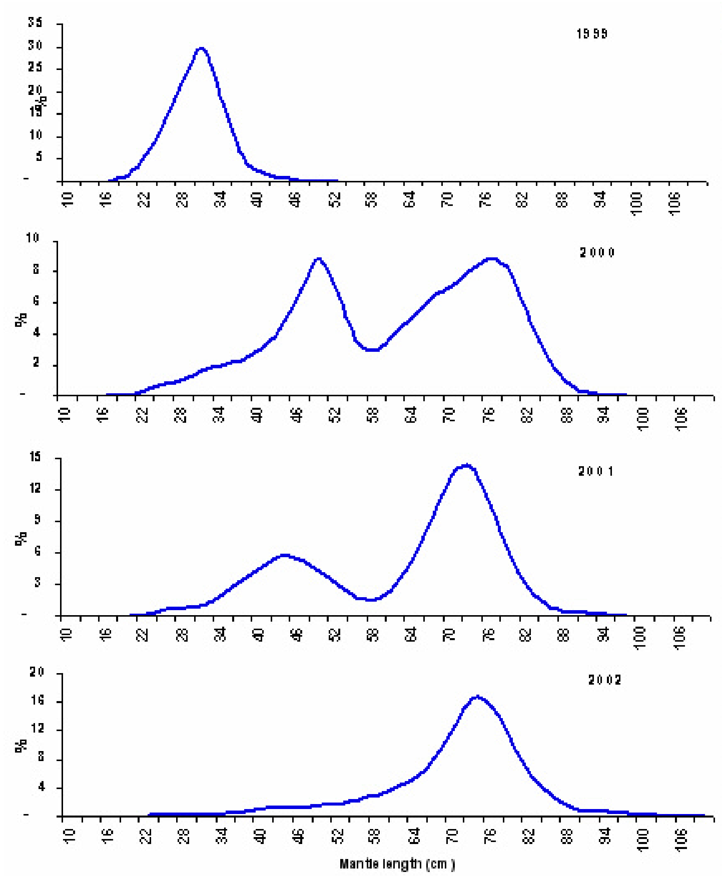

Figure 2. Size structure of jumbo squid during 1999-2002.

Use of the Leslie–De Lury modified model for the assessment of abundance of jumbo squid (*Dosidicus gigas*) in Peruvian waters during 2000.

Juan Argüelles

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Dosidicus gigas is the largest species in the family Ommastrephidae. This jumbo squid is abundant in the Peru Current and the development of the jumbo flying squid Peruvian fishery began in 1991. The exploitation is made along the Peruvian Coast principally along the north and south coast.

The Leslie – De Lury modified model described in Rosenberg et al. (1990), which takes into account natural mortality rate, was used to evaluate size population and power fishery by fleet.

Daily report data of size structure, catch, and effort (hours) were obtained by boat during 2000 for industrial fleet, whereas that for the artisanal effort in hours was estimated from previous analysis. Leslie – De Lury analysis was solved using catch-per-unit effort by week, and a natural mortality rate of 0.06 weekly.

The results of the analysis of capture, effort, and relative abundance showed that the fleet was composed by the Japanese industrial fleet, the Korean industrial fleet, and the Peruvian artisanal fleet.

The size population, estimated at 22, 000 million individuals and an average biomass of 1.24 million tons, were the principal results.

The parameter estimates and regression statistics are given in table 1.

Table 1. Parameter estimates and regresion statistics from multifleet Leslie – Delury analysis

Method	Catchability coefficient (q)	Initial size population (Millions)	Coefficient of determination r^2
Multi - fleet Leslie - Delury Method			
Japanese fleet	4.78754 x E-06	221,66	0,776
Korean fleet	2.7605 x E-06		
Peruvian artisanal fleet	3.3629 x E-22		

Indices of relative abundance for jumbo squid (*Dosidicus gigas*), an estimation using Δ-distribution.

Enrique Morales-Bojórquez[1] & Agustín Hernández-Herrera[2]

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COFAA-IPN Fellowship

We estimated an index of relative abundance and biomass for *Dosidicus gigas* in the Gulf of California, Mexico using survey research and Δ-distribution. In the jumbo squid fishery, some estimates of relative abundance and biomass with survey data have been computed, and were made assuming a normal distribution of data and using estimators of swept-area method and stratified random sampling analysis. However, these assumptions are not reliable because the spatial distribution of squid is almost everywhere patchy. When this distribution is observed, the survey research data have a lognormal distribution, and if the data contain a proportion of zeros and nonzero values then there is a Δ-distribution. A 20-day research cruise (16 May to 3 June 1996) was made in the Gulf of California onboard the R/V BIP XI of the Instituto Nacional de la Pesca (Mexico's Fishery Research Institute). The survey covered a grid of 59 stations distributed along 9 transects perpendicular to the coast line. The study zone was divided into two strata (Figure 1). Stratum A had 31 sample units, and stratum B had 28 samples units. According to this stratification, both strata showed similar mantle length frequency distributions with high abundance of small squid (mantle length 40 – 44 cm) and low occurrence of big squid (mantle length > 60 cm, Figure 2). Stratum A showed m = 22, the G_m = 4.44 and mean c = 191 kg with SE_c= 95 kg. Stratum B showed m = 24, the G_m = 5.05 and mean c = 186 kg with SE_c = 93 kg. The biomass estimation was 162,700 t. The mean and variance estimated with Δ-distribution for survey data of *D. gigas* could be an excellent estimator when data are skewed by negative stations, however its performance is diminished by positive stations with high abundance.

