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Predicting spawning date of nyale worms (Eunicidae, Polychaeta) in the southern coast of Lombok Island, Indonesia

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Abstract. Bachtiar I, Bachtiar NT. 2019. Predicting spawning date of nyale worms (Eunicidae, Polychaeta) in the southern coast of Lombok Island, Indonesia. Biodiversitas 20: 971-977. Spawning of marine nyale worms has been an important component of Sasak tradition of *Bau Nyale* (fishing nyale) for centuries and a tourism icon of the District of Lombok Tengah since the 1990s. Nyale is a mixture of epitokes of 3-5 species of Polychaeta worms (mostly *Palola* spp.) for reproduction. At present, prediction of spawning date of the nyale worms is carried out traditionally that might not satisfy demand of tourism market. The present study is to develop a scientific-based method for predicting date of nyale worms spawning or nyale swarming. Since available data are scarce, development of the method of data collection mainly uses analogy from polychaetes and other invertebrate reproduction patterns and any available information from traditional customs. Three hypotheses were developed to generate prediction for 100 years, from 2000 to 2100, and then these prediction dates were verified using available data before 2018. In the past 9 years, there are two mismatches between scientific and traditional predictions, i.e., 2015 and 2017 spawnings, in favor of the new prediction method. The new scientific prediction method provides more objective and accurate date of nyale worm spawning than the traditional method. The present prediction also shows that split spawning dates, February and March, do not come to pass every year, as traditional nyale fishers generally believe them. It is also found that nyale worms are consistently using international lunar calendar for its spawning date, instead of local and national lunar calendars. This study provided the first scientific nyale swarming prediction in Lombok to complement existing traditional prediction. The prediction is very useful to promote the biggest annual traditional festival in Lombok for international visitors.

Keywords: *Bau nyale*, cultural, Polychaete, swarming, tourism

INTRODUCTION

Prediction of polychaete worms spawning, sometimes called as swarming, is very much important for Sasak community in Lombok Island. During the spawning night, polychaete worms release their epitokes (or *nyale*, Sasak) swarming in the water column. The swarming nyale will be naturally fragmented by waves that release sperms and eggs packed inside them into seawater. In the present study, nyale worms are defined as Polychaete worms that produce swarming epitokes during the *Bau Nyale* (nyale fishing) tradition in Lombok Island. The nyale fishing tradition is carried out throughout a nyale swarming night that occurs once or twice a year.

Nyale worms are not a single species. Nyale worms at least consist of *Eunice* (*Palola*) *viridis* and *Lysidice collaris* (Jekti et al. 1993), and they are about the same as *palolo* worms (*Eunice viridis*, *Palola viridis*, *P. siciliensis*) in Samoa (Caspers 1984) and *wawo* worms (*Eunice* spp., *Palola* sp., *Lysidice oele*) in Ambon (Pamungkas 2015). Coastal people have traditionally utilized these large-body Polychaete worms for ages, but their reproductive cycle has been under examination and prediction of their spawning dates is merely prepared by traditional leaders. Scientific prediction on nyale swarming is not yet available.

Cultural value of Polychaete spawning has been strongly linked to myth and folklore. It has been hundreds of years that coastal community only rely on traditional prediction for determining date of nyale fishing. Along with their experiences on inaccuracy of the traditional prediction, traditional community has also developed local wisdom of elegant defense when traditional prediction failed. They blame the inaccuracy prediction to incomplete natural signs required for nyale swarming. This local wisdom and virtuosity to protect their traditional leader from making charitable mistakes is observed in many communities utilizing swarming worms, including Samoa, Hawaii (Caspers 1984; Mundy and Green 1999) and Sasak (Lombok). In Lombok Island, nyale swarming is no longer merely cultural event, but it is also an important economic asset as tourism attraction.

