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Ocean Station "Papa" Detailed Zooplankton Data: 1956-1980

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ABSTRACT

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Zooplankton samples were collected at Ocean Station "P" (50°N, 145°W) from 1956 to 1980, and were analyzed to various levels of taxonomic resolution over the years. Although summaries of these data have been previously published by LeBrasseur (1965) and Fulton (1978, 1983), the detailed species data have never been published. We have reformatted the detailed data, corrected any errors we discovered, and added extra information to produce one complete dataset for the whole sampling period. This dataset contains total zooplankton wet weights/m^3 for the whole period 1956 to 1980, as well as densities (numbers/m^3) for five major taxa (copepods, chaetognaths, euphausiids, amphipods, and *Aglantha*) from 1964 to 1967, and species identifications, counts and lengths for many samples collected between 1968 to 1980. The purpose of this document is to make the detailed data available to the scientific community in electronic format, and to provide a convenient reference for citing the detailed data.

A diskette is enclosed that contains the complete, "corrected", detailed zooplankton data, both of the original data files, and a dataset with other variables for samples collected from 1956 to 1964. The document contains information on the methods used to collect and process the data, and describes our version of the dataset, along with descriptions of a number of fairly minor points about the data that we were unable to resolve. It also describes, in detail, the format of the original data files, the corrections/changes we made to these files in creating our version, and how these errors affect what was published in Fulton (1983).

RESUME

Waddell, Brenda J., and Skip McKinnell. 1995. Ocean Station "Papa" detailed zooplankton data: 1956 - 1980. Can. Tech. Rep. Fish. Aquat. Sci. 2056: 21 p.

Des échantillons de zooplancton ont été prélevés à la station océanique «P» (50°N, 145°O) de 1956 à 1980 et analysés à divers niveaux taxonomiques. Des sommaires des données obtenues ont déjà été publiés par LeBrasseur (1965) et Fulton (1978 et 1983), mais la liste détaillée des espèces n'a jamais été publiée. Nous avons refait la présentation des données, corrigé les erreurs apparentes et ajouté des renseignements afin de rendre la série complète pour l'ensemble de la période d'échantillonnage. On trouve dans cet ensemble de données tous les poids humides du zooplancton par m^3 pour toute la période 1956-1980 ainsi que les densités (nombres d'organismes par m^3) pour cinq taxons importants (copépodes, chaetognathes, euphausiidés, amphipodes et *Aglantha*) pour la période 1964-1967 ainsi que le nom des espèces, le nombre et la longueur des organismes pour un grand nombre d'échantillons prélevés entre 1968 et 1980. Ce document a été produit afin de permettre aux scientifiques d'avoir accès, sur support électronique, à des données détaillées et de disposer d'une référence pratique lorsqu'il s'agit de citer ces données.

La disquette jointe contient l'ensemble des données détaillées «corrigées» pour le zooplancton qui se présentent sous la forme de fichiers de données originaux et d'un ensemble de données d'autres variables pour les échantillons prélevés de 1956 à 1964. Le document contient aussi de l'information sur les méthodes utilisées pour la cueillette et le traitement des données, présente notre version de l'ensemble des données et décrit divers problèmes relativement mineurs ayant trait aux données qu'il nous a été impossible de résoudre. On y trouve aussi une description détaillée du mode de présentation des fichiers de données de départ, des corrections ou modifications que nous avons apportées au moment de la création de notre version et des incidences de ces erreurs sur les données publiées par Fulton (1983).

INTRODUCTION

Between 1956 and 1980, Canadian weatherships at Ocean Station *P* 'Papa' (50°N Latitude, 145°W Longitude) were used as oceanographic sampling platforms. During this period, various physical and biological oceanographic data were collected routinely. Although the data collected and the sampling frequencies varied over the years, the time series that were developed represent some of the best available in the North Pacific Ocean.

Although summaries of the zooplankton data have been published by LeBrasseur (1965), and Fulton (1978, 1983), the detailed species data have never been published. In 1994, the Working Group on Data Exchange of the North Pacific Marine Science Organization (PICES) recommended that PICES facilitate the exchange of unique datasets such as the Ocean Station *P* oceanographic data. The original investigators who maintained and used these zooplankton data are either retired or deceased. As a consequence, the job was "archaeological" in nature. Fortunately, the raw data, the species codes, and the FORTRAN programs used to manipulate and summarize the data were available on one magnetic tape. Most of the files dated from the early to mid-1980's. The original raw data format was archaic and required unique programs to manipulate the data. Most of the original data were stored on I.B.M. punch cards using I.B.M. Model 029 keypunch machines and then transferred to magnetic tape. Data collected in the last few years of the project may have been entered directly onto magnetic tape.

Rather than release the raw data in the state they were discovered, we reformatted the two original (Fulton) data files, corrected mistakes and identified problems or uncertainties in the data, combined the files, and added extra information to produce one complete dataset. This dataset is provided on the enclosed diskette and includes: total zooplankton wet weights/m^3 for the whole period, 1956 to 1980; densities (numbers/m^3) for five major taxa (copepods, chaetognaths, euphausiids, amphipods, and *Aglantha*) for 1965 to 1967; and species counts by length for many samples from 1968 to 1980. To provide an audit trail, we have included the two original (Fulton) data files as we discovered them, as well as listings of every change that we made in creating an edited version of these data. The purpose of this document is to make the detailed data available to the scientific community in electronic format and to provide a convenient reference for citing the detailed data.

The first section of this report contains information on the historical methods used to collect and process the zooplankton samples, as described in Fulton (1978, 1983). The second section describes our version of the dataset and identifies a number of minor points that we were unable to resolve. Appendix 1 describes, in detail, the format of the original data files and the corrections/changes we made to these files in creating our version. It also describes how these errors affect the summary data previously published in Fulton (1983). Appendix 2 describes a supplementary dataset for samples collected from 1956 to 1964, and Appendix 3 identifies the taxonomic codes.

METHODS

1.0 FIELD SAMPLING

The samples were collected by personnel of the Pacific Oceanographic Group from C.C.G.S. "ST. CATHERINES", "VANCOUVER", and "QUADRA" in the earlier years, and by personnel of the Offshore Oceanography Division and the Ocean Chemistry Division of the Institute of Ocean Science in the latter years. Samples collected prior to 1969 were from one ship which occupied Ocean Station *P* (OSP) for alternate 6 week periods, whereas samples since 1969 were taken on a nearly continuous basis. Data collected from ships of opportunity sampling within 1° (96.6 km) of OSP are also included in the dataset.

