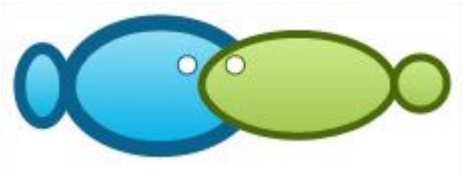

Egg quantity of wild breeders of spiny lobster (*Panulirus ornatus*) caught from southern coastal waters of Bulukumba, South Sulawesi, Indonesia

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Abstract. The rock spiny lobster (*Panulirus ornatus*) is the most valuable fishery resource in Indonesia and one of an important traditional and commercial fisheries in southern part south Sulawesi. Assessment of the population in the southern coastal waters of Bulukumba South Sulawesi, Indonesia is the subject of this study. Fecundity of the spiny lobsters, *P. ornatus* was calculated as the number of eggs deposited on the ovigerous setae on the pleopods. The smallest breeder of *P. ornatus* had a carapace length (CL) of 77.7 mm while the biggest one had a CL of 188.2 mm. The number of eggs in a single brood of *P. ornatus* ranged from from 88,000 in the smallest lobster to 1,546,226 in the biggest one. The increasing size of the single lobster is likely to increase the number of eggs. The egg quantity of these lobsters is expected to be normal.
Key Words: *Panulirus ornatus*, egg quantity, carapace length, body weight.

Introduction. Lobster fisheries generate considerable foreign exchange, contribute to the Gross Domestic Product and provide jobs and income for fishermen and their families in many countries. Spiny lobster (*Panulirus ornatus* Fabricius, 1798) is a crustacean, which inhabits shallow waters usually no deeper than 50 m and has a wide distribution in the tropical waters. *P. ornatus* is widely distributed in all shallow-waters areas around southern part of marine waters of Bulukumba (Musbir et al 2014). It can be found in sea-grass beds, among coralline growth and on sandy or rocky bottom. In the last few years, there has been a growing trend in catching live lobsters (Musbir et al 2016). Fishing occurs mostly at depths from 3 to 20 m on the extensive shelves of the south coast.

Biological information such as fecundity, size at sexual maturity, size distribution, carapace length (CL) - bodyweight (BW) relationship and sex ratio are important criteria to study the behavior and characteristics of *P. ornatus* and significantly estimating the size of lobster population in relation to the number taken by the fishery.

As this species has become an economic value to the market, hence sufficient data and information on the distribution and growth of this species are needed. The objectives of this study are to determine the biological features by analyzing the number of eggs, relationship between CL and egg number, relationship between BW and egg number of *P. ornatus* from southern coastal water of Bulukumba, South Sulawesi, Indonesia.

Material and Method

Study area. Indonesia is one of the tropical countries with high temperatures during dry season and normal temperature in the rainy season. Sulawesi is one of the biggest five islands of Indonesia. Based on administration government, the Sulawesi Island was divided into six provinces, including South Sulawesi province. South Sulawesi is located between $0^o12'$ and 8^o south latitude and between 116°48' and 122°36 74^o west longitude. For management purposes, the South Sulawesi marine area is divided into three fishing zones according to geographical location including: Makassar Strait, Flores

Sea and Bone Bay. The lobster fishery takes place in these three areas, in shallow waters, where the sea floor is sandy with rocks and coral reefs. This study focuses on the *P. ornatus* population inhabiting the southern area coastal waters of the Bulukumba, South Sulawesi.

Sampling design. Surveys were conducted between March and November in three consecutive years, 2014, 2015 and 2016. The most common type of commercial fishing gear for *P. ornatus* in southern coastal waters of Bulukumba is bottom gill net which is monofilament. These bottom gill nets usually have stretched meshes size of 12.5-15.0 cm. The total length is about 1200 meters (m), depth from 1.5 m. In general, the nets are left in the water for 24 h (one fishing day). A longer set time leads to better catches of *P. ornatus*, as it is attracted by fishes, crustaceans, mollusks and other invertebrates caught in the nets.

Berried *P. ornatus* caught in bottom-set gill nets were collected from the fishing base at Bulukumba Beach. The breeders were brought to the field laboratory of the Department of Fisheries, Hasanuddin University at Makassar and maintained in filtered seawater with adequate aeration.

