

# **Proceedings of the Second Workshop on Scientific Results of *FORV Sagar Sampada***

Editors

*V.K. Pillai*  
*S.A.H. Abidi*  
*V. Ravindran*  
*K.K. Balachandran*  
*Vikram V. Agadi*



**Department of Ocean Development  
Government of India  
New Delhi  
1996**

© 1996, Department of Ocean Development

Department of Ocean Development (DOD)  
Government of India  
Mahasagar Bhavan, Block No-12  
C.G.O. Complex, Lodi Road  
New Delhi-110 003  
India

ISBN : 81-900656-0-2

### Citation Styles

#### *For entire volume*

Pillai, V.K. Abidi, S.A.H., Ravindran, V., Balachandran, K.K. & Agadi, V.V. (Eds.) 1996. *Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada*, (Department of Ocean Development, New Delhi), pp. 564.

#### *For individual article*

Goswamy, S.C. & Shrivastava, Y. 1996. Zooplankton standing stock, community structure and diversity in the northern Arabian Sea, In: *Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada*, edited by V.K. Pillai, S.A.H. Abidi, V. Ravindran, K. K. Balachandran & V.V. Agadi, (Department of Ocean Development, New Delhi), pp. 127-137.

---

### Designed and Printed by:

Publications & Information Directorate  
Council of Scientific & Industrial Research  
Pusa Campus, New Delhi-110 012  
India

## **Distribution and abundance of zooplankton in the northern Arabian Sea with reference to oil spill in the Gulf waters**

K.J. Mathew & K. Solomon

Central Marine Fisheries Research Institute, P.B. No.1603, Cochin - 682 014

### **ABSTRACT**

Zooplankton of the northern Arabian Sea between lat. 16° and 23°N and long. 62° and 73°E was studied in March, 1991 for understanding the impact on zooplankton, of the large scale oil slick occurred in the Gulf waters during the Gulf War in January-February, 1991. On the whole the zooplankton biomass was very rich in the area and there was no evidence to show that the zooplankton community, up to a depth of 200 m was adversely affected by the oil slick. On the other hand serious depletion in the populations of zooplankton was noticed in the Bombay High area (stn.2241) where the oil drilling operations are on and tar balls of different sizes were collected in the plankton net operated at these stations. An increase from west to east was noticed in general with regard to several groups of zooplankton. However, the total biomass showed an increase from east to west. This increase was mainly due to the populations of large sized salps, west of long 68°E which also excluded other plankters from this area. The high quantities of salps with fair abundance of other plankters yielded biomass values as high as 70724 ml/1000 m<sup>3</sup> which is the highest value ever recorded from the Indian Ocean.

### **INTRODUCTION**

The zooplankton, like phytoplankton, is an indicator of the general fertility and water quality of a sea area. An imbalance in its population structure could bring about far reaching effects on the dependent fishery resources. The imbalance could be brought about by natural as well as man-made reasons. Fluctuations in the environmental conditions resulting in poor upwelling, rise in sea surface temperature, underwater disturbances, altered monsoons and water currents from natural causes while pollution, especially due to oil spills, represents one of the major man-made causes.

The northern Arabian Sea is highly prone to the pollution due to oil because of the oil drilling operations in the Gulf waters and the Bombay High. In addition, oil tankers

ply regularly in several routes across the Arabian Sea. All these could cause oil spills which could be deleterious to the living organisms especially to the millions of microscopic plankters which sustain the food supply in the sea.

In January-February, 1991, the Arabian Gulf area was under the grip of a major oil pollution which occurred during the Gulf War. It was feared that the major part of the northwestern Arabian Sea would be affected on account of oil pollution. It was also feared that the spilled oil might reach the Indian coast due to the prevailing winds and currents.

Shortly after the oil slick in the Gulf waters, it was decided to investigate into the consequences of the oil pollution, and how it would affect the Indian Exclusive Economic Zone. The *FORV Sagar Sampada* was deployed for the investigation and the vessel undertook a special cruise in the northern Arabian Sea from 16-20 March, 1991. As part of the programme, studies were made on the zooplankton also and the results are presented in this paper.