Vertical hauls were taken daily during daylight, usually in the morning, depending on weather and other duties. Occasionally more than one sample was taken in a day. A standard haul consisted of hauling the net from 150 m to the surface at 1 m/s. The ship was manoeuvred during sampling to attempt to keep the wire vertical; wire angle and the length of wire out were recorded. The nets were considered 100% efficient and estimates of volume of water filtered were considered to be the product of the mouth opening area and the wire out. All samples were preserved in 1.5% formalin and analyzed on shore.

2.0 NETS AND INTERCALIBRATION

Different nets were used throughout the years to collect zooplankton at OSP, although all had mesh sizes of 351 microns. A NORPAC conical net of white Nitex with a mouth opening of 42 cm diameter, a mouth area of 0.16 m^2, and a filtration ratio of 4.9:1 was used until 1966. This was subsequently replaced with a modified cylinder-cone design SCOR net having a mouth area of 0.25 m^2 and a filtration ratio of 14.7:1. In 1966 and 1967, both dark and light coloured SCOR nets were used, frequently as replicate tows. From 1968 onwards, only dark coloured nets were used. A Miller net with a 0.10 m^2 mouth opening was occasionally used.

The data cannot be considered as one continuous time series unless an adequate calibration between the NORPAC and SCOR nets is available. Paired tows using both net types were performed in July, 1967 (11 paired samples) and again in March, 1968 (9 paired samples) to calibrate the nets. The data collected were zooplankton wet weights standardized to 150 m tows. Fulton (1983) recommended multiplying the NORPAC wet weights by 1.5 to equate them with the SCOR samples. Unfortunately, we were unable to reproduce his result with the paired samples that he reported, and Fulton never documented his method. Fulton (1983) also referred to LeBrasseur *et al.* (1967) for information on calibrating nets, but this also did not assist in resolving how he calculated the 1.5 calibration factor.

We examined four simple methods of computing a conversion factor using three datasets. The paired tow data from July, 1967, and March, 1968, were treated separately and as a combined sample. We computed summary statistics (mean and median) of the ratios of paired SCOR:NORPAC samples, linear regressions of SCOR versus NORPAC, and errors-in-variables regressions (Fuller 1987) of SCOR versus NORPAC samples. For the errors-in-variables regressions, we assumed that the variances of the two net types were equal. The results are as follows:

	July 1967	March 1968	Combined
Ratio means	2.10	1.39	1.78
Ratio medians	1.95	1.28	1.63
Linear regression slope	1.92	0.96	2.04
Errors in variables regression slope	2.36	1.29	2.28

The linear regressions clearly violate the model assumptions, i.e. the independent variable includes measurement error that is likely as great as the dependent variable. Confidence intervals for the slopes determined from the errors-in-variables regressions do not overlap between the two sampling periods (July: 2.11-2.61, March: 1.04-1.55), suggesting that the calibration may require a seasonal component. The full errors-in-variables regression equations are as follows:

July 1967: SCOR= -28.42 + 2.36 * NORPAC
March 1968: SCOR= - 0.54 + 1.29 * NORPAC
Combined: SCOR= -19.03 + 2.28 * NORPAC

As a result of the above findings, we have made the following conclusions:

1. Fulton's conversion factor (SCOR=NORPAC*1.5) should not be used;
2. Additional paired NORPAC:SCOR samples of net zooplankton will be required to reduce the uncertainty in the estimates of appropriate conversion factors;
3. Additional samples will be required to determine the seasonal effect on net calibrations;
4. Researchers using the entire series (1956-1980) should explicitly consider uncertainty in the estimates of conversion factor before drawing conclusions;
5. Conversion factors based on least squares linear regressions should not be used;
6. The need for taxa-specific conversion factors should be considered.

3.0 SAMPLE ANALYSIS

Dr. R. J. LeBrasseur and J. D. Fulton, both formerly of the Pacific Biological Station, Nanaimo, B.C., analyzed the early zooplankton samples. Total zooplankton biomass (wet weight) (mg/m^3) was calculated for all samples for all years, 1956 to 1980 (with

medusae and salps removed). Medusae and salps were counted for all samples from 1965 to 1980. Samples from 1965 through 1968 were processed by the Canadian Aquatic Identification Center (CAIC), a branch of the National Museums of Canada. These samples were analyzed to five general taxonomic groupings: (1) copepods; (2) chaetognaths; (3) euphausiids; (4) amphipods; and (5) *Aglantha* (medusae). Samples taken from 1969 through 1980 were processed by four technicians at the Pacific Biological Station, and were identified to the species level or to the closest taxonomic division. Depending on the sample size, either whole samples were examined, or subsamples were taken with a Folsom plankton splitter to limit the size of the aliquot to between 1,000 and 5,000 organisms. Initially every fifth sample was processed as completely as possible, then "gaps" in the data were filled in later by re-examining the samples. All samples collected in 1971 and 1972 have been completely analyzed to the species level.

Note that LeBrasseur (1965) published results for zooplankton samples collected from 1956 to 1964. These data included total sample weights (g), biomass (g/1000 m^3) for seven main taxa, and estimates of percentage of sample composition for five other categories. However, he did not publish densities for these taxa, which were the main component of Fulton's dataset for the remaining years, so his data could not be included in the new dataset. Instead, we have included a separate file of these data on the diskette. Appendix 2 provides a description of the format for these data. LeBrasseur (1965) also mentions that organisms collected from 1956 to 1964 were identified to the species level, counted, and in some cases measured. Unfortunately, these data were only presented as figures, and we could not find the raw data.

4.0 DATA FORMAT FOR 'OSPZOO.DAT'

The diskette at the back of this document contains an ASCII file called 'OSPZOO.DAT' which contains zooplankton data collected at OSP from 1956 to 1980. The data are formatted so that each line contains both the bridge log and species/taxon data, with each species/taxon caught within a sample on a separate line.

