1974

A Diurnal zooplankton migration study in Lake Mead

Robert D. Staker
University of Arizona

Follow this and additional works at: https://digitalscholarship.unlv.edu/water_pubs

Part of the [Biochemistry Commons](#), [Biology Commons](#), [Environmental Microbiology and Microbial Ecology Commons](#), [Fresh Water Studies Commons](#), and the [Terrestrial and Aquatic Ecology Commons](#)

Repository Citation

Staker, R. D. (1974). A Diurnal zooplankton migration study in Lake Mead. *Journal of the Arizona Academy of Science*, 9(3), 85-88.

Available at: https://digitalscholarship.unlv.edu/water_pubs/91

This Article is protected by copyright and/or related rights. It has been brought to you by Digital Scholarship@UNLV with permission from the rights-holder(s). You are free to use this Article in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Article has been accepted for inclusion in Publications (WR) by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact digitalscholarship@unlv.edu.

A DIURNAL ZOOPLANKTON MIGRATION STUDY IN LAKE MEAD

ROBERT D. STAKER

The University of Arizona, Tucson

INTRODUCTION. — The diurnal vertical movement of zooplankton was first recorded in freshwater lakes by Weismann (1877) in Lake Constance (Bodensee), although Cuvier was credited with observing the migration of Daphniae in 1817 (Cushing, 1955). The migration is best observed in deep oligotrophic lakes and migrations of 50 m per day are described (Worthington, 1931). In addition, two species of chaetognaths are reported to migrate 400 m a day in marine waters off of Lisbon (Waterman and Berry, 1967) while Birge (1895) found little evidence of the phenomenon at all in Lake Mendota, Wisconsin.

Most zooplankton that migrate at night and sink during the day. Welch (1952) and Pennak (1944) point out that the most important factor involved in diurnal migration is light. It appears that the extent of the diurnal movements varies from lake to lake, among the sexes and among the age of a particular plankter. Crustaceae and some rotifers are the organisms that most often exhibit this phenomenon. Rare cases in which zooplankters show reversed migrations have been recorded (Worthington and Ricardo, 1936; Maloney and Tressler, 1942).

Previous studies on Lake Mead have dealt primarily with the physical limnology of Lake Mead (Smith, *et al.*, 1948; National Research Council, 1949) Anderson, 1950; Anderson and Pritchard, 1951; Harbeck, *et al.*, 1958; and Bureau of Reclamation, 1965). Moffett (1943) did a preliminary report on the plankton and fish of the lake from samples collected in November, 1941. A study by Everett (1972) showed that the highest primary productivity rates in Lake Mead occurred in the Boulder Basin. The purpose of the present investigation is to find whether nocturnal migration patterns occur in the zooplanktonic fauna of Lake Mead during times of isothermy and to determine the extent of this possible migration.

Acknowledgments. — The author wishes to acknowledge Dr. Lorne G. Everett for his help in collecting the field samples. Special thanks are extended to Dr. W. Thomas Starmer for his statistical aid in the analysis of variance. This work was supported in part by funds provided by the United States Department of the Interior, Bureau of Reclamation, Region III, Boulder City, Nevada and the Office of Water Resources Research, Tucson, Arizona, as authorized under the Water Resources Research Act of 1964.

MATERIALS AND METHODS. — The migration study field work was conducted at the Bureau of Reclamation Raft in Boulder Basin on January 10, 1972 and January 12, 1972. Samples were taken with a 6-liter Van Dorn sampler and concentrated into a 6 dram vial using a fine mesh of approximately 50 μ . Samples were collected at 0, 1, 3, 5, 7, 10, 15, 20, 25 and 30 m depths.

Sampling was done for 20 of the 24 hrs on the first day. A replication of the experiment occurred one day later with samples collected during 11 of the 24 hrs. These samples were preserved with a 10% formalin solution for examination at a later time.

Microscopic manipulation was made using a Bausch and Lomb Stereozoom microscope model BVB - 73. For higher magnifications a Zeiss compound microscope model GFL was used. The actual counting employed a technique similar to that of Knutson (1970) and Maloney and Tressler (1942) using a ruled counting chamber under a Bausch and Lomb dissecting scope. The contents of the entire vial were enumerated. The taxonomic references used to determine the classification of the zooplankton included: Ahlstrom (1943), Pennak (1953) and Ward and Whipple (1959).