The lobsters collected from the landing centre, within 200 meters from the laboratory, were transferred immediately to rearing tanks. After measuring the carapace length (CL) and total weight, the berried lobsters were weighed after shaking off the adhering water from the egg mass. Three samples of eggs, containing around 200-250 numbers, were taken and weighed to 0.01 mg accuracy. The number of eggs in the samples was counted accurately to determine the weight of single egg and to estimate the number of eggs in the brood. Total egg mass in a brood was calculated by the difference between initial weight (with egg) and the weight after the release of the eggs.

Results and Discussion. The smallest breeder of *P. ornatus* had a CL of 77.7 mm while the biggest one had a CL of 188.2 mm. The number of eggs in a single brood varied from 88,000 in the smallest lobster to 1,546,226 in the biggest one (Table 1).

Table 1

Number of eggs in a single brood in the spiny lobster, *Panulirus ornatus*

No	*Carapace length (mm)*	*Total weight (g)*	*Number of eggs*	*Number of eggs per g body weight*
1	77.7	546	88,000	161.2
2	87.5	558	134,000	240.1
3	98.2	934	321,000	343.7
4	104.4	1049	452,628	431.5
5	108.9	1250	526,562	421.2
6	115.3	1350	1,086,262	804.6
7	127.3	1700	1,150,345	676.7
8	130.3	1900	1,254,000	660.0
9	139.6	2500	1,290,000	516.0
10	142.2	2400	1,289,455	537.3
11	145.1	2800	1,312,000	468.6
12	1689	2800	1,423,680	508.5
13	185.2	3550	1,551,155	436.9
14	188.2	3300	1,546,226	468.6

Variation was found in the weight and numbers of eggs in some size groups since few lobsters were carrying a second brood with a single mating. The second brood from a single mating, which could be distinguished by the presence and nature of spermatophore in the sternum, was smaller than the first one in most of the lobsters.

The size of *P. ornatus* was larger than that of the other species in southern coastal waters of Bulukumba. The brood size of 1,546,226 recorded in *P. ornatus* (weight: 3.3 kg) is as large as two million eggs reported for the largest lobster, 1.97 million eggs

reported for *P. ornatus* by Vijayakumaran et al (2012), and 1.95 million eggs reported for *P. argus* (Bertelsen & Matthews 2001). Since *P. ornatus* grows to over 6.5 kg, the size of the single brood is likely to increase in larger lobsters, as the bigger the lobsters the larger are the number of eggs. Murugan et al (2005) have observed that under captive breeding, *P. ornatus* could produce three spawnings in six months and MacFarlane & Moore (1986) have suggested that this species could spawn 3 to 4 times in a year. The fecundity of *P. ornatus* could thus be four times the average production of 1,121,507 for breeders weighing 1.5 kg and in the fourth or fifth year age group.

In our study, a good representative sample of *P. ornatus* breeders of different size groups ranging from 77.7 to 188.2 mm CL indicated a trend that the brood size is proportional to the CL of lobsters and the number of eggs produced increases with the size of lobsters (Table 1).

Egg numbers expressed per g body weight indicates that the maximum number was 804.6 eggs per g body weight for the size 115.3 mm CL (Table 1). Vijayakumaran & Radhakrishnan (1997) have reported that about 66% of the lobster breeders belonged to the size group of 61-80 mm CL. Mohan (1997) has reported that the size group ranging from 70.1 to 75 mm CL contribute 44% and 80.1 to 85 mm CL contribute 35.8% of eggs produced by the *P. homarus* in different regions of the Dhofar coast in the Sultanate of Oman. Hence this size group of *P. ornatus* may be contributing more to the reproduction and recruitment. The fecundity and egg production of lobster may be affected by a number of other biological factors (e.g., characteristics of the tail, egg mortality, food availability, and so forth) and environmental factors (Annala 1991).

The number of egg is positively related to lobster size: the egg number increases with both the CL (Figure 1) and BW (Figure 2) increase.