Column	
2 - 4	Cruise - cruise number within that year (i.e., cruise numbers are not unique across years). Note that if the last cruise of the year goes beyond December 31, the year changes to the new year but the cruise number stays the same.
5 - 7	Technician Initials (alpha) - we believe these are the initials of the person who analyzed the sample.
8 - 12	Sample Number - sample numbers run consecutively and start at 1001 at the beginning of each cruise.
13 - 16	Time - Local Standard Time.
17 - 22	Day, Month, and Year - DY,MO,YR

23 - 24	Gear (alpha) - net type used for the plankton haul and is coded: N - NORPAC (mouth area 0.16 m^2) WS - White SCOR (mouth area 0.25 m^2) S4 - Dark coloured SCOR (mouth area 0.25 m^2) M - Miller net (mouth area 0.10 m^2)
26 - 28	Sample Depth (m)
29 - 30	Wire Angle (°)
31	Sample Analysis Status (alpha) - complete (C), partially complete (P), or incomplete (I) sample analysis
33 - 38	Sample Weight (g) - *Aglantha* was removed from all samples before weighing. When jellyfish or phytoplankton were too abundant to remove from the sample, wet weights were not taken. This is indicated by '-1'.
40 - 47	Wet Weight Biomass (mg/m^3) - again, '-1' indicates that wet weight was not taken.
49 - 51	Species Code (alpha) - Appendix 3 contains the list of species codes and names.
53 - 55	Size (mm) - body length
57 - 62	Count - total number/sample
64 - 69	Density - number/m^3

5.0 PRECAUTIONS AND UNCERTAINTIES

(1) Note that not all of the samples were fully analyzed. However, to indicate to what extent a sample has been analyzed, we added a variable to the dataset ("C" for complete (all animals identified to species level); "P" for partially complete (all animals identified, but the majority to general taxa only); and "I" for incomplete (only animals from the five general taxa identified, or only larger animals identified and then only to general taxa (e.g., fish larvae, cephalopods, siphonophores, etc.), and/or biomass weighed only)).

(2) In our opinion, data for the NORPAC and SCOR nets have not been adequately calibrated, and we do not have calibration factors we consider valid at present. Therefore, when using the dataset, be careful to select for net type before performing analyses on the data.

(3) If there was no value recorded or available for a numeric field, then it was indicated by a '.'. The only exceptions were total sample weight and zooplankton weight/m^3, where a '-1' indicated there was no value recorded because the sample was contaminated by an overabundance of jellyfish.

(4) Sample number is not necessarily unique within a cruise. Individual samples should be identified using the year, month, day, time, sample number, and the technicians initials, or there could be problems with misidentification of individual samples.

(5) Samples taken with wire angles of 35° or greater (due to high winds or strong currents) or more than 180 m of wire out were not considered as quantitative and were not used in the analysis of data in Fulton (1983). We have included these samples in the dataset, and have left it to the user to decide whether to keep them or discard them. In addition, Fulton (1983) warned the samples taken with wire angles >25° or from depths >165 m should also be used with caution.

(6) Cruise 68-1 (lines 4984 to 5036): samples collected on two consecutive dates were numbered '32', one on 09/03/68 and the next on 11/03/68.

(7) Cruise 68-1 (lines 5062 to 5092 and 5113 to 5140): two samples were numbered '45', one on 15/03/68 and the second on 16/03/68.

(8) Cruise 69-6 (lines 7967 to 8015): two samples were numbered '62', one on 13/09/69 and the next on 19/09/69.

(9) Cruise 71-2, Sample 8 (lines 12467 to 12485): the amphipod density in Fulton (1983) is incorrect. It should be 0.08, not 0.00.

(10) Cruise 71-8 (lines 15427 to 15464): Sample 35 has been entered twice, and both entries look suspiciously similar. The only differences involve the species 'RG1'.

(11) Cruise 75-4 (lines 26319 to 26324): two samples were numbered '8', one on 21/05/75 and the next on 22/05/75.

(12) Cruise 77-3 (lines 30995 to 31070): Sample 12 was identified twice, by two different people. In other words, there are two different species counts of the same sample by two different people.

(13) Cruise 77-4 (lines 31348 to 31422): Sample 4 was identified twice, by the same person (all data were the same for both entries except for species counts). In other words, there are two different species counts of the same sample by one person.

(14) Cruise 78-4 As mentioned in Fulton (1983), extra samples were taken during Cruise 78-4. Three twenty-four-hour series have the sample prefixes SA (lines 35957-36624), SB (lines 37457-37559), and SC (lines 38389-38499) (18 samples each series). Fifteen samples taken from non-standard depths are indicated by the prefix VD (lines 37189-37208 and 38540-38579). Additionally, where sample numbers, dates and time coincide, replicate counts have been made; the distinguishing difference is the sample technicians's initials (i.e., two people analyzed two different fractions of the sample and got two different counts of the species). The weights are the same for both samples because it represents the total weight, only the species counts are different. There were three sampling series like this during Cruise 78-4: (1) lines 34915-35765; (2) lines 36737-37188; and (3) lines 37711-38235.

(15) Cruise 79-5 (lines 41665-41717): It appears that Sample 23 was analyzed twice, and the

only distinguishing difference is the technician's initials ('BC1' versus 'BC2'). In Fulton (1983), the second sample (contaminated with jellyfish) was deleted from the listing. It is included in the original file ('ZOOP6880.DAT') and in OSPZOO.DAT.

OSPZOO.DAT has 45,254 records and has a file size of 3,213,035 bytes. Appendix 3 contains the species codes and the species identifications or taxonomic groupings associated with them for all the species listed in OSPZOO.DAT.

ACKNOWLEDGMENTS

We would like to acknowledge Dr. Robin LeBrasseur, the late John Fulton, and Dr. Cary McAllister for their many years of involvement in the monumental task of obtaining and analyzing the zooplankton samples. The data in this report are, for the most part, the product of their endeavours. We have only corrected minor errors, and refined and reformatted their detailed data to make it available in electronic format. Many others were also involved in collecting and/or analyzing the zooplankton samples (further acknowledgements are provided in Fulton (1983)). We would also like to thank Dr. Ian Perry for reviewing the manuscript and providing helpful suggestions.

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Appendix 1. Documentation of errors detected in the original data ('ZOOP5667.DAT' and 'ZOOP6880.DAT') and the creation of the new data file ('OSPZOO.DAT')

Two data files were used to create the new, complete file of zooplankton data collected at OSP for the years 1956 to 1980. The first file is called 'ZOOP5667.DAT' and contains the 1956 to 1967 summary data as presented in the first part of Fulton (1983). The second file is called 'ZOOP6880.DAT' and contains more detailed species information for samples collected from 1968 to 1980. This second file was used to produce summaries of the data presented in the latter part of Fulton (1983). ZOOP6880.DAT contains a few errors, and consequently the reports do as well. The following is a description of the original data files, the corrections that were made, how the corrections affected the results reported in Fulton (1983), and how a new corrected dataset (OSPZOO.DAT) was created.