RESULTS AND DISCUSSION. — The contents of 310 zooplankton samples were analyzed for calanoid and cyclopoid as well as their larval forms or nauplii, *Bosmina longirostris*, *Keratella cochlearis* and *Polyarthra* sp. These organisms were the principle zooplankton found at this time. The results of the counts for the first day are plotted in Figs. 1 through 6. The dashed lines on each graph represent the depth of the average individual. The sunset time was about 5:40 PM and the sunrise time was approximately 7:40 AM. An analysis of variance on the data comparing the variation in the mean depth during the daylight hours to the night hours was performed in order to test whether the variations were due to chance alone. T-values were calculated and the significance was at the 0.01 level. The results of the analysis of variance are shown in Table 1. These results indicate that the rotifers *Keratella cochlearis* and *Polyarthra* sp. and the cladoceran *Bosmina longirostris* are migrating. The difference in mean depth between day and night for *K. cochlearis* was 4.78 m, for *B. longirostris* the value was

Table 1. Analysis of variance designed to test whether migratory patterns were due to chance alone. The significance was at the 0.01 level.

Organism	df	t values	mean difference in depth (m)	migrating
<i>Keratella</i>	1852	11.90	4.78	yes
<i>Bosmina</i>	1301	7.91	4.70	yes
Cyclopoida	272	2.40	3.19	no
Calanoida	115	1.85	2.99	no
<i>Polyarthra</i>	1905	6.12	2.58	yes
Nauplii	373	1.39	1.34	no

Figure 1.—Diurnal migration pattern for Cyclopoida copepods. (Above)

Figure 2.—Diurnal migration pattern for Calanoida copepods. (Above)

Figure 3.—Diurnal migration pattern for copepod nauplii. (Above)

Figure 4.—Diurnal migration pattern for *Bosmina longirostris*. (Above) Figure 5.—Diurnal migration pattern for *Polyarthra* sp. (Above) Figure 6.—Diurnal migration pattern for *Keratella cochlearis*. (Above)

4.70 m and *Polyarthra* sp. shows a difference of 2.58 m. The analysis indicates that chance variations explain the differences seen in Calanoida, Cyclopoida and the nauplii.

Keratella cochlearis is an organism that is known to undergo diurnal migration patterns (Kikuchi, 1930) and Ruttner (1943) recorded that *Polyarthra* migrated in Lunzer Untersee. Information concerning migration patterns in *Bosmina* was not found in the literature. Most zooplankton migration studies are done in the warmer months when lakes are thermally stratified. In the present investigation the lake temperature was isothermal, the water temperature being about 11°C (Everett, 1972). Reports of isothermal migrations are cited for *Daphnia carinata* (Bayly, 1962). Rawson (1956) indicated that oligotrophic lakes generally have extensive migrations whereas eutrophic lakes show limited patterns. The migrating distances for the 3

organisms were less than 5 m, indicating limited patterns. Following the rationale of Rawson and Bayly one might say that the migration patterns, seen in the zooplankton of Lake Mead are not characteristic of oligotrophic waters.

SUMMARY. — The migration study shows that euplanktonic *Keratella cochlearis*, *Polyarthra* sp. and *Bosmina longirostris* were able to undergo nocturnal migrations based upon an analysis of variance. The depth of the average individual in these three organisms was found to change less than 5 m between day and night populations inferring limited migration patterns. Evidence indicates that calanoid, cyclopoid and nauplii copepods do not migrate. Since this study was performed under isothermal conditions of winter it is believed that migration is not a function of temperature.