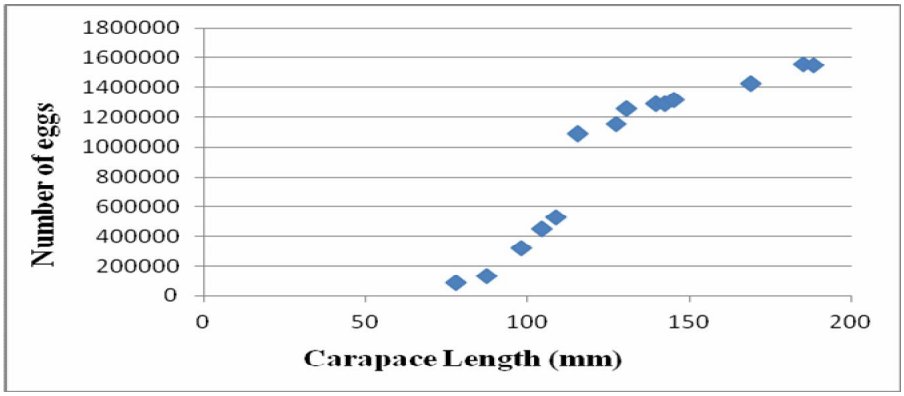

Figure 1. Relationship between carapace length and egg numbers in *P. ornatus* (n = 100).

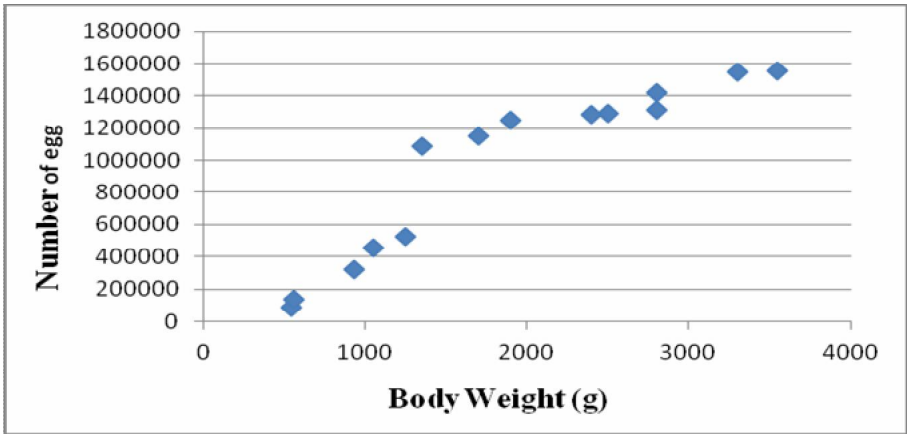

Figure 2. Relationship between body weight and egg numbers in *P. ornatus* (n = 100).

The egg number of *P. ornatus* increases from approximately 88 thousands from a female of 77.7 mm CL and 546 g body weigh to nearly 1.6 millions for a female of 188.2 mm CL and 3300 g body weigh. MacFarlane & Moore (1986) reported that egg production of *P.*

ornatus in wild populations, increases from approximately 270,000 from an animal of 80 mm carapace to nearly 700,000 for a female of 120 mm CL. Sachlikidis et al (2005) shown that the majority of reproductive *P. ornatus* females in wild breeding populations have the CL more than 100 mm. The results of the study of Pérez-González et al (2012) showed that a *P. gracilis* female would produce 242,072 eggs in CL of 60 mm and 618,342 eggs in CL of 80 mm.

The size of *P. ornatus* was larger than that of the other lobster species such as *P. versicolor* and *P. homarus* in southern coastal waters of Bulukumba. The brood size of 1,546,226 recorded in *P. ornatus* (weight: 3.3 kg) is as large as two million eggs reported for the largest lobster, 1.97 million eggs reported for *P. ornatus* by Vijayakumaran et al (2012), and 1.95 million eggs reported for *P. argus* (Bertelsen & Matthews 2001). Since *P. ornatus* grows to over 6.5 kg, the size of the single brood is likely to increase in larger lobsters, as bigger the lobsters the larger are the number of eggs. Murugan et al (2005) have observed that under captive breeding, *P. ornatus* could produce three spawnings in six months and MacFarlane & Moore (1986) have suggested that this species could spawn 3 to 4 times in a year. The fecundity of *P. ornatus* could thus be four times the average production of 1,121,507 for breeders weighing 1.5 kg and in the fourth or fifth year age group.