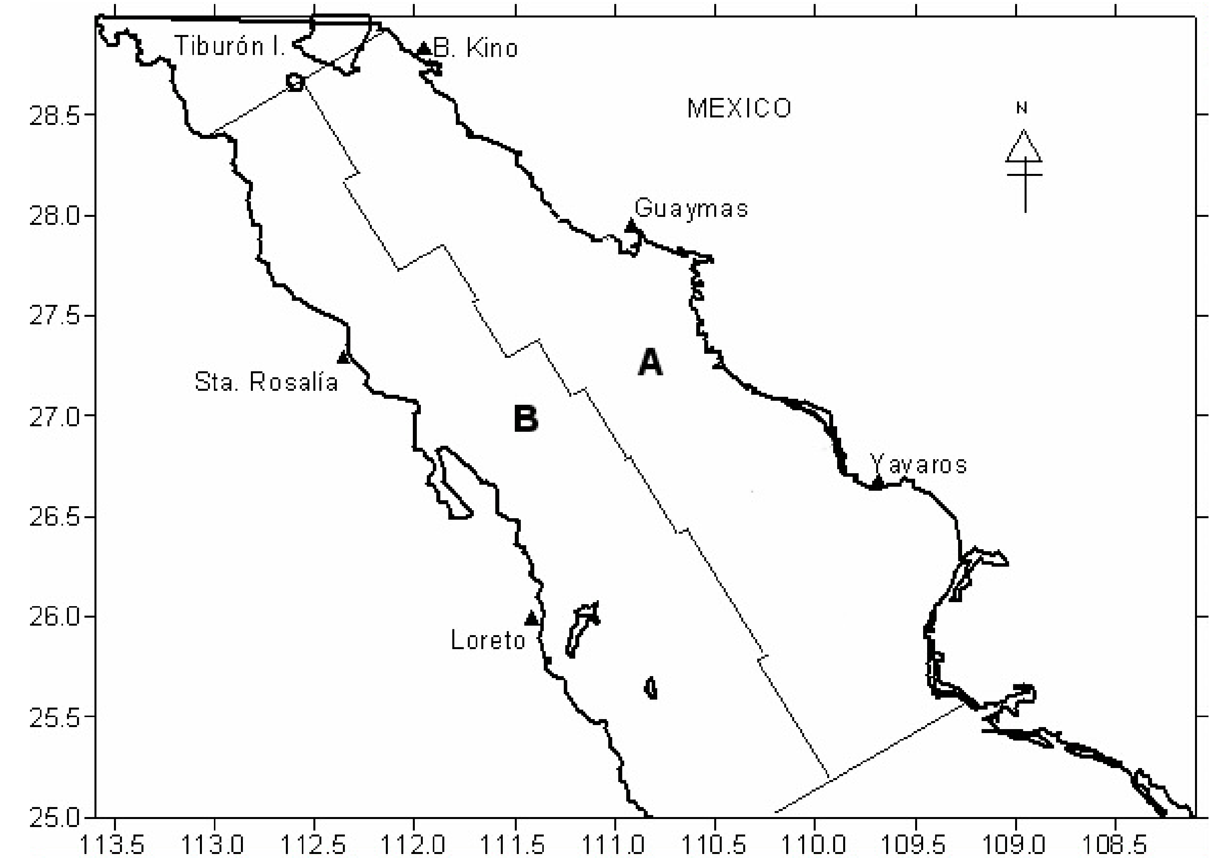

Figure 1. Survey research area in central Gulf of California divided in two strata.

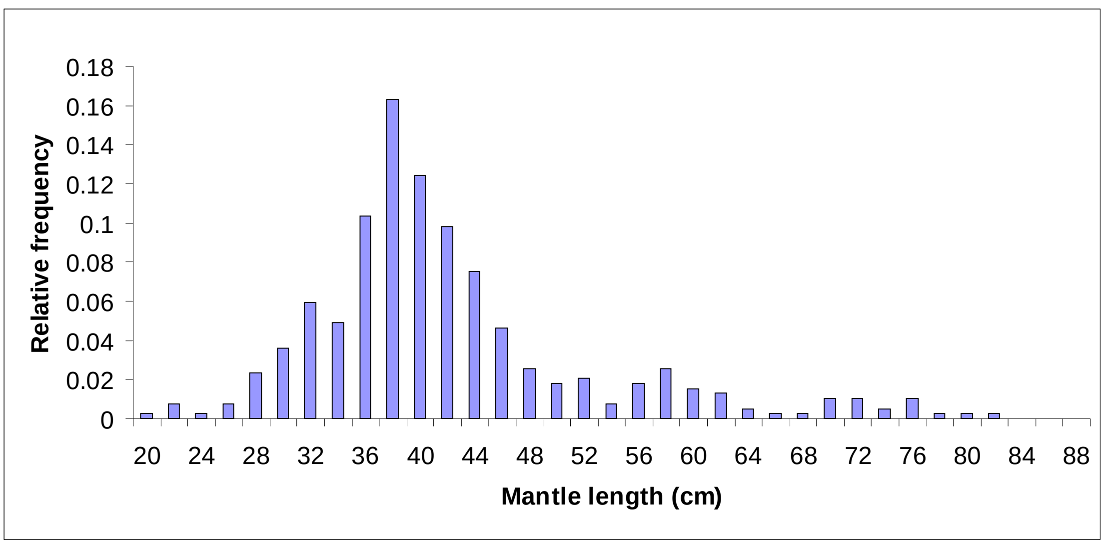

Figure 2. Survey research mantle length frequency distribution.

Is catchability really a nuisance parameter? An example with *Dosidicus gigas* fishery.

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The stock assessment in squid fisheries is commonly based on assumptions of annual cohorts. The modeling in this resource depends on the initial recruitment, and the management strategy uses a constant proportional escape as a reference point. Both management quantities (recruitment and proportional escape) depend on the catchability, and it is computed from indices of relative abundance (i.e. catch-per-unit effort). The analysis of variation in catchability can give some information regarding stock behavior and efficiency of fishing, and consequently improve the quantities used for management, such as changes in the fishing mortality during fishing season. In this study, we analyzed the effect of the outliers on the catchability coefficient estimated with a linear model. Catch (number of individuals) and effort (fishing nights) data of the landings of *D. gigas* at Guaymas, Sonora were analyzed. These data were records of the artisanal fleet during 19 fortnights (from 6 April 1997 to 3 May 1998). We estimated catchability and recruitment with the Leslie depletion model (LDM). The parameters of LDM were estimated with a mixture distribution as an objective likelihood function. This mixture distribution assumes that errors are either $N\left(0,\sigma^2\right)$ with probability $1-p$, where p is the proportion of data that were assumed as outliers. In this way, p determines the relative importance of the two density distribution functions in describing the data. The results showed differences in the slope of the model (catchability) (Fig. 1 and 2). The mixture distribution shows high performance in estimation of the slope. If the slope is constant, we consider the outliers as a hypothesis of observation error. Then, the squid fishery could be managed under assumptions of annual cohort.

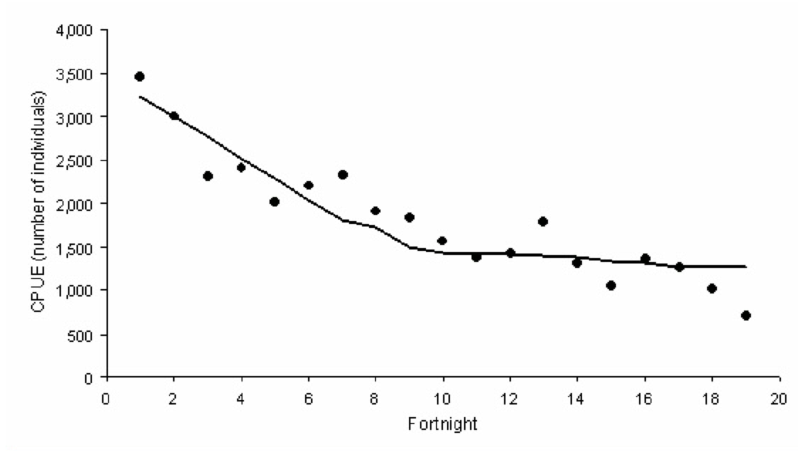

Figure 1.- Depletion model fitted with normal distribution algorithm.