1.0 1956-1967 DATA

1.1 FORMAT

ZOOP5667.DAT is simply a file that contains the summary data for the years 1956 to 1967 as presented in Fulton (1983). It does not contain the original data so it cannot be checked for errors. The format for reading ZOOP5667.DAT is as follows:

Column	
1 - 2	Year
4 - 5	Cruise - cruise number for that year. Ships of opportunity used their own cruise numbers.
6 - 10	Sample Number - sample numbers run consecutively and start at 1001 at the beginning of each cruise. Alpha codes are vessel codes for ships of opportunity samples.
11 - 14	Day, Month - DY, MO
20 - 26	Wet Weight Biomass (mg/m^3)
29 - 34	Copepod Density ($\#/m^3$)
37 - 42	Chaetognath Density ($\#/m^3$)
45 - 50	Euphausiid Density ($\#/m^3$)
53 - 58	Amphipod Density ($\#/m^3$)
61 - 66	*Aglantha* Density ($\#/m^3$)
67 - 68	Wire Angle (°)
69 - 72	Sample Depth (m)
73 - 74	Gear (alpha) - net type used for the plankton haul and is coded: N - NORPAC

WS - White SCOR
S4 - Dark coloured SCOR
M - Miller net

75 - 76 Remarks (alpha): (we did not use this field)
T - 'transition' species (usually salps)
NS - night samples? (10 occurrences)

From these data we were able to calculate the total sample weight (g) by multiplying the zooplankton biomass (mg/m^3) by the net's mouth area (m^2) and the sample depth (m), and then dividing by 1000. We were also able to calculate the count for each of the five taxa by multiplying the densities (numbers/1000 m^3) by the net's mouth area (m^2) and the sample depth (m). The data were then reformatted so that each of the taxa (with bridge data included) are now on separate lines in OSPZOO.DAT.

1.2 PRECAUTIONS AND CHANGES

(1) Note that the cruise numbers for the samples collected by the ships of opportunity are different from the cruise numbers for the regular samples. The data collected from the ships of opportunity were merged with the regular data by date.
(2) It was noticed that all of the samples collected by the Miller net had densities of zero (0.0) for all of the taxonomic groups. We believe this was unlikely and that rather than having zero densities, these samples were probably not analyzed and should have had no values. Therefore we changed all of the zero densities for the Miller samples to '.' (i.e., changed '0.0' to '.'), indicating there were no values for the densities.

2.0 1968-1980 DATA

2.1 FORMAT

ZOOP6880.DAT contains original data with two types of records, the 'bridge' or 'header' data, and the 'species data'. The two types of records are intermixed within the file, with the header record always preceding the species records for each sample. There are indicators at the end of each record to signal what type of record it is; if the last character at the end of a record is an 'H', then it is a header record, but if it is either ':' or '/' then it is a species record. A ':' in the last column of a record indicates that the species data for that sample are continued on the next line, whereas a '/' indicates the current record is the last species record for that sample.

Bridge Data Records:

Column	
1	Project - (always 1 - we did not use this field)
2 - 4	Cruise - cruise number within that year
5 - 7	Technician's Initials (alpha) - we believe these are the initials of the person who analyzed the sample.
8	Type - (always 0 or blank) - meaning unknown
9 - 12	Sample Number - sample numbers run consecutively and start at 1001 at the beginning of each cruise.
13 - 16	Time - Local Standard Time.
17 - 22	Day, Month, Year - DY,MO,YR
23 - 24	Gear (alpha) - net type used for the plankton haul and is coded: N - NORPAC S4 - Dark coloured SCOR M - Miller net
25 - 28	Sample Depth (m)
29 - 30	Wire Angle (°)
67 - 70	Sample Weight (g) - when jellyfish or phytoplankton were too abundant to remove from the sample, wet weights were not taken. This was indicated by a "J", but we have changed this to a '-1' in the new dataset.
71 - 74	Calibration Factor - converts to weights/1000 m^3 or densities/1000 m^3
89	'H' to indicate it is a 'Header' record

Species Records:

Column	
1 - 22	Replicated from above
23 - 25	Species Code (alpha) - see Appendix 3 for species codes and names
26 - 28	Size (mm) - body lengths
29 - 33	Count (total number/sample)
The last three fields are repeated to column 88	
89	'End of species data' Indicator: ':' = species data continued on next line '/' = end of species data

Note that the first record in 1968 is missing, but it is also missing in the report (Fulton 1983). Also note that data collected in early 1981 is from the end of the 1980 cruise.

3.0 ERROR CHECKS AND CHANGES

We reformatted the data from ZOOP6880.DAT and created OSPZOO.DAT, a file with one line of data for each species with the header (or bridge) information at the

beginning of each line (i.e., the bridge and species data are combined in one line of data for each species in a sample). OSPZOO.DAT was then run through another program that listed all the values and frequencies of each value within each field of the data. This was used to check whether the data within each field were reasonable (e.g., were numbers in character fields or vice versa?), and to identify any outliers.

3.1 SPECIES CODE ERRORS

Appendix 3 contains the species codes and the species identifications or taxonomic groupings associated with them for all the species listed in ZOOP6880.DAT (file obtained from Fulton's magnetic tape). There are many codes in this list that do not have species associated with them, and we do not know what they represent. Some of the species codes were incorrect or duplicated. The following changes were made to the species codes ('old' codes are in ZOOP6880.DAT, and 'new' codes are in OSPZOO.DAT):

Old Species code		New Species code
1.0		Deleted (we believe this is the size and that the species code was missing)
5A0	--->	SA0
5G0	--->	SG0
BO3	--->	B03
BI2	--->	B12
BI5	--->	B15
J10	--->	JI0
RKO	--->	RK0
R00	--->	RO0
SA4	--->	RW4
SG4	--->	SE4
SL4	--->	SJ4
TU3	--->	TV3
XFA	--->	XF4
Z09	--->	ZO9

Note also that the species code 'TM0' was not listed in the species code list, but we believe it is a copepod. It only occurs once.