## MATERIALS AND METHODS

Forty-four sampling stations were occupied in the northern Arabian Sea between lat. 16°- 23°N; long. 62°- 73°E (Fig.1). Zooplankton samples were collected using a Bongo-60 net of 0.4 mm mesh size fitted with a precalibrated digital 'Hydrobios' flow meter. Surface hauls were made at almost all the stations while vertical hauls from a depth of 200 m to surface were made at alternate stations. After determining the

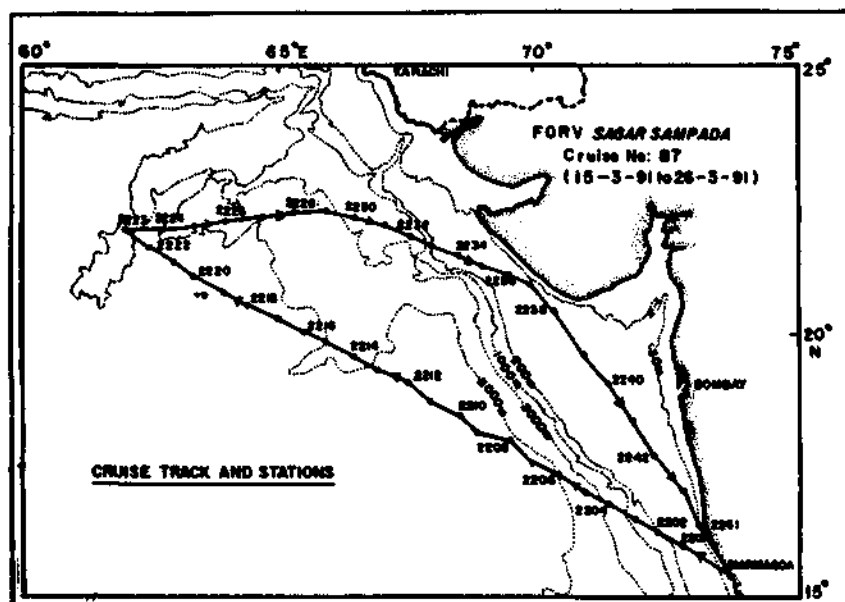


Fig. 1 - Location of sampling stations

volume by displacement method, zooplankton were sorted out into different groups and noted their numerical counts.

### RESULTS

In general, the zooplankton biomass was very rich in the area investigated except in the region of Bombay High. Tar balls of varying sizes were collected in the plankton net operated in the surface as well as column waters. The total plankton was rich in the oceanic region towards the Gulf waters.

The average biomass of zooplankton in the surface waters was 5537 ml/1000 m<sup>3</sup> (range 3.77 to 70724 ml). The minimum values were obtained from the Bombay High between Stations 2240 and 2242. Very high values were due to the preponderance of salps of which large sized were present towards the Gulf area especially between stations 2215 and 2228. The highest biomass value of 70224 ml/1000 m<sup>3</sup> was obtained from station 2209. Out of the six samples which showed high abundance of zooplankton, five were collected during night.

The average biomass of zooplankton in the column waters was estimated to be 5666 ml/1000 m<sup>3</sup>. This value was almost similar to that of surface waters. As in the case of surface zooplankton, the total biomass in the column waters was also more towards the Gulf region (Fig.2). In the column plankton also the salps contributed the maximum. The highest value of 24000 ml was from station 2225 and the least value of 62.5 ml in the column waters was, again, from the Bombay High area. Out of the 13 stations with high volumes of zooplankton, six were sampled in the day while