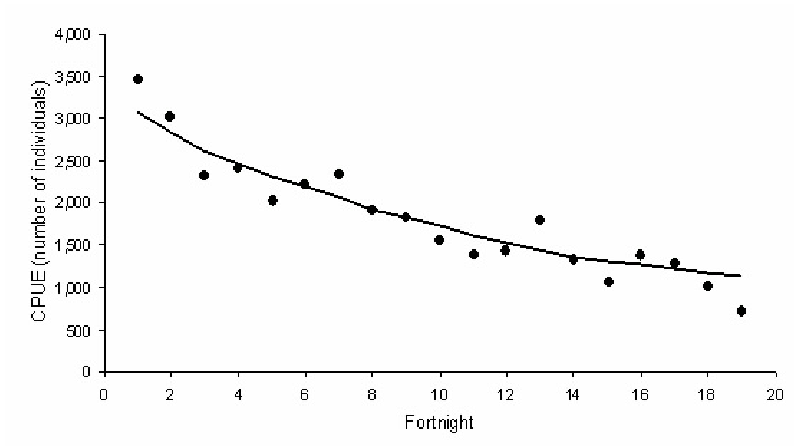

Figure 2.- Depletion model fitted with mixture distribution algorithm.

Unusual occurrence of giant squid *Dosidicus gigas* at the Southwestern coast of Baja California Sur in the Spring and Summer of 1998

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Great concentrations of giant squid occurred five to ten miles off the mouth of Bahia Magdalena from April through July 1998; so much squid as to allow for a fishing season from small boats and have their catch sampled. This happened in an unusual area and within a period in which they was expected to be at the central and northern part of Gulf of California according with their migrating pattern. Average catch per day and per boat of eviscerated weight was 690 kg. Mantle average length was 59.7 cm, with a minimum of 50 cm. Fifty-one percent of the squid showed mature gonads. Sex ratio was 1:1.71, males and females. *Pleuroncodes planipes* was found as stomach contents. The giant squid moved offshore even more by the end of July, which halted the fishing. We propose a hypothesis to understand the occurrence of the giant squid at the southwestern coast of Baja California in the light of both the distribution records available along the Baja California peninsula and the 1997-1998 El Niño effects on the oceanographic conditions.

Analysis of the commercial captures of giant squid (*Dosidicus gigas* D'Orbigny, 1835) in Baja California Sur during ENSO 1997-1998. Ecological implications and proposal of adaptation of the industry.

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During 1998 the squid fleet off shore unusually landed 7470 tons in the port of San Carlos on the western coast of Baja California and 6990 tons in La Paz B.C.S. Because of the great demand of the product in the market, the displacement of the resource to sites of propitious fishing previously not used caused the transfer of more than 500 fishermen to the different ports where the giant squid was concentrated. The product of the capture was transferred in cooled trucks from the different fishing fields temporarily qualified to the processing plants of giant squid located mainly in Santa Rosalía, Cd. Constitución, Mulegé, and Loreto. The present work shows the behavior of displacement of the squid fleet off shore considering it as an indicator of the availability of the resource, and relates the conditions of sea surface temperature during 1997-1999 to the giant squid capture. This movement of the giant squid to concentrate off the western coast of the state must be considered within the plans of operation of the productive plant to optimize its processing during anomalous climatic events like ENSO that happened in 1997-1998.

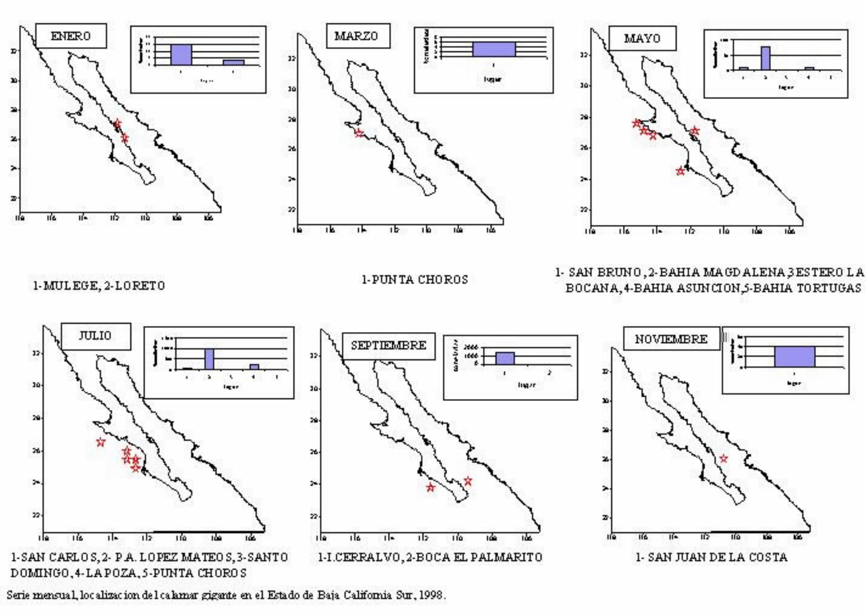

Figure 1. Location of jumbo squid by month in Baja California Sur during 1998. Stars show the landing places. Bar arrangement is North to South from the Gulf of California to West Coast.

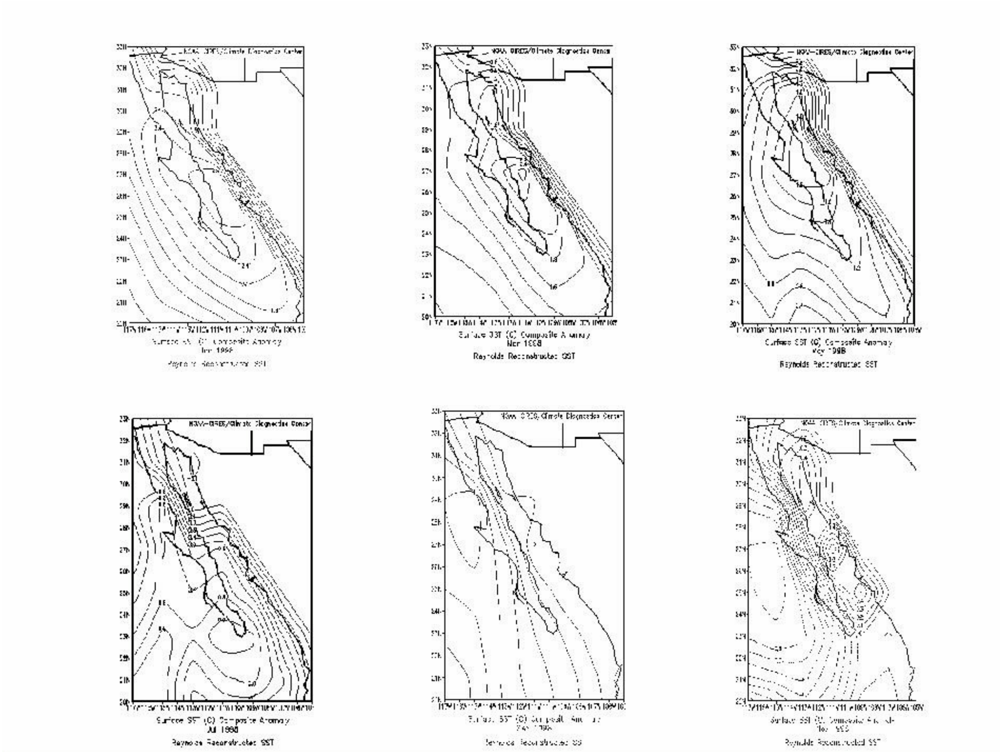

Figure 2. Monthly Sea surface temperature to 1998 (NOAA, 2002)

Spent females of *Gonatus madokai* (Teuthida: Oegopsida) from the Okhotsk Sea.

