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PRELIMINARY REPORT ON THE "PALOLO"
WORM OF SAMOA, EUNICE
VIRIDIS (GRAY).¹

W. McM. WOODWORTH.

SINCE a Monograph of Samoa would not be complete without some account of the "Palolo," at Dr. Krämer's request I have prepared the following summary, reserving for a subsequent publication a detailed account of the "Palolo" and other annelids of the coral reefs of the Pacific. In this preliminary paper I can only touch upon historical matters and the often written story of the "rising" and "fishing" of the "Palolo," referring the reader to the publications of Collin,² Friedlaender,³ Krämer,⁴ and Ehlers.⁵

The "Palolo" has been known to naturalists for more than half a century and much has been written about it in a fragmentary way. It was, however, during the period of Krämer's investigations in Samoa that its true history was brought to light, and

¹This provisional account prepared for Krämer's monographic work on the Samoan Islands (Krämer, Augustin, *Die Samoa Inseln* etc. Stuttgart, E. Nägele, 1903, Bd. 2, pp. 399-403) and translated by him into German, is reprinted here with some changes and corrections. The author has in preparation an extended study of the life history, morphology and distribution of the "Palolo," and allied Eunicidæ.

²Collin, A. Bemerkungen über den essbaren Palolowurm, *Lysidice viridis* (Gray). Appendix to Krämer's *Bau der Korallenriffe* pp. 164-174.

³Friedlaender, B. Über den sogenannten Palolowurm. *Biolog. Centralblatt*. Bd. 28, p. 337-357. 1898. — *Idem*, Notes on the Palolo. *Jour. Polynesian Soc.* Vol. 7, p. 44-46; Wellington, N. Z. 198. — *Idem*, Nochmals der Palolo etc. *Biolog. Centralblatt*. Bd. 19, pp. 242-269. 1899.

⁴Krämer, A. *Über den Bau der Korallenriffe und die Plankton-Verteilung an der samoanischen Küste nebst vergleichenden Bemerkungen*. Kiel und Leipzig 1897. — *Idem*, Palolountersuchungen. *Biolog. Centralblatt*. Bd. 19, pp. 15-30. 1899. — *Idem*, Palolountersuchungen im October und November 1898 in Samoa. *Ibid.* pp. 237-239. 1899.

⁵Ehlers, E. Über Palolo (*Eunice viridis* Gray). *Nachr. K. Ges. Wiss. Göttingen. Math.-naturw. Kl.* 1898. pp. 400-415.

much of our knowledge of this interesting worm is due directly to him and to the stimulus of his work. The first extended account was written by Collin¹ as an appendix to Krämer's earlier work on Samoa. In this account Collin, with previous writers, considers the "Palolo" to be the posterior part of *Lysidice viridis* (Gray), a few detached heads of which had from time to time been taken with the "Palolo" at the 'fishing' season, and as no other annelid heads were taken with the "Palolo" and all "Palolo" were headless, it was natural, for want of better evidence, to ascribe the "Palolo" to the genus *Lysidice*. The discovery of the origin of the "Palolo" was made independently by Krämer and Friedlaender, although the latter was the first to publish an account of his investigations.² Friedlaender succeeded in obtaining from the reef rock at Samatau several specimens of "Palolo" together with the head ends of an annelid of different appearance and much larger size belonging to the genus *Eunice*. His material was afterwards studied by Ehlers³ who recognized an extreme case of sexual dimorphism and showed the "Palolo" to be the epitokal posterior portion of *Eunice viridis* (Gray). Ehlers says, "Ich ergänze das im Voraus damit, dass ich die *Eunice*, die nun den Namen *Eunice viridis* (Gray) erhält, in den Kreis der *Eunice siciliensis* Gr. bringe und an ihr die Ausbildung des "Palolo" als eine Form der Epitokie auffasse, wie sie zum ersten Male aus der Familie der Euniciden, und in ihrer Besonderheit abweichend von allen Erscheinungen der Epitokie, die von Borstenwürmern bekannt sind, sich darstellt. Demnach ist in der Art eine atoke und epitoke Form, in der letzteren eine atoke und epitoke Körperstrecke zu unterscheiden."

It was my good fortune to be at Levuka in the Fiji Islands during the "rising" of the "Palolo"⁴ in November, 1897, where I gathered much material and information, and in the following year went to Samoa to learn more about the history of this

¹ *Op. cit.*

² See Thilenius, G. Bemerkungen zu den Aufsätzen der Herrn Krämer und Friedlaender über den sogenannten Palolo. *Biol. Centralblatt*, Bd. 20, pp. 241-242, 1900.