Absorbing nyale fishing tradition into tourism market gives result in demand to have more accurate prediction on date of nyale swarming. Government promotes the event of nyale fishing festival internationally just after a sacred meeting is run by cultural leaders, *Sangkep Beleq*. The traditional meeting is to determine the date of nyale swarming, which is usually held in early December. The meeting comes up with the date of nyale swarming on the following year on February-March. Tourism market needs

beforehand information on the date of swarming, as early as one year. The market also needs more accurate prediction to satisfy visitors. Both demands, however, can hardly be fulfilled by traditional prediction. When this cultural event becomes tourist attraction, however, the elegant defense might no longer be acceptable. There is an urgent need, therefore, to have a scientific prediction. Spawning of nyale worms is biologically an ultimate part of reproduction processes that it should be scientifically predictable.

Reproduction cycle has been predictable in many marine invertebrates. Spawning animals invest high amount of resources with low fertilization opportunity in aquatic environment. Reproductive synchrony is therefore very much important to maximize reproductive output. Such asynchrony may be achieved by using natural cues from annual cycles of temperature (Olive 1980; Willis et al. 1985; Babcock et al. 1986) or photoperiod (Olive 1995) or both of them (Babcock et al. 1994; Olive 1995; Brownstein and Loya 2015), and lunar or tidal cycles (Fong 1993). Coral reproduction in the Great Barrier Reefs has long been accurately predicted to species level and hours of spawning time (Willis et al. 1985; Babcock et al. 1986) since it has been known that their spawning date and time are strongly linked with temperature, moon phase, and tidal cycles.

Reproductive patterns of nyale worms annual spawning, however, is less studied. Caspers (1984) has studied patterns of palolo worm spawning from data of 127 years observations at Samoa. He found that spawning of palolo is consistent in several days but inconsistent in other days. There is neither similar study on prediction of palolo swarming nor wawo and nyale swarming. Swarming of these highly cultural-value worms is predicted only by traditional method that unable to satisfy demands of tourism market.

The present study developed a scientifically based method to predict the date of nyale swarming. Constructing such a prediction model requires data on spawning dates on previous years. In the case of nyale worm spawning, there are very few data available. Both traditional community and government do not have record of swarming dates, including date of large and low harvest of nyale. This paper will predict dates of nyale swarming based on only 4 (four) available data and verify the prediction with available data on websites.

MATERIALS AND METHODS

Hypothesis development

Previous studies on marine invertebrate showed that spawning patterns of nyale worms are similar to spawning patterns of corals. It has been reported that Polychaete spawned at about the same nights with coral spawning in the Great Barrier Reefs (GBR), Australia (Willis et al. 1985; Babcock et al. 1986; Hutching and Howitt 1988) and in Samoa (Mundy and Green 1999). Coral spawning in GBR usually occurs once a year in October or November or in both months (Harrison et al. 1984; Willis et al. 1985; Babcock et al. 1986). Palolo worms spawning also take place in October and November in Samoa (Caspers 1984). It has also been known that dates of coral and palolo worm

spawning are synchronized by lunar cycle (full moon).

Similarities between spawning patterns of corals and polychaete worms suggest that coral spawning prediction method at GBR can be customized to predict polychaete worm spawning at Lombok waters. Cultural leaders of Lombok people (Sasak) testify that spawning date of nyale worms regularly occurs once a year in February and March. Date of spawning is on the twentieth of lunar date in the Sasak or Rowot Calendar. In Lombok, some coral spawning also peaks in February and March (Bachtiar 2001) and the spawning date is strongly related to full moon. Furthermore, coral spawning in Lombok waters is about the same as in Dampier Archipelago, Western Australia (Babcock et al. 1994). These similarities suggest the existence of a particular spawning pattern in nyale worms of Lombok waters.

In the GBR, coral spawning pattern has critical dates related to the full moon of October. Corals had split spawning in October and November, when full moon occurred in 10th and 13th October as happened in 1981 and 1984 respectively (Willis et al. 1985). Soft corals of the GBR also had split spawning in October and November when full moon occurred in 7th October 1987 (Alino et al. 1989). Caspers (1984) observation on palolo worms in Samoa revealed that palolo swarming was consistent when it occurred between 18th-31th October and 1st-18th November, but it inconsistent between 8th-18th October and 18th-23rd November. He also recorded that palolo worm spawning takes places on the last third quarter of the moon phase, or 6 days after the full moon.