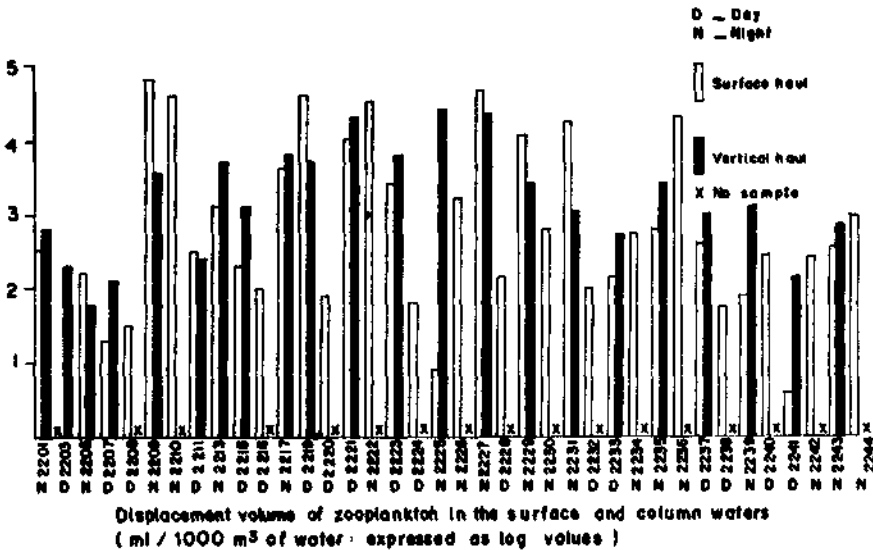


Fig. 2 - Zooplankton biomass collected from surface and column waters arranged stationwise (ml/1000 m<sup>3</sup> of water expressed as log values)

seven were sampled in the night thereby indicating almost equal abundance of zooplankters during day and night in the column waters.

It was found that majority of the groups had a tendency to increase numerically towards the eastern part of the study area (Figs.3,4), the groups being decapods, euphausiids, amphipods, polychaetes, siphonophores, medusae, gastropods, heteropods, *Lucifer*, foraminifers, fish eggs and fish larvae. In the column waters also all the above groups with addition of appendicularians, mysids, chaetognaths and doliolids showed a numerical abundance towards the east. Copepoda was one group which was almost uniformly represented throughout the area sampled.

Copepods were numerically the second abundant group. Their range in the surface waters was between 4955 and 125340 and in the column waters their range varied from 22316 (between 67° and 68°E) to 255507 (between 68° and 69°E) (Fig.3). A flourishing copepod population was noticed towards the Gulf waters. Three stations, say, 2200, 2213 and 2217 had unusual numbers of ostracods at 626819, 510993 and 3784800 respectively. The ostracods being a surface swarming group showed considerable variations in their abundance. They showed a gradual increase towards west. The appendicularians were numerically more in the column waters (range 1185, between 63° and 64°E to 48301, between 68° and 69°E). This group was almost uniformly present in the study area. The decapods were less represented in the western part and the increase from west to east was evident.

Euphausiids showed a marked increase from west to east. The maximum number of 35096 was noticed in the Indian shelf waters and the increase was mostly due to the surface swarming species of *Euphausia sibogae* and *E. diomedae*. In the column waters the maximum number of euphausiids was collected between 68° and 69°E. The amphipods were numerically well represented, their abundance being towards the east. Their number was more in the surface waters the maximum being 31007 between 64° and 65°E. Closer to the Gulf region (64° and 65°E) mysids at the rate of 80911 were recorded. These were also sparsely distributed in the column waters. A definite eastward increase was noticed with planktonic polychaetes. More of them were found in the column waters maximum being 2023 between 70° and 71°E.

The siphonophores were more abundant towards the coastal zone. A strong east-west difference in abundance was noticed, the trend of abundance being more towards the east. In the surface waters, from a mere 132 at the westernmost station, their number rose to 48277 in the Indian shelf waters. The medusae which has a patchy distribution was more towards the east. They were more abundant in the column waters. However, whatever present showed a increase towards the east. In the surface waters their number ranged from 14 to 7825 while in the column waters the range was between 86 and 32955. The chaetognaths formed an abundant group in the surface as well as column waters the minimum and maximum number in the respective water bodies being 935-36647 and 4929-94166. The planktonic molluscs were represented by pteropods, heteropods and few other gastropods. They were seen in large numbers