Oleg N. Katugin & A. Yu Merzlyakov,

Pacific Research Fisheries Centre (TINRO-Centre), Vladivostok, Russia

Almost 20 species of the family Gonatidae inhabit the waters of the nothern Pacific Ocean. At present, little is known about reproduction and the life cycle of most of them, partly because the adults are mainly deep-water dwellers and are hard to catch. There are also certain difficulties in accurate species identification, particularly in species losing tentacles upon maturation, and with gelatinous degeneration of muscle tissues. Herein we report on the first record of spent females of one of the most common gonatid squid in the Okhotsk Sea, the long-armed gonate squid *Gonatus madokai* Kubodera et Okutani, 1977. This species is characterized by gelatinous degeneration even in immature and maturing specimens. Nothing is known about the species reproductive habits, including spawning and postspawning behavior. Spawning and postspawning adults have not been found (or correctly identified) so far.

A total of 57 large spent females of *G. madokai* were caught in midwater demersal trawls during commercial fishery for walleye pollock (*Theragra chalcogramma*) in the Okhotsk Sea in April-May 2001. Though intensive trawling has been made in the eastern and northern Okhotsk Sea, spent females of *G. madokai* occurred predominantly over the latter area (Figure 1). Those were caught mainly in the upper slope belt over a depth range from 200-500 m, at trawling depths from 135-450 m. The greatest occurrence of spent females was observed to the east of the Kashevarov Bank in the region between 145-152°E, and 55-57°N, where 1 to 3, with a maximum of 5 individuals per hour trawling have been recorded. The estimated distribution density of spent females of *G. madokai* over that area changed generally from 1 to 5, and did not exceed 8 animals per square km.

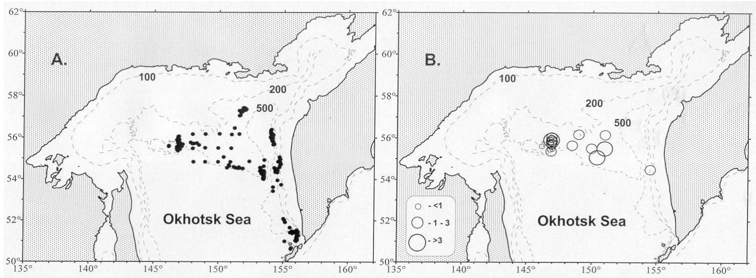

Figure 1. Occurrence of spent females of *Gonatus madokai* in the Okhotsk Sea: A – trawling stations; B – number of individuals per hour trawling.

General external features of those squid specimens were large squid with very large fin and remnants of tentacles (small stumps) between the bases of arms III and IV; body flaccid and gelatinous (muscle tissues of mantle, fin, head, and arms fully degenerated, being medusoid in appearance); arms markedly swelled proximally, and weak and tattered distally; no suckers on the arms, only two medial rows of hooks left on arms I, II, and III; skin pale gray to brownish, easily comes off, exposing almost transparent mantle; shreds of dark tissue (presumably remnants of the egg-mass) on the inner parts of the arms, adhered to hooks. Funnel remains were rather tough and strong suggesting that jet propulsion continues to provide locomotion of the waterlogged squid body. Of all the animals analyzed, only half a dozen came almost intact from the net, whereas most of the individuals appeared in parts; fins, mantle cones, heads, and arm crowns were frequently found separately, even after a short trawling. Gladii were typical for the species with characteristically pronounced cone flags, small wings, weakly defined border between wings and lateral plates, and long free part of the rachis. Gladii in postbreeding animals differed from those of younger conspecifics in having lateral plates expanded and curved downwards in the central part, and anteriormost part of free rachis wrinkled and folded. It is thus evident that gladius overgrows its shell sack during the squid's life.

Reproductive system appeared exhausted; dark yellow ovaries almost always totally empty, sometimes with a bunch of partly resorbed oocytes; oviducts heavily worn out, empty or with 1 to 15 yet unspawned ripe oval eggs of the mean size 3.98 x 2.78 mm (maximum diameter ranging from 3 to 5 mm); nidamental glands (NG) generally small, of about 15% of the gladius length. One spawning female with the ovary and oviducts full of mature eggs possessed large swelled NG of about 27% of the gladius length. We may therefore suggest that upon maturation NG rapidly grow in size, and become strongly exhausted during the process of spawning, their lavish secretion serving as a media for supposedly large egg-mass. Almost every female had singly implanted spermatophores all over the buccal mass and lappets, sometimes on the arm bases. The number of copulations varied from none to approximately 70 per female. Judging from different appearance of implanted spermatophores, some females mated several times.

No traces of food were found in digestive tracts of spent *G. madokai*, meaning that females were not feeding. Digestive gland of a spent female appeared comparatively small, approximately 2% of the total body weight (W). Usually, liver weight accounts for about 14% to 26% of W in immature and sexually maturing females of this species.

To determine length-weight relationships for *G. madokai*, data from unsexed juveniles, immature, maturing , and spent females were considered, with dorsal mantle length (DML) ranging from 55 to 60 mm. The overall relationship between W and DML can be equally well described by power and exponential regressions (Figure 2). Of special interest is rapid weight growth in spawning and spent females in spite of almost empty gonoducts, and an exhausted midgut gland. Some spent females with moderate DML fall below the exponential curve on the W versus DML plot, and this is most likely caused by underestimation of their weight after heavy damage by the trawl net.

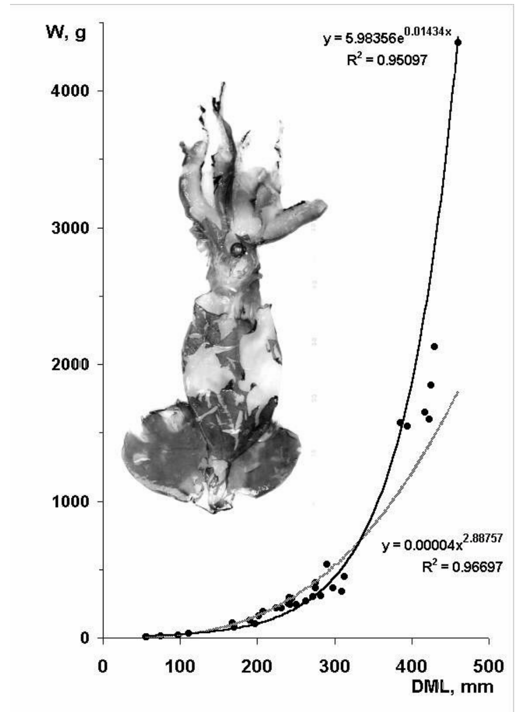

Figure 2. Weight (W) – length (DML, dorsal mantle length) relationships for *Gonatus madokai* from the Okhotsk Sea (exponential and power regressions are given).