Spawning observations during the last 4 (four) years (2015-2018) revealed that: (i) Spawning of nyale worms take places only in February (2016), only in March (2015, 2018) or in both February and March (2017). (ii) Date of spawning always takes places in the 20th lunar day (5 days after the full moon), regardless of the month of spawning. (iii) Time of spawning also consistently start at 03:00 am early in the morning. (iv) There was no spawning in February 2015, when full moon occurred on 4th of February 2015. Neither spawning occurred in February 2018, when full moon appeared on 31st January. (v) Spawning may be distributed or split in two months, February and March. The split spawning took place in 2017, but did not happen in 2015 and 2016.

Based on existing studies on coral spawning and the four years observations, we developed three hypotheses (Figure 1): (i) Spawning will take place 5 days after the full moon of March only, when February full moon occurs in the first quarter (1-6 solar days). (ii) Spawning will occur 5 days after the full moon of both February and March, when the full moon of February arises in the second quarter (7-14 solar days). (iii) Spawning will happen 5 days after the full moon of February only, when February full moon occurs in the second half (15-29 solar days).

These hypotheses need to be verified with existing data to determine its accuracy. In the present study, 100 prediction of spawning dates were generated based on the three hypotheses to see patterns of the swarming (Table 1). The prediction dates are then verified with data of spawning dates in the past (2007-2018).

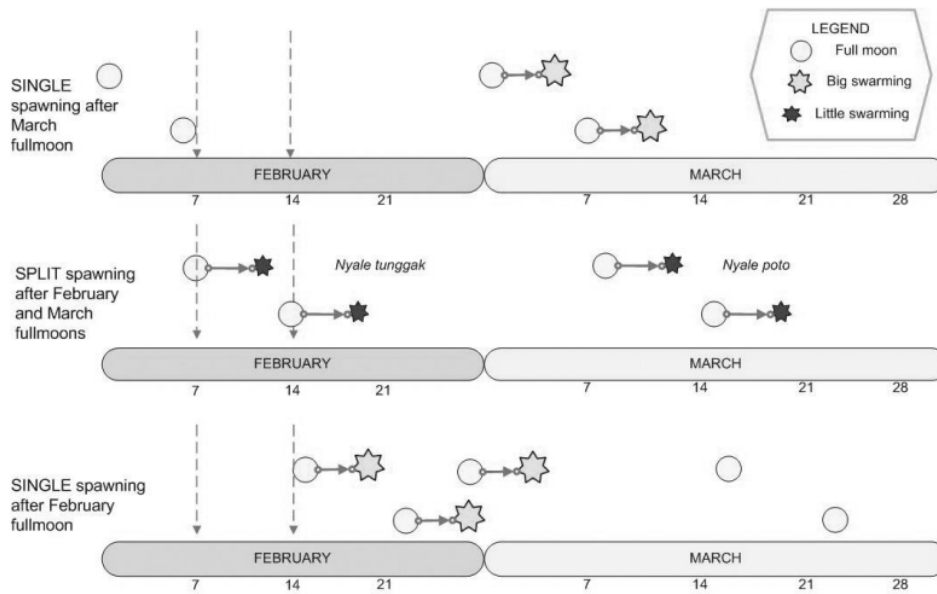


Figure 1. Hypotheses of spawning patterns of nyale worms in southern coast of Lombok Island, Indonesia

Data collection

Data of full moons in international lunar calendar or Chinese lunar calendar were collected from www.timeanddate.com. Data of full moons on lunar National (Hijri), Bali and Rowot Calendars were collected from printed calendars.

Spawning dates of nyale worms were observed in February and March during the period of 2015-2018. Additional data on nyale worm spawning were collected from social media that was available on the internet. Some people posted their travels on *Bau Nyale* Festive. Sometimes, they included reports on how much worms were collected. These data are the only available data to verify the hypotheses.