Vijayakumaran et al (2005) reported that the captive breeders of *P. homarus* spawned 4 times in a year. Berry (1971) also has observed that 3-4 spawnings per year is possible for *P. homarus* in a breeding season.

Wild *P. ornatus* lobsters likely reaches legal harvest size in 20-40 months, depending on location. *P. ornatus* reaches sexual maturity at CL of approximately 70-80 mm. Estimation of size at first maturity in lobster is often growth rate in females after attainment of sexual maturity limited due to several factors (Kizhakudan & Patel 2010). Pérez-González (2011) suggested that many fisheries appear to have the potential to alter population sex ratio and sexual size dimorphism, and they noted a number of factors that could result in sex biased exploitation. For example, one sex may be more vulnerable to capture due to its greater spatial or temporal exposure to fishing gear.

The bulk of the female population is expected to migrate to deeper waters during egg development and to return to inshore areas prior to egg hatching. This suggests that *P. ornatus* females are less catchable than males during their reproductive period because the bulk of the female population probably migrates to deeper waters and presents decreased activity. This pattern of movement of the females toward deeper waters has been observed in *P. argus* in the northern Caribbean and Bahamas (Herrnkind 1980; Kanciruk 1980), south of Florida (Gregory & Labisky 1986), and in the northwest islands of the Cape Verde Archipelago (east-central Atlantic) (Freitas & Castro 2005). It has also been observed in *P. ornatus* in the Gulf of Papua (Pitcher et al 1992), and in *Palinurus elephas* in the western region of the Mediterranean Sea (Goñi et al 2001).

Evaluation of egg quantity of lobster is one consideration of setting minimum legal size for capturing. This is relevant to fishery management decisions involving minimum size restrictions for this species. Mehanna et al (2012) reported that the management of spiny lobster in the coast of Oman is a minimum size limit of 80 mm CL for all species along the coast of Oman.

Thus, obtaining information on the egg quantity and size composition of *P. ornatus* captured is fundamental for the effective management of fishery resources. It is important to establish some form of cooperation among fishers, scientists, and government agencies for implementing sustainable management programs. For this reason, periodic evaluations of the lobster fishery should be conducted to improve monitoring of the status of this fishery on the southern coastal of Bulukumba, South Sulawesi.

Conclusions. The smallest breeder of *P. ornatus* had a CL of 77.7 mm while the biggest one had a CL of 188.2 mm. The number of eggs in a single brood of *P. ornatus* ranged from 88,000 in the smallest lobster to 1,546,226 in the biggest one. The increasing size of the single lobster is likely to increase the number of eggs. The egg quantity of these lobsters is expected to be normal.

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References

Annala J. H., 1991 Factors influencing fecundity and population egg production of *Jasus* species. In: Crustacean egg production. Wenner A., Kuris A. (eds), Balkema, Rotterdam, pp. 301-315.

Bertelsen R. D., Matthews T. R., 2001 Fecundity dynamics of female spiny lobster (*Panulirus argus*) in a South Florida fishery and Dry Tortugas Park lobster sanctuary. Marine and Freshwater Research 52:1559-1565.

Berry P. F., 1971 The biology of the spiny lobster, *Panulirus homarus* (Linnaeus) of the east coast of southern Africa. South African Association for Marine Biological Research, Oceanographic Research Institute, Investigation Reports No. 28, 75 pp.

Freitas R., Castro M., 2005 Occurrence of *Panulirus argus* (Latreille, 1804) (Decapoda, Palinuridae) in the northwest Islands of the Cape Verde Archipelago (central-east Atlantic). Crustaceana 78(10):1191-1201.

Goñi R., Reñones O., Quetglas A., 2001 Dynamics of a protected western Mediterranean population of the European spiny lobster *Palinurus elephas* (Fabricius, 1787) assessed by trap surveys. Marine and Freshwater Research 52:1577-1587.

Gregory D. R., Labisky R. F., 1986 Movements of the spiny lobster *Panulirus argus* in south Florida. Canadian Journal of Fisheries and Aquatic Sciences 43:2228-2234.