3.2 DENSITY ERRORS

The data from ZOOP6880.DAT were summarized in Fulton (1983). Densities (numbers/m^3) of each of the five taxonomic groups (copepods, chaetognaths, euphausiids, amphipods, and *Aglantha* (medusae)) were calculated by adding together all of the species from each of the taxonomic groups (separately) and dividing by the product of the net's

mouth area and the sample depth. Species that were not included in one of these five taxonomic groupings were not reported in Fulton (1978, 1983), but are included in OSPZOO.DAT. Species codes or species counts were occasionally input into the original dataset (ZOOP6880.DAT) incorrectly (as mentioned above), and as a result, some of the densities of the five taxonomic groups in Fulton (1983) are reported incorrectly. Not all errors in the dataset resulted in errors in the report (e.g., if the count for the incorrect species code was low, or if the species was not in one of the five taxonomic groups reported in the reports).

3.2.1 Density Errors Due to Incorrect Species Codes

The following are the corrections to densities reported in Fulton (1983) due to corrections to the species codes, as listed above (line # is where the error occurred in ZOOP6880.DAT; '*' means there are other errors in the same line; 'NC' means corrections resulted in 'no change' to reported density; errors were corrected for OSPZOO.DAT):

'SA5' was incorrectly typed as '5SA':
Line 8582 - Cruise 79-7, Sample 10, 12/10/79 - changes copepod density from 4.7 to 6.5.

'5G0' was incorrectly typed as '5GO':
Line 7789 - Cruise 78-6, Sample 17, 29/08/78 - NC to copepod density.

'B03' was incorrectly typed as 'BO3' - Changes chaetognath density for:

Line#	Cruise	Sample	Date	# Occurrences	Old Value	New Value
1463	70-6	15	25/08/70	3	11.5	NC
1733	70-9	6	01/01/71	2	5.1*	NC
4547	74-9	1	01/11/74	1	0.1*	NC
4691	75-2	23	07/03/75	2	1.5*	NC
4707	75-2	29	11/03/75	3	2.3*	NC
4976	75-5	8	26/06/75	1	4.7	NC
4981	75-5	11	27/06/75	2	5.4	NC
4885	75-5	14	28/05/75	1	1.2	NC
4988	75-5	17	29/06/85	3	4.6	NC
4992	75-5	20	30/06/75	1	3.3	NC
5013	75-5	28	04/07/75	2	5.8	NC
5021	75-5	32	06/07/75	2	5.4	NC
5026	75-5	34	07/07/75	2	3.6	NC
5031	75-5	36	08/07/75	2	5.6	NC
5038	75-5	38	09/07/75	2	4.0	NC
5042	75-5	41	10/07/75	2	4.2	NC
5049	75-5	44	11/07/75	2	5.3	NC
5053	75-5	47	12/07/75	2	4.6	NC
5059	75-5	53	15/07/75	1	4.2	NC
5064	75-5	57	18/07/75	2	5.2	NC
5070	75-5	59	19/07/75	2	3.2	NC
5078	75-5	65	21/07/75	1	2.6	NC
5081	75-5	67	22/07/75	1	1.0	NC
5086	75-5	72	25/07/75	2	1.8	NC
5090	75-5	74	26/07/75	2	3.0	NC
5099	75-5	79	28/07/75	2	3.5	NC
5108	75-5	87	31/07/75	2	4.6	NC
5114	75-5	89	01/08/75	2	4.6	NC
7459	78-4	21	08/06/78	2	14.0	NC

'B12' was incorrectly typed as 'BI2':
Line 4547 - Cruise 74-9, Sample 1, 01/11/74 - NC to chaetognath density
Line 4690 - Cruise 75-2, Sample 23, 07/03/75 - NC "

'B15' was incorrectly typed as 'BI5' - Changes chaetognath density for:
Line 1733 - Cruise 70-9, Sample 6, 01/01/71 - NC to chaetognath density
Line 3176 - Cruise 73-3, Sample 12, 19/04/73 - NC "
Line 4691 - Cruise 75-2, Sample 23, 07/03/75 - NC "
Line 4707 - Cruise 75-2, Sample 29, 11/03/75 - NC "

'RK0' was incorrectly typed as 'RKO' - Changes copepod density for:
Line 180 - Cruise 68-2, Sample 3, 23/05/68 - from 108.8 to 137.0
Line 263 - Cruise 68-2, Sample 46, 13/06/68 - from 67.8 to 84.5

'TV3' was incorrectly typed as 'TU3' - Changes copepod density for:
Line 1197 - Cruise 70-5, Sample 18, 09/07/70 - from 216.3 to 221.4
Line 1216 - Cruise 70-5, Sample 24, 12/07/70 - from 173.3 to 177.2
Line 1612 - Cruise 70-6, Sample 38, 16/09/70 - from 56.1 to 56.4
Line 1625 - Cruise 70-6, Sample 40, 18/09/70 - from 35.8 to 36.4

3.2.1 Density Errors Due to Incorrect Species Counts

The following errors, due to incorrect species counts, were observed in ZOOP6880.DAT and corrected for OSPZOO.DAT (line numbers refer to ZOOP6880.DAT):

Line 7: Cruise 68-1, Sample 3: the count for one of the species was in the wrong column.
Error: 'PS04.5 2 XM5'
Correction: 'PS04.5 2XM5' (No change in density)

Line 53: Cruise 68-1, Sample 21: the count for one of the species was in the wrong column.
Error: '3B038.5 41 C716.5'
Correction: '3B038.5 41C716.5'
As a result, the chaetognath density in Fulton (1983) changes from 10.9 to 1.09.

Line 313: Cruise 68-2, Sample 73: data are in the wrong columns. Sizes don't appear to be ever given for either PC0 or PF6 in the dataset. Therefore the count for PC0 and PF6 species have been put in the wrong columns.
Error: 'PC0 336PF6 40'
Correction: 'PC0 336PF6 40 ' (No change in density)

Line 2985: Cruise 72-6, Sample 4: the count for one of the species was incorrect.
Error: 'B037.5 C90'
Correction: 'B037.5 90' (No change in density)

Line 3366: Cruise 73-5, Sample 12: the count for one of the species was in the wrong column. Error: '8PI010. 15 :'
Correction: '8PI010. 15:' (No change in density)

Line 4992: Cruise 75-5, Sample 20: the count for the species code 'PF6' was '2 0' and it was changed to '20'. (No change in density)

Line 5858: Cruise 77-1, Sample 21: the count for one of the species was in the wrong column. Error: '15PC012. 1 /'
Correction: '15PC012. 1/'
As a result, the *Aglantha* density in Fulton (1983) changes from 4.6 to 1.92.