Data of dates of spawning published in online media were selectively used in verification. Online media mostly used data from the government source. They usually produced information on government preparation for the *Bau Nyale* Festive and the date of the coming festive. Two times (2015, 2017) in the last four years, however, dates of spawning issued on government websites were inaccurate. When wrong prediction occurred, online media did not report about this issue, neither did government website. The news about the *Bau Nyale* Festive in online media, therefore, showed low accuracy.

There were no available data on government offices to verify the hypotheses. Government-produced online information on *Bau Nyale* Festive, but it is only about dates when the festival will be carried out on a particular year. This data will only be used as supporting data.

RESULTS AND DISCUSSION

Scientific prediction revealed that during the period of 2000 to 2100 (100 years), months of nyale worms spawning would be distributed unequally in favor to March than February. Spawning frequency in February, March and both months (split spawning) are 58, 68 and 25 respectively (Table 1). These results show some significant differences from existing local knowledge on nyale swarming. It is thought that February is the most common spawning month of nyale worms, but this prediction model shows that nyale swarming is more frequent on March than February.

The scientific prediction also shows that split spawning does not come about every year. This prediction is in contrast with community perception or beliefs from traditional leaders. They claim that nyale swarming always occurs two times a year, in February and March. The first nyale swarming is called *nyale tunggal* (in February) and the second swarming is called *nyale poto* (in March). They are also aware that abundance of nyale between the two swarming dates is not the same, sometimes more plentiful on the first swarming in other times it is more copious on the second one. In 2015, 2016, 2017 and 2018, traditional nyale fishers came to Mandalika Beach in both February and March. They only found the split spawning in 2017.

Table 1. A century spawning prediction generated from Bachtiar hypotheses

Year	Fullmoon		Predicted swarming date	Year	Fullmoon		Predicted swarming date
	Feb.	Mar.			Feb.	Mar.	
2000	20	20	25 Feb.	2051	25	27	2 Mar.
2001	8	10	Split spawning 13 Feb. and 15 Mar.	2052	15	15	20 Feb.
2002	27	29	4 Mar.	2053	3	5	10 Mar.
2003	17	18	22 Feb.	2054	22	24	27 Feb.
2004	6	7	12 Mar.	2055	12	13	Split spawning 17 Feb. and 18 Mar.
2005	24	26	1 Mar.	2056	1	2	7 Mar.
2006	13	15	Split spawning 18 Feb. and 20 Mar.	2057	19	21	24 Feb.
2007	2	4	9 Mar.	2058	8	10	Split spawning 13 Feb. and 15 Mar.
2008	21	22	26 Feb.	2059	27	29	4 Mar.
2009	9	11	Split spawning 15 Feb. and 16 Mar.	2060	16	17	21 Feb.
2010	-	1, 30	6 Mar.	2061	4	5	10 Mar.
2011	18	20	23 Feb.	2062	23	25	28 Feb.
2012	8	8	Split spawning 13 Feb. and 13 Mar.	2063	13	15	Split spawning: 20 Feb. and 20 Mar.
2013	26	27	3 Mar.	2064	3	3	8 Mar.
2014	15	17	20 Feb.	2065	21	22	26 Feb.
2015	4	6	11 Mar.	2066	10	12	Split spawning 15 Feb. and 17 Mar.
2016	23	23	28 Feb.	2067	-	1, 31	6 Mar.
2017	11	12	Split spawning 15 Feb. and 17 Mar.	2068	18	19	23 Feb.
2018	-	2, 31	7 Mar.	2069	6	8	13 Mar.
2019	19	21	24 Feb.	2070	25	27	2 Mar.
2020	9	10	Split spawning 14 Feb. and 15 Mar.	2071	14	16	Split spawning: 19 Feb. and 21 Mar.
2021	27	29	4 Mar.	2072	4	4	9 Mar.
2022	17	18	22 Feb.	2073	22	24	27 Feb.
2023	6	7	12 Mar.	2074	12	13	Split spawning 17 Feb. and 18 Mar.
2024	24	25	29 Feb.	2075	1	3	8 Mar.
2025	12	14	Split spawning 17 Feb. and 19 Mar.	2076	20	21	25 Feb.
2026	2	3	8 Mar.	2077	8	10	Split spawning 13 Feb. and 15 Mar.
2027	21	22	26 Feb.	2078	27	28	4 Mar.
2028	10	11	Split spawning 15 Feb. and 16 Mar.	2079	16	17	31 Feb.
2029	-	1, 30	6 Mar.	2080	5	6	11 Mar.
2030	18	20	23 Feb.	2081	23	25	28 Feb.
2031	7	9	Split spawning 12 Feb. and 14 Mar.	2082	13	15	Split spawning 18 Feb. and 20 Mar.
2032	26	27	3 Mar.	2083	3	4	9 Mar.
2033	14	16	Split spawning: 19 Feb. and 21 Mar.	2084	22	22	27 Feb.
2034	3	5	10 Mar.	2085	10	11	Split spawning 15 Feb. and 16 Mar.
2035	22	24	27 Feb.	2086	28	30	5 Mar.
2036	12	12	Split spawning 17 Feb. and 17 Mar.	2087	17	19	22 Feb.
2037	-	2, 31	7 Mar.	2088	7	7	Split spawning 12 Feb. and 12 Mar.
2038	20	21	25 Feb.	2089	25	26	2 Mar.
2039	9	11	Split spawning 14 Feb. and 16 Mar.	2090	14	16	Split spawning: 19 Feb. and 21 Mar.
2040	28	28	5 Mar.	2091	4	5	10 Mar.
2041	16	18	21 Feb.	2092	23	24	28 Feb.
2042	5	7	12 Mar.	2093	11	13	Split spawning 16 Feb. and 18 Mar.
2043	24	25	1 Mar.	2094	-	2	7 Mar.
2044	13	14	Split spawning: 18 Feb. and 19 Mar.	2095	19	21	24 Feb.
2045	2	3	8 Mar.	2096	8	9	Split spawning 13 Feb. and 14 Mar.
2046	21	22	26 Feb.	2097	26	28	3 Mar.
2047	10	12	Split spawning 15 Feb. and 17 Mar.	2098	16	17	21 Feb.
2048	29	30	5 Mar.	2099	5	7	12 Mar.
2049	18	19	23 Feb.	2100	24	26	29 Feb.
2050	7	8	Split spawning 12 Feb. and 15 Mar.				