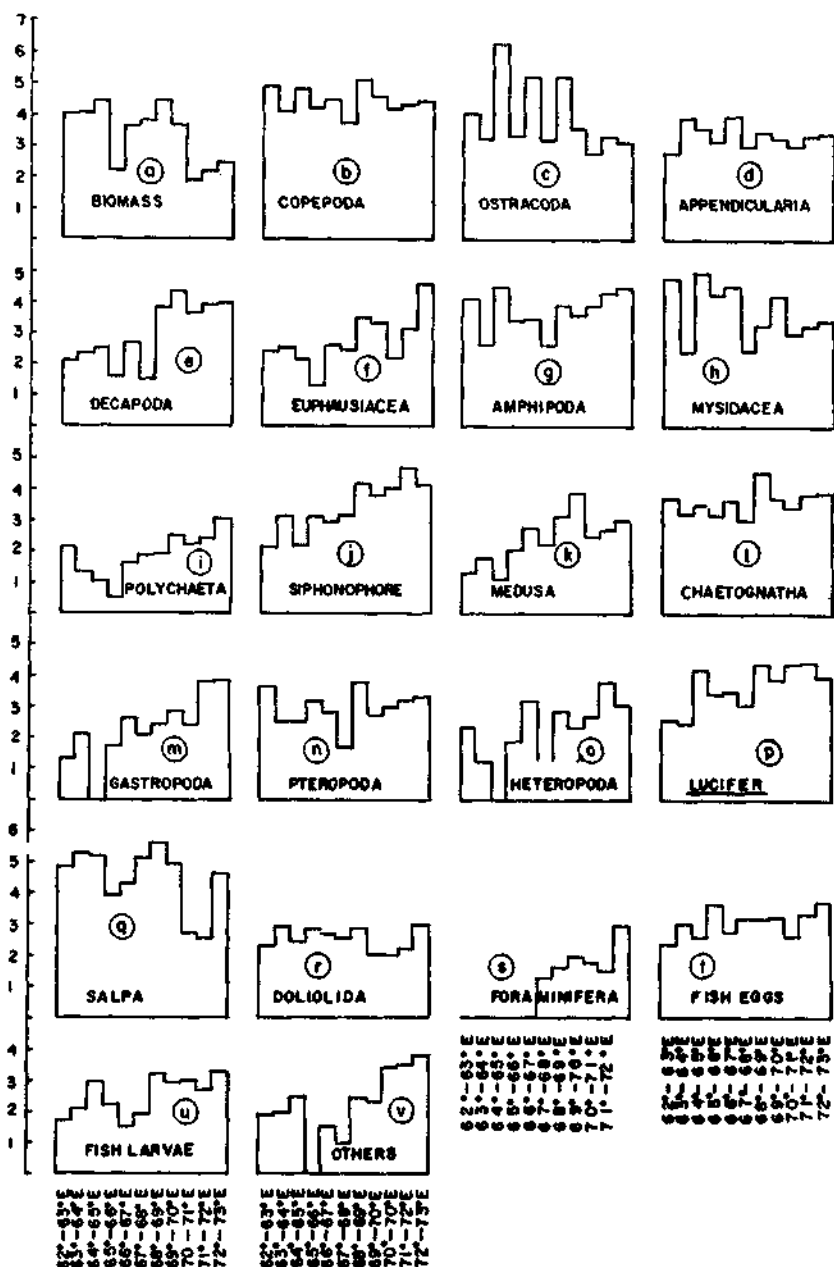


Fig. 3 - Quantitative abundance (no./1000 m<sup>3</sup> of water expressed as log values) of major zooplankters in the surface waters (average values for each longitudinal sector arranged from west to east)