LITERATURE CITED

- AHLSTROM, E. H., 1943. A revision of the rotatorian genus *Keratella* with descriptions of three new species and five new varieties. Bull. Amer. Mus. Nat. Hist. 80:411-457.
- ANDERSON, E. R., 1950. A review of evaporation theory and development of instrumentation. Lake Mead Water Loss Investigation, Interior Report, Navy Electronics Laboratory Report 159.
- ANDERSON, E. R., and D. W. PRITCHARD, 1951. Physical limnology of Lake Mead. U.S. Navy Electronics Laboratory Report 258.
- BAYLY, I. A. E., 1962. Ecological studies on New Zealand lacustrine zooplankton with special reference to *Boeckella propinqua* Sars (Copepoda: Calanoida). Aust. J. Mar. Freshwat. Res. 13: 143-197.
- BIRGE, E. A., 1895. Plankton studies on Lake Mendota. I. The vertical distribution of the pelagic Crustacea during July, 1894. Trans. Wis. Acad. Sci. Arts Lett. 10: 421-484.
- Bureau of Reclamation, 1970. Water quality study of Lake Mead, Report No. CHE-70, Office of Chief Engineer, Denver, Colorado.
- CUSHING, D. H., 1955. Some experiments on the vertical migration of zooplankton. J. Anim. Ecol. 24: 137-166.
- EVERETT, L. G., 1972. A mathematical model of primary productivity and limnological patterns in Lake Mead. Reports on Natural Resource Systems Collaborative effort between the following Departments: Hydrology and Water Resources, Biological Sciences.
- HARBECK, G. E., 1958. Water — loss investigations: Lake Mead studies. U.S. Geol. Survey Prof. Paper 298.
- KIKUCHI, K., 1930. A comparison of the diurnal migration of plankton in eight Japanese lakes. Mem. Coll. Sci. Kyoto Univ., ser. B. 5: 27-46.
- KNUTSON, K.M., 1970. Plankton ecology of Lake Ashtabula Reservoir, Valley City, North Dakota. (Doctorate Dissertation). North Dakota State University Library. Fargo, North Dakota.
- MALONEY, M. and W. L. TRESSLER, 1942. The diurnal migration of certain species of zooplankton in Caroga Lake, New York. Trans. Amer. Microsc. Soc. 61: 40-52.
- MOFFETT, J. W., 1943. A preliminary report on the fishery of Lake Mead, U.S. Fish and Wildlife Service, Natural History Museum, Stanford University, California.
- National Research Council, 1949. Interdivisional Committee on Density Currents, Subcommittee on Lake Mead. Lake Mead Density Currents Investigation, 1937 — 40. Vol. 1, 2; 1941 — 46. Vol. 3, Washington, U.S. Bureau of Reclamation.
- PENNAK, R. W., 1944. Diurnal movements of zooplankton organisms in some Colorado mountain lakes. Ecology 25: 387-403.
- , 1953. Freshwater Invertebrates of the United States. The Ronald Press Company. New York.
- RAWSON, D. S., 1956. Algal indicators of trophic lake types. Limnol. Oceanogr. 1: 18-25.
- RUTTNER, F., 1943. Beobachtungen ueber die tagliche Vertikabwanderung des Planktons in tropischen Seen. Arch. Hydrobiol. 40: 474-492.
- SMITH, W. O., C. P. VETTER and G. B. CUMMINGS, 1948. Comprehensive survey of sedimentation in Lake Mead. U.S. Department of the Interior, Geol. Survey, Bureau of Reclamation.
- WARD, H. B. and G. C. WHIPPLE, 1959. Freshwater Biology. W. T. Edmondson (ed.). John Wiley and Sons. New York.
- WATERMAN, T. H. and D. A. BERRY, 1967. Evidence for diurnal vertical plankton migration below the photic zone. Amer. Zool. 7: 417.
- WEISSMANN, A., 1877. Das Tierleben im Bodensee. Schr. Gesch. Bodensees Umgebung. 7: 1-31.
- WELCH, P. S., 1952. Limnology, 2nd ed. New York, McGraw-Hill Book Co.
- WORTHINGTON, E. B., 1931. Vertical movements of freshwater macroplankton. Int. Revue ges. Hydrobiol. Hydrogr. 25: 394-436.
- , and C. K. RICARDO, 1936. Scientific results of the Cambridge expedition to the East African lakes 1930-1, No. 17. The vertical distribution and movements of the plankton in Lakes Rudolf, Naivasha, Edward and Bunyoni. J. Linn. Soc. Zoology 40: 33-69.