Line 5964: Cruise 77-3, Sample 14: the count for one of the species was in the wrong column. Error: '7PF68.0 3 PS315.'
Correction: '7PF68.0 3PS315.' (No change in density)

Line 6127: Cruise 77-4, Sample 21: the count for one of the species was in the wrong column. Error: '744RN02.0 360 RO07.0'
Correction: '744RN02.0 360RO07.0'
As a result, the copepod density in Fulton (1983) changes from 215.7 to 129.28.

Line 6170: Cruise 77-5, Sample 2: the count for one of the species was in the wrong column. Error: '12C713.0 108 C715.0'
Correction: '12C713.0 108C715.0' (No change in density)

Line 6713: Cruise 78-3, Sample 9: the count for the last species code was in the wrong column. Error: 'D670.5 12 /'
Correction: 'D670.5 12 /' (No change in density)

Line 6735: Cruise 78-3, Sample 12: the count for one of the species was in the wrong column. Error: '104D660.3 24'
Correction: '104D660.3 24 ' (No change in density)

Line 7110: Cruise 78-4, Sample SA05: species code is '168' and size 'C70' - these are either reversed, or the number is the count from the previous species. We believe '168' is the count for the previous species and that it was put in the wrong column, and that species 'C70' has no size. Error: 'B158.0 168C70 80'
Correction: 'B158.0 168C70 80'
As a result, the chaetognath density in Fulton (1983) changes from 2.1 to 6.61.

Line 7258: Cruise 78-4, Sample 13: the count of one of the species was in the wrong column. Error: '424RO07.0 24 RO05.0'
Correction: '424RO07.0 24RO05.0'
As a result, the copepod density in Fulton (1983) changes from 173.9 to 110.51.

Line 7799: Cruise 78-6, Sample 20: the count of the last species code is in the wrong column.
Error: 'ZQ90.5 16 /'
Correction: 'ZQ90.5 16 /' (No change in density)

Line 7812: Cruise 78-7, Sample 1: the count of the last species code is in the wrong column.
Error: 'PS02.5 36 /'
Correction: 'PS02.5 36 /' (No change in density)

Line 7995: Cruise 78-9, Sample 8: the count for one of the species was in the wrong column.
Error: '9XM012. 1'
Correction: '9XM012. 1 ' (No change in density)

Line 8352: Cruise 79-4, Sample 32: the count for one of the species was in the wrong column.
Error: '160B155.0 384'
Correction: '160B155.0 384 '
As a result, the chaetognath density in Fulton (1983) changes from 4.5 to 14.7.

Line 8466: Cruise 79-6, Sample 13: the count for one of the species was in the wrong column.
Error: '32RO07.5 28 RM0'
Correction: '32RO07.5 28RM0'
As a result, the copepod density in Fulton (1983) changes from 30.7 to 24.0.

Line 8704: Cruise 80-1, Sample 4: the count for the last species code was in the wrong column.
Error: 'B0320. 2 (32 spaces) /'
Correction: 'B0320. 2 (33 spaces) /' (No change in density)

Line 9198: Cruise 80-9, Sample 7: the count for the last species code was in the wrong column.
Error: 'XM015. 1 (10 spaces) /'
Correction: 'XM015. 1 (11 spaces) /' (No change in density)

3.3 SPECIES SIZE ERRORS

We discovered a 'list of known errors' in John Fulton's paper archives, all dealing with errors in species size. The following errors were noted in ZOOP6880.DAT and corrected for OSPZOO.DAT (line numbers refer to ZOOP6880.DAT):

Line 986: Cruise 70-3, Sample 10: the size for the species code JI0 was incorrect and was changed from 340 to 3.0.

Line 1068: Cruise 70-3, Sample 24: the size for the species code PC0 was incorrect and was changed from 11b to 11..

Line 1767: Cruise 71-2, Sample 22: the size for the species code RQ0 was incorrect and was

changed from 7.2 to 1.2.

Line 1809: Cruise 71-2, Sample 69: the size for the species code RQ0 was incorrect and was changed from 7.5 to 1.5.

Line 5905: Cruise 77-2, Sample 7: the size for the species code SA0 was incorrect and was changed from 25. to 2.5.

Line 6572: Cruise 77-9 (1978), Sample 23: the size for the species code PS3 was incorrect and was changed from 340 to 3.0.

3.4 MISCELLANEOUS ERRORS

The following miscellaneous errors were noted in ZOOP6880.DAT and corrected for OSPZOO.DAT (line numbers refer to ZOOP6880.DAT):

Line 142: Cruise 68-1, Sample 69: the size for 'C71' is 13.6, which is 4 columns wide when it should only be 3 columns. This is either a typo or just not rounded to 3 columns? The possibilities are: 13., 14., 3.6, 1.6. The next size given for C71 in the same sample is 6.3, and since the sizes were usually given from smallest to largest, we decided that there was probably an extra '1' typed in by mistake, and the size should have been 3.6.

Error: 'C7113.6 '
Correction: 'C713.6 '

Lines 150 to 157: Cruise 68-1: the sample number was incorrect - sample '82' should be '81'.

Error: ' 108212'
Correction: ' 108112'

Line 3139: Cruise 73-1, Sample 1: the wire angle was in the wrong column.

Error: '160 20'
Correction: '16020'

Line 3195: Cruise 73-3, Sample 19: the wire angle was incorrect.

Error: '150025'
Correction: '15025'

Line 3542: Cruise 73-5, Sample 36: the size was incorrect for the species code PT2, and was changed from 220 to a blank.

Line 3619: Cruise 73-6, Sample 4: the wire angle was incorrect.

Error: '160025'
Correction: '16025'

Line 4802: Cruise 75-3, Sample 38: the wire angle was incorrect.
Error: '157017'
Correction: '15717'

Line 4829: Cruise 75-3, Sample 42: the wire angle was incorrect.
Error: '155010'
Correction: '15510'

Line 4991: Cruise 75-5, Sample 20: the wire angle was incorrect.
Error: '150008'
Correction: '15008'

Line 5107: Cruise 75-5, Sample 87: the wire angle was incorrect.
Error: '170010'
Correction: '17010'

Lines 5116-5123: Cruise 75-7, Sample 1: the project code was incorrect (typo?) and was changed from 5 to 1. (We did not use the project code in the new dataset).