³ *Op. cit.*

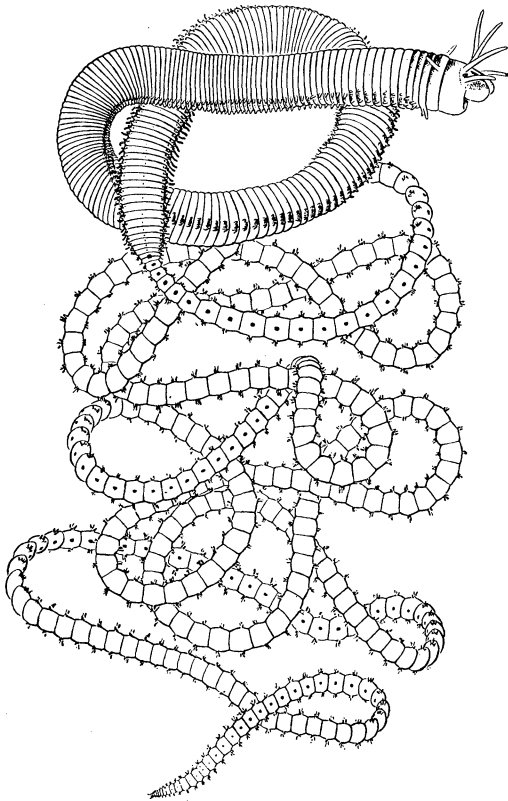
⁴ Bololo, pronounced Mbololo in Fijian.

mysterious worm. I arrived at Apia on October 20 and was fortunate in meeting Dr. Krämer who placed at my disposal the notes he had collected during three years in the islands. I made my headquarters in the village of Falelatai on the South side of Upolu a little to the eastward of Samatau where Friedlaender obtained his material. After several days of fruitless search on the reef between Samatau and Falelatai my native friends took me to a shallow bay called Fagaiofu about two miles east of our village. The bay lies between two small promontories and is about one quarter of a mile wide, the distance from the shore to the edge of the fringing reef, which fills the bay, is not more than 150 meters. The place is so shallow that at low tide one can wade from the shore to the edge of the reef. The reef platform, which is composed chiefly of dead coral and honeycombed reef rock, is interrupted by two narrow deep channels or passages.

The reef at Fagaiofu proved to be literally alive with "Palolo." They were discovered by prising off, with a crowbar, masses of the rock at the edges of the channels. They could be seen dangling from the freshly exposed surfaces and wriggling free into the deeper water of the channel to be carried seaward by the retreating tide, to the astonishment of my natives who had never seen the "Palolo" before the time appointed for its appearance—this was three days before. Owing to the great length of the entire worm, its fragile structure and intricate association with the cavities of the honeycomb rock, the operation of freeing unbroken specimens is a delicate one. With the aid of chisels and forceps I succeeded with great difficulty in obtaining, in addition to other material, three worms complete from head to tail.

My experiences confirm the discoveries of Krämer and Friedlaender as to the origin of the "Palolo." The accompanying figure, which is drawn to scale, shows the complete animal, the broad anterior atokal portion being sharply marked off from the more attenuated and much longer posterior epitokal part which, when free-swimming, is known as the "Palolo." The total length averages 400 mm., about one fourth of this length being in the anterior atokal part. 429, 359, and 250 atokal segments were counted; the first two in male specimens the latter in a

female. These figures are not accurate as a dense gelatinous secretion in the posterior part of the atokal region makes it difficult to count the segments. The greatest diameter of the atokal region is 4 mm. and that of the epitokal region 1-1½ mm. diminishing gradually at the anal end, and more abruptly at the junction of the atokal and epitokal parts. The color of the male is



Eunice viridis (Gray). The narrow posterior epitokal part when detached and free-swimming is known as the "Palolo." $\times 2$.

reddish brown, that of the female bluish green. These colors, which are very marked in the epitokal portions are due to the colors of the sperm and ova; after the discharge of these elements the collapsed integument is translucent and colorless. These distinctive sexual colors are also present in the atokal parts but are not so marked, the female being more greenish in

hue than the male; the colors here are integumentary. Each of the epitokal segments bears on its ventral surface a prominent pigmented spot, the "Bauchauge" of Ehlers. These eye spots can be traced into the atokal part through about 20 segments, diminishing in size toward the anterior end; they are lacking on the anal segment and are usually absent in 2-6 of the preanal segments.