Note: Feb.: February, Mar.: March

Verification of the accuracy of the prediction shows that the scientific prediction in this study is very accurate. Data from 2007 to 2014 collected from traveler posts on their blogs are almost all in agreement with prediction. There is a disparity, however, between scientific prediction and online-media in 2009 (Table 2). The present scientific prediction reveals that nyale worms had a split spawning on 14th February and 16th March 2009. Two online-media

(Antara and Lombok Guide) showed that government announcement on date for *Bau Nyale* was on 15th February. Another online media, Viva, reported the same date and also claimed there were about 30 thousand visitors came to the event. There was no report, however, whether nyale worms really spawned on the predicted morning or not, and no picture showing nyale worms. Such online-media data did not necessarily confirm the date of nyale worm

spawning. They only reported that *Bau Nyale* Festival was there. For example, many online-media and blogs reported that government cultural programs for *Bau Nyale* 2015 would be held in 10th February. The crowd was there but there was no swarming nyale. The failure of government prediction in 2015 did not appear in online media and blogs, but the 2017 failure was reported in one online media only, Liputan6.com.

Swarming observation made between 2015-2018 showed that scientific prediction is very much more accurate than government prediction. In 2015, government prediction missed one month. It was said that *Bau Nyale* festive would be held on 9th February but nyale swarm actually occurred on 11th March 2015. Furthermore, in 2017, government prediction missed one day. *Bau Nyale* was said to be done on 17th February but all nyale has already swarmed on 16th February. In the last 5 years,

government prediction missed two times but scientific prediction showed its 100% accuracy.

