THE BIOGEOGRAPHY AND NUMERICAL TAXONOMY OF THE OEGOPSID SQUID FAMILY OMMASTREPHIDAE IN THE PACIFIC OCEAN. Bulletin of the Scripps Institution of Oceanography, vol. 23. John H. Wormuth. University of California Press, Berkeley, California, U.S.A. 1976. 90 p. US$ 3.50.

The oceanic squid family Ommastrephidae, distributed throughout the world oceans, is represented by 23 recognized species, and, as such, is one of the most specious of oegopsid families. Ommastrephids are extremely abundant and occur in such huge numbers that extensive fisheries are supported. For example, about 500,000 metric tons of a single species, *Todarodes pacificus,* are landed each year from Japanese waters, while several ten-thousands of tons of 4-5 other species are captured in Atlantic, Mediterranean and Pacific waters. Furthermore, ommastrephids constitute significant portions of the diets of many marine mammals (e.g., toothed whales, seals), pelagic birds and large fishes. Several of the ommastrephid species (e.g., *Dosidicus gigas* and *Ommastrephes caroli*) attain quite a large size and are among the largest of squids.

While some of the species are distinctive and easily identified, most ommastrephids often have been identified by their localities of capture rather than by their morphological characteristics, a procedure that really isn't quite "fair." Besides, too frequently overlapping or sympatric closely related species occur, so the problem of identification becomes complicated. This is particularly true in the Atlantic Ocean where 3 species in each of 2 genera, *Illex* and *Ommastrephes,* are sympatric in parts of their ranges.

Such a taxonomic dilemma in the Pacific Ocean no longer exists because of the detailed study by John Wormuth, recently published as a Bulletin of the Scripps Institution of Oceanography. Prior to Wormuth's work the most comprehensive studies of ommastrephids were those of G. Pfeffer (1912, *Ergebnisse der Plankton-Expedition der Humboldt-Stiftung,* Vol. II, Verlag von Lipsius & Tischer, Kiel-Leipzig, 815 p) and J. Steenstrup (1855-1898; translated in Volsoe, Knudsen & Rees, 1962, *Cephalopod Papers of Japetus Steenstrup,* Danish Science Press Ltd., Copenhagen, 330 p) when just over half the present number of species was known. Wormuth's effort, therefore, represents a much needed study. Based on the extensive collections of Scripps Institution, the work concentrates on the interspecific relationships and geographical distributions of Pacific Ocean species. In this approach, Wormuth is more concerned with the inter-relationships of similarity groupings of species than with the differentiations between species. The work is a healthy blend of traditional descriptive taxonomy and of modern numerical taxonomy.

Ten species of Pacific and Indian Ocean ommastrephids form the basis of the study, but 2 Atlantic species, *Illex illecebrosus* and *Ommastrephes pteropus,* were also examined, because no *Illex* (Illicinae) occur in the Pacific and Indian Oceans and because *O. pteropus* is so closely related to *Symplectoteuthis oualaniensis,* which is excluded from the Atlantic. For most species examined, a sufficient number of specimens was available for the numerical analyses to allow a careful selection of specimens to eliminate the variability effects of sex, size, broad geographical range, etc. A broad selection of quantitative characters was examined in each species so that intraspecific variability could be compared with interspecific variability.

The numerical taxonomy consisted of 3 different techniques to examine the species affinities in order to achieve the "best" concept of the interspecific relationships. These included the clustering technique of the weighted variable group method, the recurrent group analysis and the factor analysis. This study represents the 1st major numerical taxonomic analysis to be accomplished on a group of cephalopods, and the results are thought-provoking and interesting.

Lest the use of numerical taxonomy "turns off" the more conservative teuthological

brethren, I hasten to point out that a solid traditional approach presents full species descriptions and synonymies. A number of new characters are introduced, e.g., changes in brachial sucker ring dentition and protective membranes, while other formerly little-used characters are expanded, e.g., fin angle, nape angle. The hectocotyli (mating arm) of *Nototodarus hawaiiensis* and *Dosidicus gigas* are described for the first time. Comments are given for each species on geographical and vertical distributions, habitat, prey-predator relationships, etc.

Although extensive geographical variability is not widespread among most species examined, *Dosidicus gigas* does exhibit a marked latitudinal variation in size in its longitudinally limited range in the eastern Pacific, whereby it grows much larger south of the equator than north of the equator. On the other hand, *Ommastrephes bartrami* has a very broad discontinuous distribution in the Pacific, Indian and Atlantic Oceans with no apparent significant geographical differences.

I feel 2 omissions occur in the descriptive section that detract from a more complete utility of the paper. 1) While good illustrations of the whole animal occur for most, but unfortunately not all, species, no illustrations are given of the distinguishing characteristics. Illustrations in each species of the hectocotylus, the tentacular club and fixing apparatus, and even of the variations in arm and tentacular sucker dentitions would have added to the utility of the paper. 2) The author's stated primary purpose of delineating species affinities not withstanding, a concise comparison of characters for differentiating species would have been most helpful to persons wishing to identify ommastrephids.

A cautionary note is also necessary here. The appearance of tables and distribution charts does not always coincide with the species account in the text, so the reader must check the figure and table legends carefully to avoid mistakes.

The results of the 3 numerical techniques were generally similar in that they divided the species studied into 4 species groups. While these species affinities may raise some traditional eyebrows, they certainly are worthy of consideration, because in some instances at least they seem more justified than are the former groupings. Group A consists of *Symplectoteuthis oualaniensis, Ommastrephes pteropus, Dosidicus gigas* and *O. bartrami*; Group B of *S. luminosa* and *Hyaloteuthis pelagica*; Group C of *Ornithoteuthis volatilis, Illex illecebrosus* and *Todarodes pacificus*; Group D of *Nototodarus hawaiiensis, N. sloani* and *N. gouldi.* Groups A and B show closer affinities to each other, as do Groups C and D. As Wormuth points out, these groups are made up of about half the known species, so a complete analysis at this time is impossible. However, I feel that Groups A (or A and B) and D certainly are reasonable and probably will hang together as discrete units in future analyses, but Group C seems to contain too diverse an assemblage to be natural, in my opinion. It appears as an assemblage in this study because of the species and characters used, but in reality it would break up if all Atlantic species were included and if all pertinent characters were analyzed, e.g., number of rows of suckers on the club (dactylus) in *Illex. Illex illecebrosus* and *T. pacificus* may well be ecological counterparts in habitat and behavior in the Atlantic and Pacific Oceans respectively, but a very close taxonomic relationship does not seem justified.

Wormuth presents a revised arrangement of species and genera for the Ommastrephidae strongly suggested by his numerical studies, but he stops short of proposing this as a required taxonomic change. This is much to Wormuth's credit, as he recognizes the necessity of studying all ommastrephid species from all oceans prior to erecting a new system. New generic diagnoses are presented which will provide extremely helpful guidelines to anyone working in the group.

A thorough knowledge of the vertical distributions of ommastrephids is hampered largely by inadequate sampling techniques. Small nets are easily avoided and large nets are seldom fished deep enough to allow determinations of the lower limit of distribution. However,

1500 m certainly appears to approach the maximum depth attained by ommastrephids. Most ommastrephid species are distributed according to particular water masses, and, in general, are divided into oceanic species and neritic species.

This paper is a very detailed and careful piece of work that fills a long-standing need in cephalopod systematics. Given the rate of production of major revisionary works in cephalopod systematics, I judge that Wormuth's publication will form the basis of our knowledge of ommastrephid systematics for many years to come.

CLYDE F.E. ROPER

Department of Invertebrate Zoology (Mollusks)
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560, U.S.A.