Line 5169: Cruise 75-7, Sample 37: the wire angle was incorrect.
Error: '150000'
Correction: '15000'

Line 5226: Cruise 76-1, Sample 4: the wire angle was incorrect.
Error: '150025'
Correction: '15025'

Lines 5384-5386: Cruise 76-4, Sample 33: the project code was incorrect (typo?) and was changed from 6 to 1. (We did not use the project code in the new dataset).

Line 5420: Cruise 76-4, Sample 38: the wire angle was incorrect.
Error: '150027'
Correction: '15027'

Line 6203: Cruise 77-5, Sample 11: the wire angle was incorrect.
Error: '150019'
Correction: '15019'

Line 6578: Cruise 78-1, Sample 1: the wire angle was incorrect.
Error: '150031'
Correction: '15031'
Also sample weight was incorrect.
Error: '0 .8'
Correction: ' 0.8'

Line 6584: Cruise 78-1, Sample 3: the wire angle was incorrect.
Error: '150010'
Correction: '15010'

Line 6591: Cruise 78-1, Sample 4: the wire angle was incorrect.
Error: '150005'
Correction: '15005'

Line 6599: Cruise 78-1, Sample 5: the wire angle was incorrect.
Error: '150010'
Correction: '15010'

Line 6606: Cruise 78-1, Sample 7: the wire angle was incorrect.
Error: '150020'
Correction: '15020'

Lines 7215-7222: Cruise 78-4, Sample 10: the project code was incorrect (typo?) and was changed from 0 to 1. (We did not use the project code in the new dataset).

Line 7575: Cruise 78-4, Sample 25: the size for the species code C70 was incorrect and was changed from 610 to a blank.

There were many instances where blanks occurred in the species data records. They were either in the middle of a line or at the end of the line, and the remainder of the species coding for that sample continued on the next line. Our FORTRAN program that read ZOOP6880.DAT and created OSPZOO.DAT was re-written to check for blanks in the species information and skip these sections. Examples of blanks in the species data in ZOOP6880.DAT are on lines 6055 (middle of line), 6637 (several at end of line), and 6746 (one in the middle and one at the end of the line). The spaces may be where data were originally deleted, but we are not certain.

Appendix 2. Supplementary data file from LeBrasseur (1965) (LEBR5664.DAT).

LeBrasseur (1965) published data for samples collected from 1956 to 1964, including total sample weights (to 0.1 g), total zooplankton biomass (wet weight, to 0.1 g/1000 m^3), biomass for seven major taxa (copepods, euphausiids, amphipods, decapods, chaetognaths, pteropods, and cephalopods), and the percentage of sample wet weights for five other minor taxa or categories (medusae, *Tomopteris*, ostracods, *Oikopleura*, and eggs). He also discussed species composition and length measurements, and presented figures for these data, but he did not provide detailed density information (i.e., the raw data are not available). Since these data are not compatible with our dataset, OSPZOO.DAT, but are none the less valuable, we decided to include a file with LeBrasseur's (1965) data (LEBR5664.DAT) on the enclosed diskette.

1.0 FORMAT

Column	
1 - 3	Data collected by the weathership (WS) or by a ship of opportunity (S#)
5 - 6	Cruise - cruise number (note that unlike OSPZOO.DAT, cruise numbers are unique for each year. Also note that ships of opportunity use their own cruise numbers, and they do not correspond to LeBrasseur's cruise numbers).
8 - 9	Sample Number - sample numbers run consecutively and start at 1 at the beginning of each cruise. Again note that ships of opportunity also use their own sample numbers.
11 - 16	Day, Month, and Year - DY,MO,YR
18 - 21	Sample Weight (X.X g)
23 - 27	Total wet weight biomass (XXX.X g/1000 m^3)
29 - 33	Copepod wet weight biomass (XXX.X g/1000 m^3)
35 - 38	Euphausiid wet weight biomass (XX.X g/1000 m^3)
40 - 43	Amphipod wet weight biomass (XX.X g/1000 m^3)
45 - 48	Decapod wet weight biomass (XX.X g/1000 m^3)
50 - 53	Chaetognath wet weight biomass (XX.X g/1000 m^3)
55 - 58	Pteropod wet weight biomass (XX.X g/1000 m^3)
60 - 64	Cephalopod wet weight biomass (XXX.X g/1000 m^3)
66 - 67	% Medusae of sample wet weight (TR = trace)
69 - 70	% *Tomopteris* of sample wet weight (TR = trace)
72 - 73	% Ostracods of sample wet weight (TR = trace)
75 - 76	% *Oikopleura* of sample wet weight (TR = trace)
78 - 79	% eggs of sample wet weight (TR = trace)
81 - 83	Sample Depth (m)

Appendix 3. Species codes and their associated taxonomic classifications.

CODE	SPECIES
A70	Cyphonautes sp.
A90	Chaetognatha (General)
A93	Chaetognatha juvenile
BJ0	
BO0	Sagitta sp.
B03	Sagitta elegans
B12	Sagitta scrippsae
B13	
B15	Eukrohnia hamata
C70	Larvacea (General)
C71	Oikopleura sp.
C73	Oikpleura labradorensis
C75	Fritillaria borealis
C90	Ascidiacea (General)
C93	
C96	Thaliacea (General)
C97	Doliolium sp.
C98	Thalia democratica
C99	Salpa aspera
D00	Salpa maxima
D01	Salpa fusiformis
D02	Doliolium gregenbauri
D60	Eggs (General)
D66	Eggs 300-400 um
D67	Eggs 400 um
D77	
D80	
D81	Fish larva
DF6	
FD0	
HL0	
JE0	
JI0	Cyclops sp.
JI1	
KS3	
PA0	Coelenterata (General)
PA3	Medusae (General)
PA8	Hybocodon prolifera
PB0	
PB1	Rathkea octopunctata
PC0	Aglantha digitale
PC3	Aegina citrea
PC6	Proboscidactyla flavicirrata
PD0	
PE0	Siphonophora (General)
PE1	Siphonophora larvae
PF0	Muggia atlantica
PF4	
PF6	Dimophyes arctica
PF9	Chelophyes appendiculata
PG4	Velella sp.
PG7	Agalma sp.
PG9	
PI0	Ctenophora (General)
P10	
PI1	Ctenophora larva
PI4	Pleurobrachia pileus
P14	
PJ0	Beroe cucumis