Our data suggest that *G. madokai* spawns in the northern Okhotsk Sea in spring, most likely in the areas (or water layers) with comparatively low hydrodynamics at depths from approximately 150-300 m over the upper continental slope, and presumably over the outer shelf. A spawning female supposedly keeps an egg-mass between the arms nursing externally fertilized eggs. Swelling of muscle tissues caused by gelatinous degeneration provides exponential weight gain in *G. madokai*. Wide fin, and jelly-like consistency of the body rapidly reduce negative buoyancy of the squid, and may serve as adaptations to safe parachuting and effective baby care in a relatively stable water layer. Postspawning females, carrying egg-masses between their arms, can be likened to large free-floating nurseries.

Distribution of *Berryteuthis anonychus* (Gonatidae, Oegopsida) in the North Pacific Ocean.

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The smallfin gonate squid *Berryteuthis anonychus* (Pearcy and Voss, 1963) is distributed across the Subarctic zone of the Pacific Ocean. This primarily offshore oceanic species inhabits epi- and mesopelagic layers. It is also known to undergo vertical migrations, and can descend down to bathypelagic layers even as deep as 1000 m. The species is rather small, with a maximum known dorsal mantle length (DML) of 183 mm, though usually DML of adults does not exceed 150 mm. The life cycle of *B. anonychus* is weakly documented, and little is known about the species reproductive biology and migration. In this short report we summarized our own data on the distribution and size structure of *B. anonychus* from the vast areas of the North Pacific Ocean (NPO), collected during 1960-2000. The information came mainly from the TINRO-Centre research vessels (RV), and Japanese RV with Russian observers on board. Collections for *B. anonychus* were obtained primarily from midwater trawls (MT-93/500, -108/528, -118/620), usually without special equipment for catching small-sized squid, hence our data are evidently biased towards animals of larger size. Early life stages of the squid were taken with Ichthyoplankton Conical Net (ICN-80). General trends in the species distribution have been shown, and a hypothesis on the squid life cycle is proposed.

B. anonychus was present in net hauls almost through the entire NPO (Figure 1). The species occurred from the Gulf of Alaska, along the North American coast down to offshore areas of Baja California (20°35'N, 118°00'W), and that was the southern- and easternmost record of the squid. The species geographic range extends through the oceanic areas generally north of 40°N to the west as far as the southern Kuril Islands and northeastern Hokkaido (44°09'N, 147°00'E), and this is the westernmost region of the species occurrence. To the north, *B. anonychus* approaches the Aleutian Archipelago and southern Bering Sea, and have been occasionally caught in the eastern Okhotsk Sea (52°01'N, 153°29'E), and northern Bering Sea (60°50'N, 179°02'W) – the latter being the northernmost point of the species capture reported to date. There is a certain pattern to the squid geographic range, and being related to distribution of life stages, it generally coincides with principal schemes of surface circulation in the NPO. On the whole, the species spatial distribution area fits into the Subarctic Current System, and could be divided into the "eastern" and "western" parts, thus encompassing the Alaskan Gyre (AG) and Western Subarctic Gyre (WSG). The "Eastern" area roughly includes a vast region east of 175°E. Here in the epipelagic layers, paralarvae, juveniles, and sexually maturing individuals of *B. anonychus* have been regularly observed. Maximum catches for *B. anonychus* have been recorded in summer in two regions of the “eastern” area. In one region (47°15’N, 175°35’W) approximately 76,000 adult squid with DML 90 to 110 mm (2 t), and in the other region (47°50’N, 133°58’W) up to 47,000 individuals with DML 100 to 120 mm (1.62 t) per hour trawling were caught. The “Western” area is characterized by much lower abundance of *B. anonychus* with a maximum known catch of only up to 117 juvenile and immature individuals per hour trawling in July. The squid occurrence decreases to the outskirts of its range with incidental catch of juveniles off Hokkaido and Mexico, and immature and maturing adults in the eastern Okhotsk Sea and off the Kuril Chain. The species abundance is the highest in summer, with a rapid drop during autumn and winter, and a gradual rise in mid-spring. In the central and eastern NPO, paralarvae and small juveniles occurred in March-April, and October-January, whereas in the western NPO they were seen in July-August.

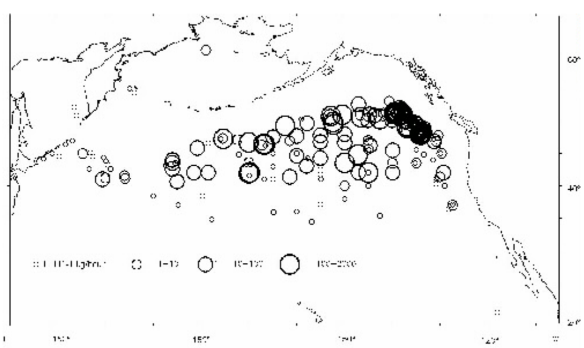

Figure 1. Map of *Berryteuthis anonychus* catches (kg per hour trawling) in the North Pacific Ocean.

There are several peaks on size frequency distribution graphs of *B. anonychus* (Figure 2). In the eastern part of the AG, there exists a noticeable trend towards increase of the squid size northward, with the largest animals (DML from 78 to 121 mm) on the advanced sexual maturity stages distributed mainly north of 48°N. Somewhat smaller animals (DML from 50 to 98 mm), mostly immature, were caught generally south of 48°N. Paralarvae and juveniles of *B. anonychus* (DML from 2.8 to 15.8 mm) have been recorded in the area between approximately 170°E-155°W, and 36-38°N. In the WSG area, polymodal size frequency distribution of *B. anonychus* (DML range from 10 to 110 mm) corresponds to the basic life stages: early juveniles, immature and maturing adults.

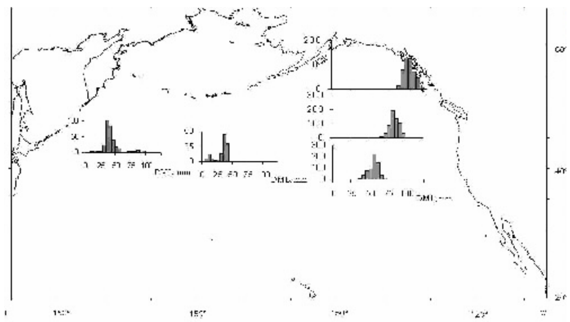

Figure 2. Size (DML, dorsal mantle length) frequency distribution of *Berryteuthis anonychus* by areas.

Having considered our data, and the circulation pattern in the NPO, the following hypothetical scheme of the *B. anonychus* life cycle can be proposed for the central and eastern parts of the species range. The squid reproduces mainly off the Alaskan coast. The resultant pool of newly hatched paralarvae is carried away by the Alaskan Stream along the Aleutians, and diverges en route. A portion of that pool moves into the Bering Sea through the Aleutian passes, and paralarvae appear widely distributed over the south-central part of the Bering Sea. Some of them are even transported with the Transverse Current across the sea to the north almost as far as cape Navarin. The main pool of paralarvae from the Alaskan Stream turns south of the Aleutian-Commander Arc, and enters the

Subarctic Current Area, where young squid migrate eastward, and grow up on their way to the natal areas in the AG. Finally having gained sexual maturity in the east of the gyre, they close up the species counterclockwise cycle. The presence of paralarvae, juveniles, and immature adults in the northwestern Pacific Ocean suggests that the life cycle of *B. anonychus* is evidently accomplished within that area, and should also be associated with the general circulation pattern of the WSG, though our data are insufficient to soundly speculate on the matter.