There is one case that small number of nyale swarmed outside the predicted date. In 2018, scientific prediction was the same as government prediction. It was expected that there would not be any nyale swarming in February since there was no full moon on February 2018 (Chinese calendar). In national Hijri calendar, full moon occurred on 1st February. A few people went to fishing nyale and some of them showed that they caught small number of nyale in social media. The minor nyale swarming was reported happening at Kaliaantan Beach, Mandalika Beach and its surroundings (Kuta, Seger and Serinting Beaches). The real swarming took place on 7th March 2018. It was estimated 25 thousand people went fishing nyale and they caught a large number of nyale (*nyale tumpah*). Such a February minor swarming was also reported in Caspers (1984) and was considered not to be included in swarming pattern.

Table 2. Verification of nyale swarming prediction in Mandalika Beach, Lombok, Indonesia

Year	Scientific prediction	Verification	Sources*	Notes
2007	9 Mar.	Accurate	https://lombokleisuretour.com/festival-bau-nyale/ https://tickets.wordpress.com/2010/09/24/pantai-kuta-lombok-selatan/ http://hubbulwatoni.blogspot.com/p/blog-page_29.html http://mahsan-lombok.blogspot.com/2011/04/bau-nyale.html http://matalombok-tourtravel.blogspot.com/2009/	Single spawning
2008	26 Feb.	Accurate	https://rumah-wisata.blogspot.com/2008/02/lombok-kembali-gelar-tradisi-bau-nyale.html https://www.antarafoto.com/korporasi/v1204109661/tradisi-bau-nyale	Single spawning
2009	14 Feb. and 16 Mar.	GP (15 Feb), no confirmation	https://www.viva.co.id/berita/nasional/30309-valentine-disambut-bau-nyale-di-lombok http://www.thelombokguide.com/issue_31.html#bau_nyale_2009 https://mataram.antaranews.com/berita/1072/menyambut-putri-nyale-di-pantai-selatan-oleh-anwar-maga	Split spawning
2010	6 Mar.	Accurate	http://forum.detik.com/festival-bau-nyale-di-kuta-lombok-tgl-5-6-March-t142858.html https://www.antarafoto.com/peristiwa/v1267862403/tradisi-bau-nyale	Single spawning
2011	23 Feb.	Accurate	https://travel.detik.com/event-wisata/d-1573547/festival-pesta-rakyat-bau-nyale-2011 http://www.berbagifun.com/2011/03/pesta-bau-nyale-lombok-part-2.html	Single spawning
2012	13 Feb. and 13 Mar.	Accurate	http://www.kemepar.go.id/asp/detil.asp?c=16&id=1196 http://wonderfulnusantaraa.blogspot.com/2017/09/festival-bau-nyale-2012-melebur-dalam.html# https://news.detik.com/foto-news/1840845/karnaval-jelang-festival-bau-nyale/1 http://budi-lombok18.blogspot.com/2012/02/event-bau-nyale-di-pantai-seger-kuta.html	Split spawning
2013	3 Mar.	Accurate	http://www.kemepar.go.id/asp/detil.asp?c=43&id=308 http://www.berbagifun.com/2013/02/bau-nyale-2013-di-lombok-tengah.html http://ultimoparadiso.com/keunikan-festival-bau-nyale-angkat-pariwisata-lombok.html	Single spawning
2014	20 Feb.	Accurate	https://www.thelangkahtravel.com/wisata-di-lombok-festival-bau-nyale/ http://lombok.panduanwisata.id/wisata-sejarah/pesta-adat-bau-nyale-di-nusa-tenggara-barat/ http://www.jurnalsulawesi.com/wisatawan-diajak-meriahkan-tradisi-bau/	Single spawning
2015 **	11 Mar.	Accurate	Present study	Single spawning
2016	28 Feb.	Accurate	Present study	Single spawning
2017 ***	16 Feb. and 19 Mar.	Accurate	Present study	Split spawning
2018	7 Mar.	Accurate	Present study	Single spawning

Note: *collected from Google searching; ** government (traditional)'s prediction (GP) missed one month; *** missed one day

There were two other mismatches, however, between the scientific prediction and dates of nyale worm spawning published in proceeding and journal articles. In 1992, nyale swarming was reported to take place on 23rd February and 23rd March (Jekti et al. 1992). Since February full moon occurred on 18th February 1992, scientific prediction did not show split spawning but single spawning in 23rd February. In addition, nyale swarming in 1993 was reported to have happened on 13th February (Jekti et al. 1993). This was one day mismatch with the prediction. In 1993, full moons were on 7th February and 8th March, that nyale was expected to have split spawning on 12th February and 13th March. The mismatches in 1992 and 1993 swarming left without any convincing explanation.