CODE	SPECIES
PP3	
PQ0	Annelida (General)
PR0	Polychaeta (General)
PR2	Polychaeta larva
PS0	Tomopteris sp.
PS3	Tomopteris septentrionalis
PS4	
PS6	Tomopteris renata
PS9	Typhloscolex mulleri
PT2	Rhynchonerella angelini
PT5	Poebius meseres
PT8	Callizona angelini
PU0	
PW4	
RG0	
RG1	Ostracoda (General)
RG5	Conchoecia sp.
RG6	
RG8	Conchoecia alata minor
RK0	Copepoda (General)
RK2	Copepoda nauplius
RK6	Caligus sp.
RK8	
RL0	Calanus sp.
RM0	Calanus pacificus
RM3	Calanus pacificus I-V
RM4	Calanus pacificus VI
RM6	Calanus pacificus VI females
RN0	Neocalanus plumchrus
RN3	Neocalanus plumchrus I-IV
RN4	Neocalanus plumchrus V
RN7	Neocalanus plumchrus VI females
RO0	Neocalanus cristatus
RO3	Neocalanus cristatus I-IV
RO4	Neocalanus cristatus V
RQ0	Pseudocalanus sp.
RQ1	Pseudocalanus egg
RQ3	Pseudocalanus copepodite
RQ4	Pseudocalanus adult
RR8	Pseudocalanus minutus adult males
RS0	Eucalanus sp.
RS3	Eucalanus copepodite
RS4	Eucalanus adult
RS7	Eucalanus bungi VI females
RU0	Euchaeta sp.
RU3	Euchaeta copepodite
RU4	Euchaeta adult
RW0	Metridia sp.
RW3	Metridia copepodite
RW4	Metridia adult
RZ0	Metridia okhotensis
SA0	Metridia pacifica
SB0	Acartia sp.
SB4	Acartia adult
SC0	Acartia clausi
SD0	Acartia longiremis
SE0	Aetidius sp.
SE4	Aetidius adult
SF0	Aetidius armatus

Appendix 3. Cont.'d.

CODE	SPECIES
SG0	Aetidius pacificus
SG9	Aetidius pacificus adult females
SJ0	Candacia sp.
SJ3	Candacia copepodite
SJ4	Candacia adult
SK0	Candacia bipinnata
SK6	Candacia bipinnata VI female
SL0	Candacia columbiae
SM3	Centropages copepodite
SP0	Clausocalanus sp.
SR4	Chiridius adult
TA0	Gaetanus sp.
TA4	Gaetanus adult
TC0	Caetanus simplex
TD3	Gaidius copepodite
TG0	Gaidius variabilis
TH0	Heterorhabdus sp.
TI0	Heterorhabdus tanneri
TK0	Microcalanus sp.
TL0	Microcalanus pusillus
TL4	Microcalanus adult
TM0	
TO0	Pleuromamma sp.
TR0	Pleuromamma scutullata
TS9	
TU0	Racovitzanus sp.
TU4	Racovitzanus adult
TV0	Racovitzanus antarcticus
TV3	Racovitzanus copepodite
TV4	Racovitzanus antarcticus VI female
TW0	Scaphocalanus sp.
TW4	Scaphocalanus adult
TX0	Scaphocalanus brevicornis
TY0	Scaphocalanus echinatus
TZ0	Scolecithricella sp.
TZ3	Scolecithricella copepodite
TZ4	Scolecithricella adult
UA0	Scolecithricella minor
UA8	Scolecithricella minor adult males
UB0	Scolecithricella ovata
UB7	
UB8	Scolecithricella ovata adult males
UC0	Spinocalanus sp.
UC4	Spinocalanus adult
UD0	Spinocalanus brevicaudatus
UL0	Oithona sp.
UL4	Oithona adult
UP0	Oncaea sp.
UP4	Oncaea adult
UQ0	Oncaea borealis
UQ4	
UY2	Harpacticoid nauplius
UY8	Harpacticoid adult oval males
VA0	Harpacticus sp.
VC4	
VX2	
VY2	Cirripedia cyprid
WA0	Mysidacea (General)
WG4	
WQ0	Isopoda (General)
WQ4	Isopoda parasitic

CODE	SPECIES
WT0	Amphipoda (General)
WU0	Gammeridae (General)
WV0	Lysianassidae
WV3	Cyphocaris challengeri
XE0	Hyperiidea (General)
XE2	Vibilia sp.
XE4	Paraphronima sp.
XF1	Cystisoma pellucidum
XF4	Euprimno sp.
XF6	Euprimno rectimannus
XF9	Hyperia sp.
XG1	Hyperia medusarum
XG2	Hyperia spiniger
XG4	
XG6	Hyperoche medusarum
XG9	Parathemisto pacifica
XH2	Phronima sedentaria
XH5	Scina borealis
XJ0	Caprelliidea (General)
XM0	Euphausiacea (General)
XM1	Euphausiacea egg
XM2	Euphausiacea nauplius
XM3	Euphausiacea calyptopis
XM4	Euphausiacea furcilia
XM5	Euphausiacea juvenile
XM6	Euphausiacea post-nauplius 1-6mm
XM7	
XN0	Euphausia pacifica
XN2	
XN3	
XN4	Thysanoessa sp.
XN5	Thysanoessa inermis
XN6	Thysanoessa inspinata
XN7	Thysanoessa longipes
XN8	Thysanoessa raschii
XN9	Thysanoessa spinifera
XO1	Tessarabrachion occulatus
XO5	Nematoscelis difficilis
XS0	Crab (General)
XS1	Crab zoea
XS2	Crab megalopa
YH1	Shrimp larvae
YH2	Shrimp juvenile
YS1	Shrimp adult
ZG9	
ZJ0	Mollusca (General)
ZK0	Gastropoda (General)
ZM6	Atlanta sp.
ZN7	Margarites succintus
ZO9	Lirularia succincta
ZQ0	
ZQ9	Limacina helicina
ZR2	Limacina retroversa
ZR6	Clione limacina
ZS0	Euclio sp.
ZU0	
ZU5	
ZV0	Cephalopoda (General)
ZW5	Octopoda (General)
Z71	