Lengths of *Dosidicus gigas* in central Gulf of California, Mexico

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The studies of the giant squid *Dosidicus gigas* in the Gulf of California shows the presence of at least three different size groups; small, medium and large. These groups has been related to reproductive processes and fishery recruitment. We consider that the presence of these groups could show the basic dynamic of recruitment. The objective of this work is to determine seasonal patterns of squid per size groups. Data correspond to mantle length frequencies sampled from November 1995 to December 1997, and during summer and autumn of 2000 through 2002. Length groups were defined from a Bhattacharya analysis and literature reports (Fig. 1). Results showed medium and large size squid during all seasons and years but small squid are more important from May to August and change during the years (Table 1). Squid length composition per year showed important changes, especially in 1997 (Fig. 2).

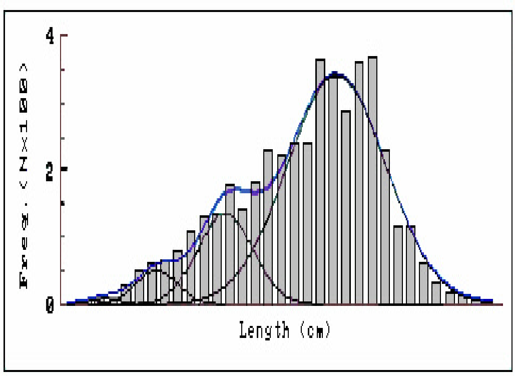

Figure 1. *D. gigas* size groups from Bhattacharyas's method.

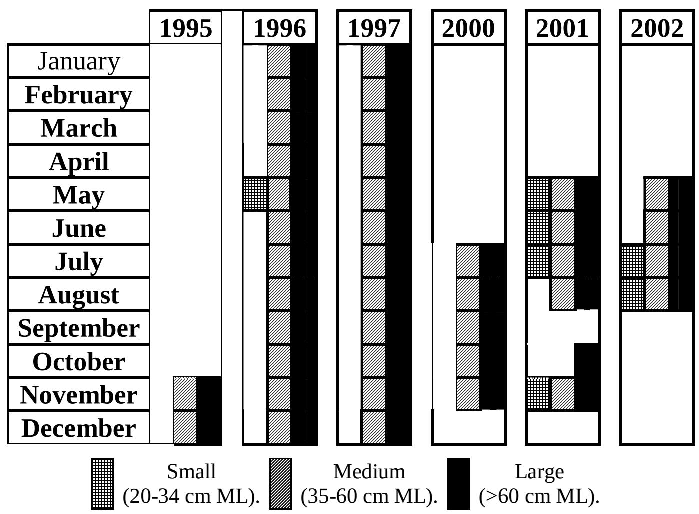

Table 1. *D. gigas* size groups (small, medium, large) per month and year.

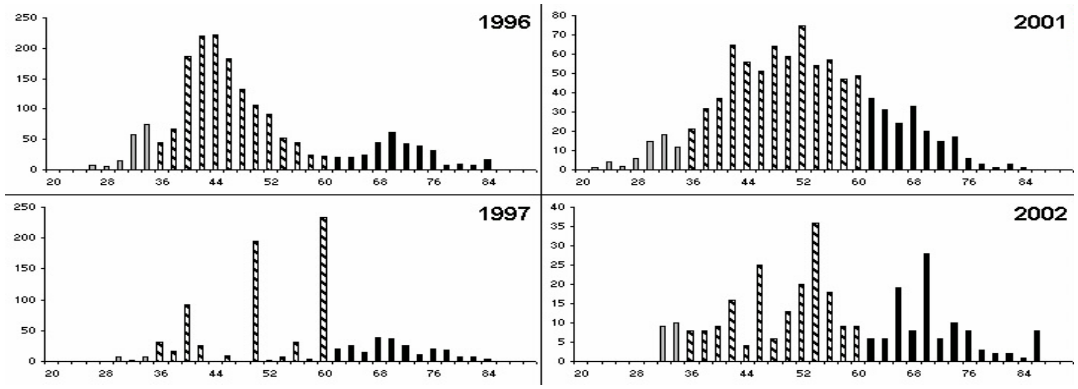

Figure 2. *D. gigas* the size groups during May – August of sampled years.

How many cohorts are there in the squid Mexican fishery?. An overview from catchability analysis.

Susana Martínez-Aguilar.[1] , Enrique Morales-Bojórquez.[1], Francisco Arreguín-Sánchez[2] & Agustín Hernández-Herrera[2]

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Using the deterministic model of catchability (DMC) and a data sets of catch-per-unit-of-effort (CPUE) mantle length-structured, we determined catchability-at-length of the jumbo squid (*Dosidicus gigas*) fishery from the Gulf of California, Mexico. We analyzed two time periods for the same fishing season, from 19 May to 11 August 1996 (referred to as before) and from 12 January to 6 April 1997 (referred to as after). Catchability coefficient, fishing mortality, and abundance per forthnight were determined. The proportional escape, $K = e^{-F}$, was estimated for each period of time; $K_{before} = 0.24$ and $K_{after} = 0.37$. We observed a possible inverse relationship between the catchability coefficient and abundance. Moreover, we described a rate of change of catchability that depends on mantle length-distribution with respect to a time period. This index suggested different patterns between small and large squid. The results showed the presence of only one cohort of *D. gigas* in the period analyzed, however the index of catchability showed the presence of small squid during May when the recruitment occurs and later during the fishing season. This method can be applied over short time periods or when the De Lury method cannot be fitted.

Growth, mortality and yield of the jumbo squid (*Dosidicus gigas*) of Guaymas, Mexico.

Manuel O. Nevárez-Martínez[1,2], F.J. Méndez-Tenorio[1], C. Cervantes-Valle[1], J. López-Martínez[2] & M.L. Anguiano-Carrasco[1].