There are explanations, however, for government missed predictions in 2015 and 2017. In both years, nyale swarming was in favor of scientific prediction. In 2015, the government missed one month. On the present hypotheses, nyale would never swarm before 12th February. Since February full moon was on 4th February, then nyale would swarm after the March full moon, 11th March. In 2017, government's missed prediction was due to difference in dates of full moon among printed calendars. Hijri (national) and Rowot (Lombok) lunar calendars showed that the full moon occurred on 12th February, therefore they predicted nyale swarming on 17th February. In contrast, Chinese and Balinese lunar calendars indicated the full moon was on 11th February that, according to these calendars, nyale would be swarm on 16th February. The fact was nyale swarmed on 16th February.

Concurrence the date of nyale swarming to Chinese lunar calendar has also happened on 2016 swarming. There were four versions of February full moon among four lunar calendars. Lunar calendars of Balinese, Nasional (Hijri), Chinese and Rowot displayed February full moon on 21st, 22nd, 23rd, and 24th respectively. Nyale swarming occurred on 28th February. So far, there are two cases indicating that nyale worms are likely run-through Chinese lunar calendar.

The present study still has two unresolved concerns. Firstly, critical date of February full moons that changes spawning pattern, i.e., 7 and 14 of February (solar calendar), is urgent to be determined its accuracy. These critical dates were constructed with very limited data. Since there are no sufficient available records and nyale reproductive cycle only once a year, we need to wait until 2031 and 2050 (February full moon will be on 7th) and 2034 and 2071 (February full moon will be on 14th). Available data on other places may be helpful to understand these critical dates in nyale swarming. Furthermore, this study does not recognize the inconsistency of spawning dates as reported by Caspers (1984). He recorded several dates when palolo swarming occurs inconsistently, i.e., 8th-18th October and 8th-23rd November. Since palolo swarming take place 7 (seven) days after the full moon in Samoa (Mundy and Green 1999), the inconsistent swarming dates occurred when October full moon happens on 1st-11th October. In Lombok, nyale swarming was predictable when February full moon

was on 4th February (2015), 11th February (2017) and none on February (2018). Since data on nyale swarming dates are very much less than data on palolo swarming, it did not really show that patterns of nyale swarming do not support Caspers' observation in Samoa.

This study potentially can be used to find out spawning patterns of wawo worms in Ambon and palolo worms in Samoa. Palolo worms in Samoa have a good record of their spawning times. Wawo worms in Ambon, however, might not have records on their spawning, unless there is a missionary recording data as what happened in Samoa. In developing countries, such as Indonesia and Samoa, government staffs are very rare in recording data on natural cycles of animal reproductions as the spawning of nyale worms. When there is no scientist studying the animal, there will not be any data for centuries.

The present scientific prediction can be used to satisfy tourism market demand in promotion. Using this prediction traveler can make an accurate and long-term travel plan when they want to see nyale fishing (*Bau Nyale*) festival. It should be realized however that the prediction should not dismiss existing traditional sacred meeting to determine date of nyale fishing, the *Sangkep Beleg*. Since the meeting is part of the cultural protocol in *Bau Nyale* tradition, the scientific prediction should be apprehended as scientific contribution to strengthening cultural and economic development. Indonesian Ministry of Tourism and Culture should adopt the present study to better promoting Lombok tourism. A century nyale swarming dates predicted in the present study (see Table 1) would be more than sufficient to improve tourism promotion for international travelers.

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