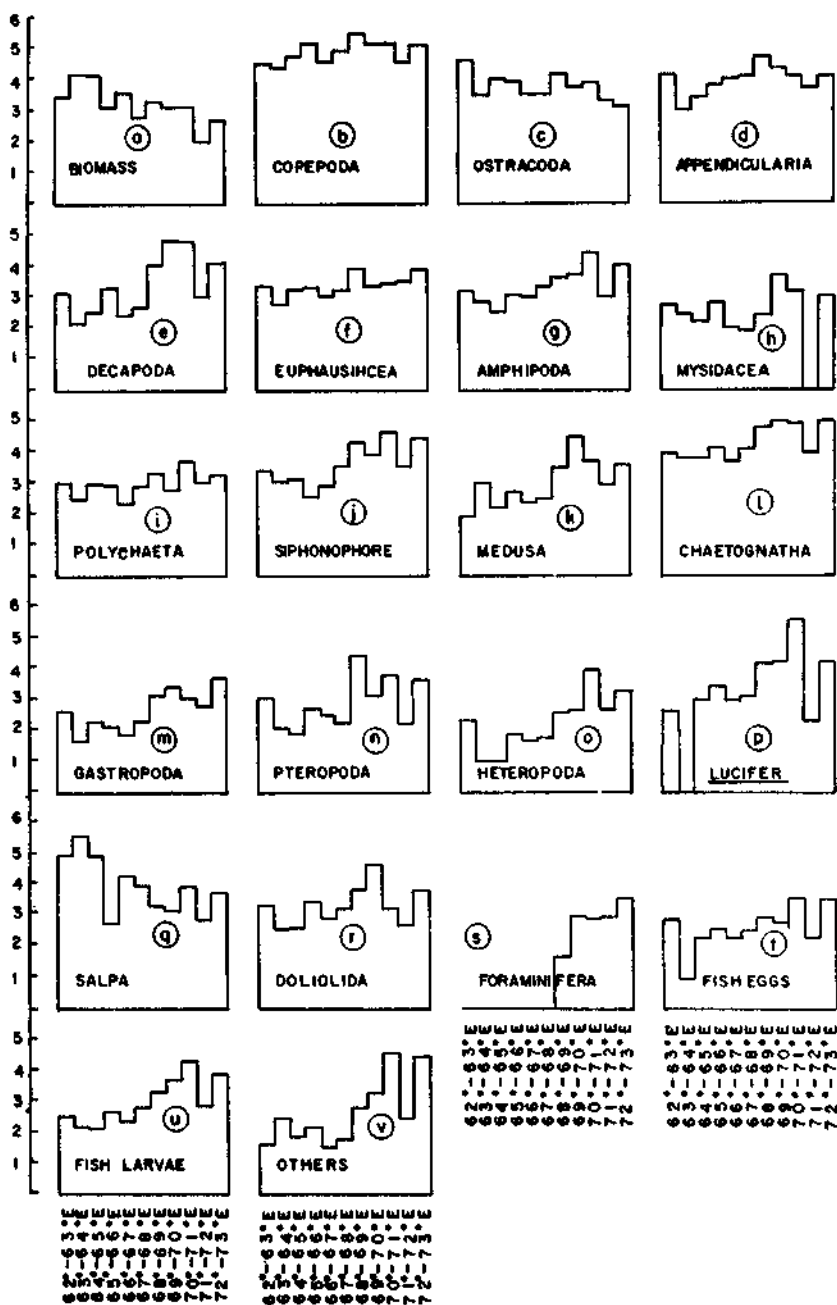


Fig. 4 - Quantitative abundance (no/1000 m<sup>3</sup>) of major zooplankters in the column waters up to 200 m depth (average values for each longitudinal sector arranged from west to east)



in the Indian shelf waters. The *Lucifer*, a neritic group was more in the Indian coastal waters.

The salps occurred in abundant numbers in the surface and column waters. Younger forms were more in the nearshore and shelf areas while larger specimens were the rule in the oceanic waters. Their quantity was such that about 70 ml/m<sup>3</sup> of water was present at station 2210. Their best population was noticed in the Bombay High area. The maximum number of salps per 1000 m<sup>3</sup> of water was 829888 in the surface and 585869 in the column waters. The doliolids though widely present were always moderate in number. A striking feature observed with foraminifers was that they were absent west of 67°35'E. They were mostly inshore in habit.

The fish eggs and larvae registered an increase towards the east and were particularly abundant over the continental shelf with the maximum nearer to the coast. While the eggs were comparatively more in the surface, the larvae were more in the column waters.

## DISCUSSION

The northern Arabian Sea supports a very rich population of zooplankton. Haq *et al.* (1973) who studied the plankton of the Arabian Sea near to the Pakistan coast have recorded the biomass values as high as 2080 ml/1000 m<sup>3</sup> which they considered as the highest value ever recorded from the Indian Ocean. However, Paulinose & Aravindakshan (1977) obtained values as high as 2800 ml/1000 m<sup>3</sup> during December 1973 and May 1974 from the Arabian Sea and the high values were due to the abundance of ostracods, which very often surpassed the biomass of the copepods. During the present investigation, the presence of large sized salps especially towards the Gulf area resulted in very high biomass values than ever. The highest value noted for the surface waters was 70724 ml/1000 m<sup>3</sup> at station 2208 and in terms of number it was 829888/1000 m<sup>3</sup>. The ostracods were also numerous at this station being 626819. In the column waters the highest biomass value noted for salps was 24000 ml/1000 m<sup>3</sup>, its number being 139394.