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The jumbo squid population dynamics are analyzed (*Dosidicus gigas*) from specimens from the Gulf of California and that landed in Guaymas, Mexico. The period of analysis embraces the fishing seasons 1989-1999 to 2000-2001. The information for this work was the size structure, individual weight, and total catch. The intervals of sizes in the catches went from 20 to 78 cm of mantle length for 1998-99, 32 to 88 cm for 1999-00, 28 to 92 cm for 2000-01, and 24 to 96 cm for 2001-2002. As a result of the analyses we estimated the following:

Parameter	*1998-1999*	*1999-2000*	*2000-2001*	*2001-2002*
a	0.004	0.0021	0.001	0.0082
b	3.3438	3.5019	3.6460	3.1582
L_∞ (cm)	90.0	92.0	95.4	98.0
K/year	1.05	1.05	1.09	1.11
M	1.57	1.57	1.63	1.66

The squid catch were variable with 1970 t in 1998-99, 16200 t in 1999-00, 13000 t in 2000-01, and 41300 t in 2001/02 being landed. The analysis of cohorts and the Thompson-Bell predictive model indicated that the recruitment showed an upward behavior, there being estimated 4.9 million for 1998-99 and 37.8 million squid for 2001-02. The rate of exploitation annual average was between 0.70 and 0.33 and the mortality for fishing was high (3.6/year) in 1998-99 and later stayed between 0.44 and 0.81. The predictive model indicates that for 1998-99, the maximum sustainable yield (MSY) could have been obtained with 30% of the applied effort. However for the following fishing seasons the MSY could have obtained with a higher fishing effort level. We observe that the F_{MSY} does not necessarily coincide with the $F_{\%BR}$ (Fig. 1).

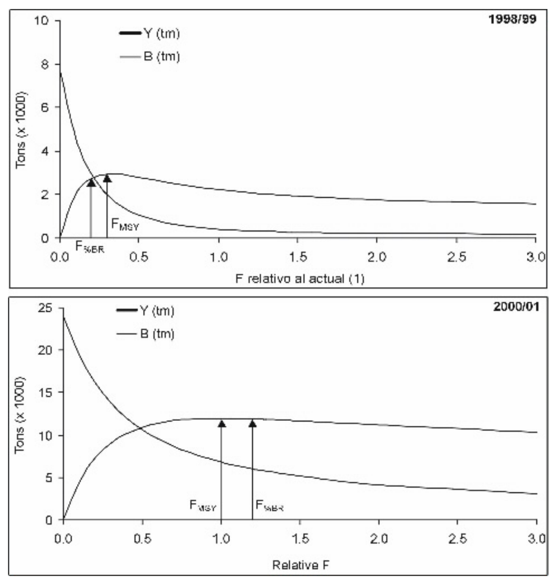

Figure 1. Yield (thick lines) and mean annual biomass (thin lines) of jumbo squid from Guaymas, Mexico. The F_{MSY} and the $F_{\%BR}$ are marked.

Biomass, distribution, size structure, and maturity of the jumbo squid (*Dosidicus gigas*) in the Gulf of California, Mexico, June 2002.

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A research cruise on jumbo squid was made in the Gulf of California, during June 2002, onboard the R/V BIPXI. The survey covered a grid of 49 stations within 25 - 29 °N and 110 - 113 °W (Fig. 1). At each station six manual jigs were used using attraction with light. Biomass was estimated by stratified random sampling, and swept area by strata. With the first method an estimate of 461,800 t was obtained, with the 95% confidence interval 448,920 - 474,720 t, and the second method gave an estimated biomass of 234,600 t with a 95% confidence interval between 216,200 and 253,100 t. The jumbo squid had a wide distribution, being distributed along the coast of Sonora and the peninsula of Baja California, with the highest abundances mainly in the center-south part of the study area (Fig. 1). The sizes structure (Fig. 2) had an interval between 20 and 94 cm, with three modes, and 49.7 cm average length. The sex rate was 2.5:1(females and males) and the reproductive activity was present in a third of the stations, over a large geographical area.

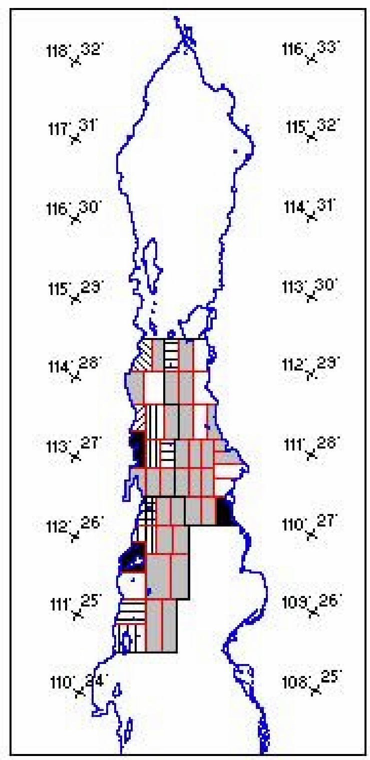

Figure 1. Spatial distribution of the jumbo squid *Dosidicus gigas* in the Gulf of California, June 2002. Blank areas indicate zero catch, gray 1 to 72 kg, horizontal lines of 72.1 to 144 kg, vertical lines of 144.1 to 216 kg, inclined lines to the right of 216.1 to 288 kg, inclined lines to the left of 288.1 to 360 kg, squares of 432.1 to 504 kg, and the areas in black catches greater than 648 kg.

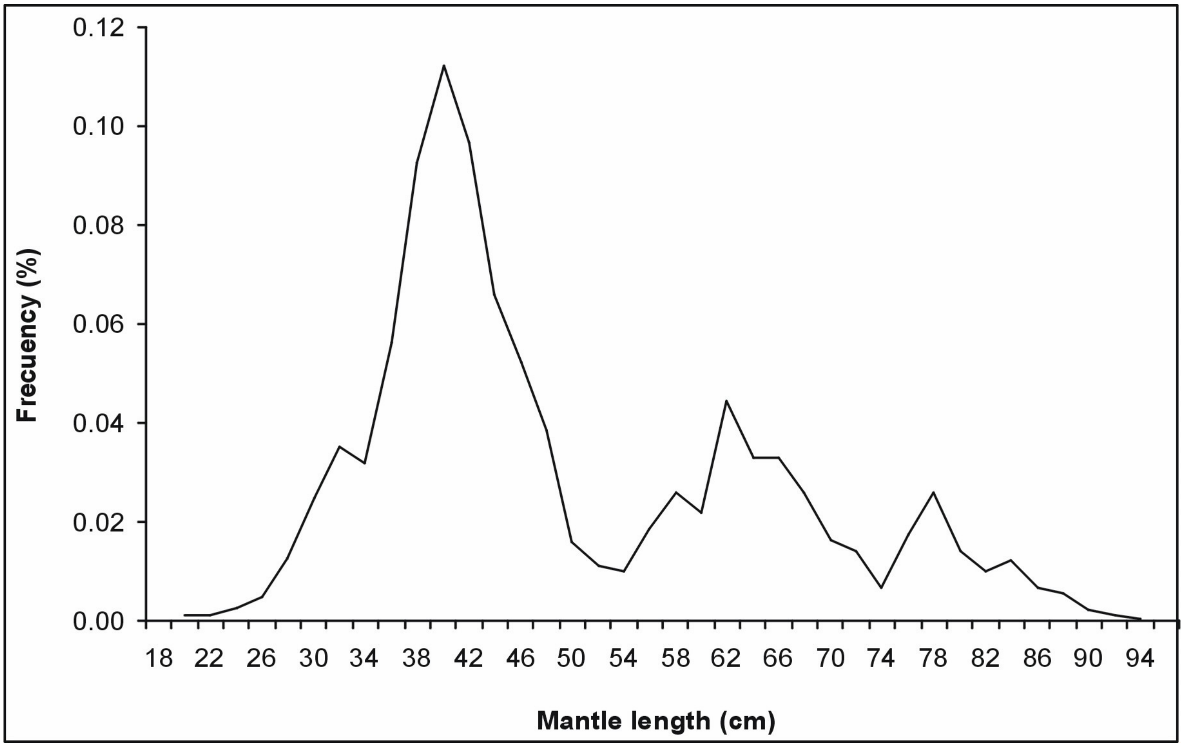

Figure 2. Size structure of the jumbo squid during June 2002 in the Gulf of California.