A similar swarming of marine annelids, and at corresponding seasons, is known for other islands of the Pacific, though the worms have not everywhere been identified. Powell¹ speaks of them in the Gilbert Islands where they are known to the natives as *te nmatamata* and Codrington² gives a detailed account for Mota in the Banks Islands where they are known as *un*.³ Brown⁴ mentions an annual appearance of a "Palolo" on the East coast of New Ireland, and the *warwo* of Rumphius which occurs at Amboina in the Moluccas is doubtless the same, as has been pointed out by Collin.⁵ Seeman⁶ mentions the occurrence in the New Hebrides, and it is known in Fiji and Tonga. It is reasonable to suppose that a systematic search would show the "Palolo" or some allied form to have a wider distribution in the coral reefs of the Pacific than has been as yet recorded. That the annelid is best known from Samoa and Fiji is accounted for by these two groups of islands having been most visited and longest inhabited by whites. It is significant also that such records as we possess from other places, though meager, have come to us through the missionaries, the pioneers of intelligent whites in the islands of the Pacific.⁷

¹ Powell, T. Remarks on the Structure and Habits of the Coral Reef Annelid *Palolo viridis*. *Journ. Linn. Soc. London*. Vol. 16, pp. 393-399. 1883.

² Codrington, R. H. *The Melanesians. Studies in their Anthropology and Folke Lore*. Oxford 1891.

³ Doubtless the *a'oon* of McIntosh.

⁴ Brown, G. Notes on the Duke of York Group, New Britain and New Ireland. *Journ. Roy. Geog. Soc.* Vol. 47, pp. 137-150. 1877.

⁵ *Op. cit.*

⁶ Seeman, B. *Viti. An Account of a Government Mission to the Vitian or Fijian Islands in the Years 1860-1861*. Cambridge 1862.

⁷ Cases of swarming associated with extreme sexual dimorphism have been described for a Eunice from Florida (Mayer, A. G., *Bull. Mus. Comp. Zool.* Vol. 37, 1900) and for one of the Lycoridæ from Japan (Izuka, A., *Journ. Coll. Sci. Imp. Univ.* Tokyo, 1903).

The "Palolo" makes its appearance in Samoa in the months of October and November during the last quarter of the moon. This is the time of the lowest or spring tides when the reef flats in shallow places are uncovered or only awash, and at this season the sun is nearest to the zenith. I must reserve for my final paper a discussion of the causes of the swarming of the "Palolo" and will only say here that I am inclined to believe in some thermotropic or heliotropic reaction of the eyes borne on the ventral segments of the epitokal part of the worm. These eyes have recently been studied histologically by Hesse¹ on material collected by Krämer. Hesse states that from their structure the eyes probably do not form images, but function rather in reacting to light of different intensities, the direction of light and possibly to different colors. It is significant that these eyes are found only on a few of the posterior segments of the atokal sedentary part and are not well developed; while on the other hand they are highly developed on all but the anal segments of the epitokal active part which leads such an ephemeral free existence.

This spring season is recognized as the period of ripeness and sexual activity throughout the Pacific Islands and where the "Palolo" occurs the season and even the months are named for it. All of the many other kinds of annelids inhabiting the reefs are sexually mature as shown by the extensive collections made by Krämer and myself in Samoa and Fiji and this is true also of the reef fauna in general. The spawning time of the land crabs, the occurrence of certain fish, etc., is reckoned by the natives as so many days before or after the "Palolo," and so for the appearance of blossoms the ripening of fruits and tubers. In Samoa the "Palolo" season is called *taumafamua* (*i. e.* the time of much to eat), in the Banks Islands they say "*tau matua* the season of maturity, yams can be eaten."²

The "Palolo-time" in Samoa embraces three successive days. When in the last quarter of the moon in October and November, more especially the latter, the water on the "Palolo-grounds"

¹ Hesse, R. Untersuchungen über die Organe der Lichtempfindung bei niederen Thieren. V, Die Augen der polychaeten Anneliden. *Zeitschr. wiss. Zool.*, Bd. 65, pp. 459, 1899.

² Codrington, *op. cit.*

has a turbid or riled look, with floating patches of scum, the natives know that two days later the "Palolo" will 'rise.' This first day is called *salefu*. The second day is marked by the swarming of a small annelid, headless like the "Palolo," and the sexes distinguished by the same yellow and greenish tints. This day is called *motusaga*. The third is the *tatelega* when the "Palolo" swarms and the natives come many miles to the favored places to gather it. With "Palolo" of the *tatelega* day many of the small annelids of the *motusaga* occur, and a few "Palolo" appear on *motusaga* day. A microscopical examination of the *salefu* scum shows it to consist of a gelatinous slime in which are grains of sand, appendages, fragments and casts of Entomostraca and a varied detritus of the seething life inhabiting the reefs, including many ova of various kinds in different stages of segmentation. The *salefu* may be looked upon as a manifestation of the awakening of the "Palolo" previous to its swarming or marriage-swim; an annual activity of countless numbers of annelids resulting in a discharge into the water of the deposits accumulated in the galleries and crevices of the reef-flats. The small annelid of *motusaga* day is *Lysidice falax* Ehlers, the *L. vividis* (Gray) to which the "Palolo" was so long ascribed.

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