Prasad (1969) observed that the zooplankton values were high in the Arabian Sea between 10° and 25°N and between 50° and 65°E. The average biomass was of the order of 274 ml/1000 m<sup>3</sup>. Earlier Bogorov & Vinogradov (1961) obtained an average value of 100 ml from the northern Arabian Sea in March. The average biomass value obtained during the present studies were 5537 ml for surface and 5665 ml for the column waters which are far higher than that recorded at any time in the Indian Ocean. The fact that these higher values have been obtained during March, when the phytoplankton populations are at a minimum due to nutrient restrictions, especially in the oceanic waters is interesting. However, the most dominant plankter, the salps, being a carnivore feeding upon other zooplankters might not have had any influence from the least production at the primary level.

In the Bombay High area between 70° and 72°E there was marked decrease in the overall quantity of zooplankton and the various groups. The least represented groups were polychaetes, medusae, salps, doliolids in the column waters. At stations 2241 and 2242, the water was highly impoverished of zooplankton. Several common groups namely ostracods, decapods, euphausiids, amphipods, mysids, polychaetes, medusae, chaetognaths, gastropods, pteropods, doliolids and fish eggs which were abundant in the nearby areas were totally absent in the column waters in these stations. In the surface waters at these stations six groups namely euphausiids, mysids, polychaetes, pteropods, salps and doliolids were absent. The plankton samples collected from the surface as well as column waters at the above two stations contained of tar balls of different sizes.

With regard to the eastwest abundance of zooplankton groups, it was seen that majority of them had minimum abundance in the western part of the area studied from where their number gradually increased to the eastern part which is towards India. However, volumetrically the increase was westward and this was due to the very high abundance of large sized salps there.

Copepods, ostracods, appendicularians, decapods, euphausiids, amphipods, mysids, polychaetes, siphonophores, chaetognaths, pteropods, heteropods, *Lucifer*, doliolids, fish eggs and fish larvae had an abundance in the column waters of the westernmost zone (long. 62°-63°E) than the immediate eastern sector (63°- 64°E). However, the number of salps was 82675/1000 m<sup>3</sup> in the western most sector which was not in anyway a low number. In the surface waters, closer to the Gulf countries, abundance of zooplankton was exhibited by majority of the groups except appendicularians, euphausiids, siphonophores, medusae, gastropods, salps, doliolids, fish eggs and fish larvae. However, the observed reduction in number of these groups was not significant except in the case of appendicularians, siphonophores and salps.

From the foregoing account it could be seen that the zooplankton populations in the area investigated were rich except in the Bombay High area. The observed eastwest increase or decrease in the case of certain groups was only relative, in the sense that a group was considered less abundant because of the very high abundance of certain other group or groups in the same area, which shadowed all others. Thus the observed relatively low numbers of various zooplankters, other than salps towards the Gulf area, was more due to the extraordinary high number of salps, and the total biomass was more towards the Gulf area. Thus it could be concluded that the Gulf waters were congenial for the occurrence and abundance of zooplankton at the time of observations and the large oil spill had either no influence on them or the effect, if at all there had been any, did not exist at the time of investigation.

#### ACKNOWLEDGEMENT

Authors are thankful to Dr P.S.B.R. James, former Director for his keen interest in this work and to Dr R. Sen Gupta, National Institute of Oceanography, Goa for the help and guidance.

## REFERENCES

- Bogorov, V.G. & Vinogradov, M.E. 1961. Some features of plankton biomass distribution in the surface water in the Indian Ocean during the winter of 1959-60, *Okeanol, Issled.* 4: 72- 75.
- Haq, S.M., Ali Khan, J. & Chugatai, S. 1973. The distribution and abundance of zooplankton along the coast of Pakistan during postmonsoon and premonsoon period, In: *The biology of the Indian Ocean*, edited by B. Zeitzchel, (Springer-Verlag, Berlin) 257-272.
- Paulinose, V.T. & Aravindakshan, P.N. 1977. Zooplankton biomass, abundance and distribution in the north and northeastern Arabian Sea, In: *Proceedings of the symposium on warm water zooplankton*, (UNESCO/NIO, Goa) 132-136.
- Prasad, R.R. 1969. Zooplankton biomass in the Arabian Sea and the Bay of Bengal with a discussion on the fisheries of the region. *Proc. Nat. Inst. Sci. India*, 35: 399-437.

\* \* \*