Herrnkind W. F., 1980 Spiny lobster: patterns of movement. In: The biology and management of lobsters. Vol. 1. Physiology and behavior. Cobb J. S., Phillips B. F. (eds), Academic Press, New York, pp. 349-407.

Kanciruk P., 1980 Ecology of juvenile and adult Palinuridae (spiny lobsters). In: The biology and management of lobsters. Vol. 2. Ecology and management. Cobb J. S., Phillips B. F. (eds), Academic Press, New York, pp. 56-96.

Kizhakudan J. K., Patel S. K., 2010 Size at maturity in the mud spiny lobster *Panulirus polyphagus* (Herbst, 1793). Journal of the Marine Biological Association of India 52(2):170-179.

MacFarlane J. W., Moore R., 1986 Reproduction of the ornate rock lobster, *Panulirus ornatus* (Fabricius), in Papua New Guinea. Australian Journal of Marine and Freshwater Research 37:55-65.

Mehanna S., Al-Shijibi S., Al-Jafary J., Al-Senaidi R., 2012 Population dynamics and management of scalloped spiny lobster *Panulirus homarus* in Oman coastal waters. Journal of Biology, Agriculture and Healthcare 2(10):184-194.

Mohan R., 1997 Size structure and reproductive variation of the spiny lobster *Panulirus homarus* over a relatively small geographic range along the Dhofar coast in the Sultanate of Oman. Marine and Freshwater Research 48:1085-1091.

Murugan T. S., Remany M. C., Leema T. M., Kumar J. D., Santhanakumar J., Vijayakumaran M., Venkatesan R., Ravindran M., 2005 Growth, repetitive breeding, and aquaculture potential of the spiny lobster, *Panulirus ornatus*. New Zealand Journal of Marine and Freshwater Research 39(2):311-316.

Musbir, Sudirman, Bohari R., 2014 Catch composition and size distribution of the spiny lobster (*Panulirus* spp.) related to oceanography parameters of the southern coast of South Sulawesi. Proceeding of the 3rd International Seminar of Fisheries and Marine Science, Pekanbaru, Indonesia, pp. 116-121.

Musbir, Sudirman, Bohari R., 2016 The resources of spiny lobster (*Panulirus* spp.) in southern coastal waters of Bulukumba Regency. International Seminar: Sustainable Utilization of Coastal Resources in Tropical Zone, Bengkulu, Indonesia, pp. 186-191.

Pérez-González R., 2011 Catch composition of the spiny lobster *Panulirus gracilis* (Decapoda: Palinuridae) off the western coast of Mexico. Latin American Journal of Aquatic Research 39(2):225-235.
Pérez-González R., Valadez L. M., Rodríguez-Domínguez G., Aragón-Noriega E. A., 2012 Seasonal variation in brood size of the spiny lobster *Panulirus gracilis* (Decapoda: Palinuridae) in Mexican waters of the Gulf of California. Journal of Shellfish Research 31(4):935-940.
Pitcher C. R., Skewes T. D., Dennis D. M., 1992 Research for management of the ornate tropical rock lobster, *Panulirus ornatus*, fishery in Torres Strait. Report on CSIRO Research, 1987-1990. CSIRO, Australia, 60 pp.
Sachlikidis N. G., Jones C. M., Seymour J. E., 2005 Reproductive cues in *Panulirus ornatus*. New Zealand Journal of Marine and Freshwater Research 39:305-310.
Vijayakumaran M., Radhakrishnan E. V., 1997 Live transport and marketing of spiny lobsters in India. Marine and Freshwater Research 48:823-828.
Vijayakumaran M., Murugan T. S., Remany M. C., Leema T. M., Kumar J. D., Santhanakumar J., Venkatesan R., Ravindran M., 2005 Captive breeding of the spiny lobster, *Panulirus homarus.* New Zealand Journal of Marine and Freshwater Research 39(2):325-334.
Vijayakumaran M., Maharajan A., Rajalakshmi S., Jayagopal P., Subramanian M. S., Remani M. C., 2012 Fecundity and viability of eggs in wild breeders of spiny lobsters, *Panulirus homarus* (Linnaeus, 1758), *Panulirus versicolor* (Latrielle, 1804) and *Panulirus ornatus* (Fabricius, 1798). Journal of the Marine Biological Association of India 54(2):5-9.

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