Preliminary results of tracking experiment for jumbo squid *Dosidicus gigas* in the Gulf of California, Mexico

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Conventional plastic tags were applied to near 1,000 jumbo squid, *Dosidicus gigas*, from the Gulf of California in each of two experiments. The primary goal was to obtain a realistic estimate of return rate from the commercial fishery to develop a program of archival and pop-up satellite tagging for use with this squid species and potentially others. Additional goals are to elucidate migration patterns of jumbo squid in the Gulf of California and to obtain direct growth rates.

For the first experiment, made off Santa Rosalia during October 2001, 80 squid were recovered between Oct and Dec off Santa Rosalia and 10 off Guaymas from Dec to Feb (Fig. 1A). In the second experiment, made from Guaymas in April 2002, 58 tags have been recovered to date off that harbor, and 18 have been reported from Santa Rosalia (Fig. 1B). During this experiment the recovery rate increased with squid size (Fig. 2).

Our work indicates that *Dosidicus* is relatively easily tagged, with either conventional plastic or electronic tags, and the tagging operation produced no obvious deleterious effects on the squid. These results also confirm a reciprocal migration of squid between the seasonal fishing grounds off Santa Rosalia and Guaymas. The extent of this migration or exact routes followed remains uncertain and merit future investigation using these established techniques.

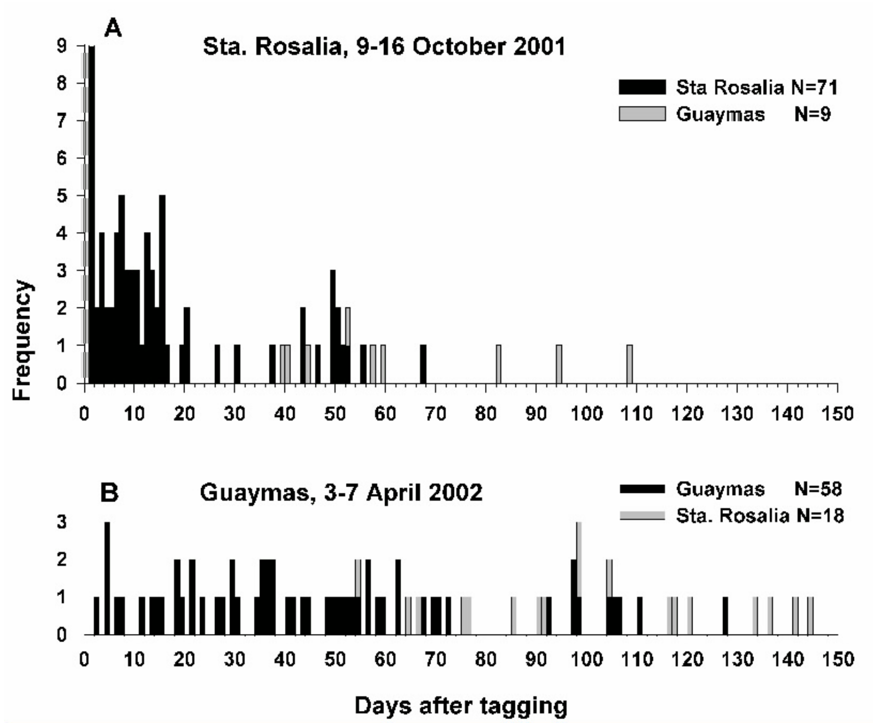

Figure 1. Recapture data distribution for jumbo squid tagged off Santa Rosalia (A) and off Guaymas (B).

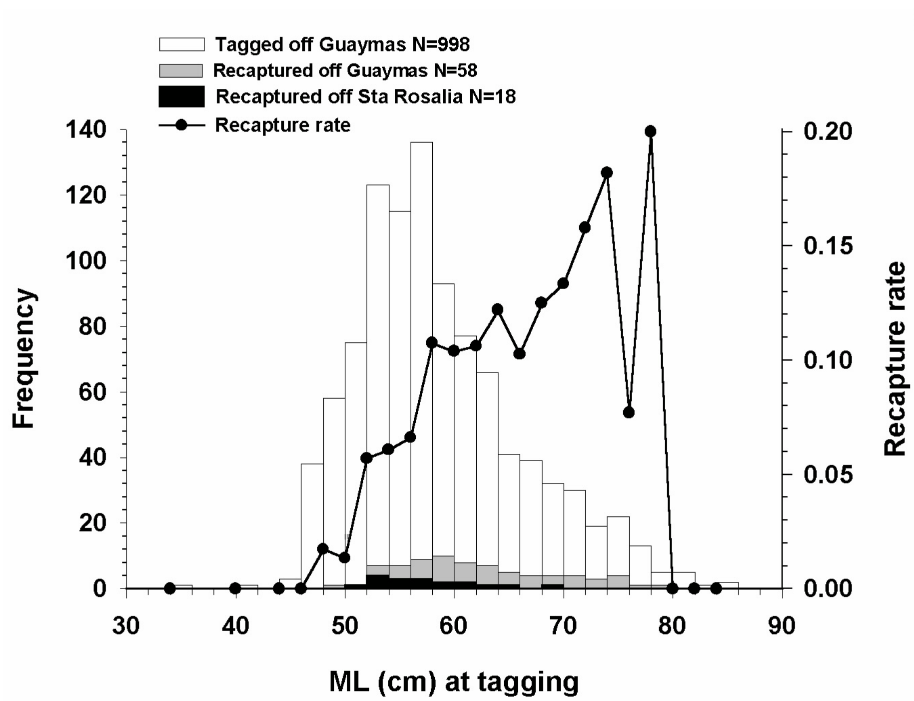

Figure 2. Jumbo squid mantle length distribution for jumbo squid tagged off Guaymas and those recaptured; and recapture rate distribution by squid mantle length.

Using lights to track squid fishing fleets from space

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This study examines the influence of environmental variability on the distribution of the fishing fleet targeting *Dosidicus gigas* (the jumbo flying squid) in the southeast Pacific. As for the majority of ommastrephid species, *D. gigas* exhibits large fluctuations in abundance from year to year, which are thought to be related to environmental variability driven by the El Niño-Southern Oscillation (ENSO). The commercial fishery consists of a multinational jigging fleet, and the emission of light from squid jigging vessels can be observed using satellite-derived imagery obtained by the United States Air Force Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). Using a Geographic Information System (GIS), interannual variability in the location of the fleet (as derived from DMSP-OLS data) is compared with the local oceanography (using satellite derived sea surface temperature data) to examine the influence of El Niño and La Niña events on squid abundance and the distribution of the fishery.

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