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»FAKE« SPAWNING OF THE MUSKY OCTOPUS, *Eledone moschata* (LAMARCK, 1798), IN EXPERIMENTAL CONDITIONS*

D. Valić

Summary

Musky octopus, *Eledone moschata* is widespread in the Mediterranean on various bottom types. Although it is common in fishery landings its ecology is still poorly known. The life span of this species is up to two years. Females can spawn in wide period, ranging from couple of days to few months. This study was designed as an attempt to culture octopus paralarvae and to determine food requirements of the newly hatched individuals. »Fake« spawning in experimental conditions was observed. Condition of eggs in the laboratory together with behaviour of the female during this experiment is described.

Key words: spawning, *E. moschata*, octopus, behaviour

INTRODUCTION

The present state of knowledge in the field of ecology and reproductive biology of musky octopus *Eledone moschata* is still incomplete. This species is widely present in the Mediterranean Sea to the depth of 200 m. The hatchlings of this species are benthonic in contrast to planktonic as in *E. cirrhosa* or *Octopus vulgaris*. Most species from order Octopoda, including *E. moschata*, have a short life span of one to two years. It terminates in a single breeding season in which spawning of the female takes place over a period of time ranging from few days to few months (Boyle and Daly, 2000). The reproduction season in *E. moschata* lasts from October to June (July) with a laying period from January to June for males and from March to June for

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females (Ezzeddine–Najai, 1997). Regarding its feeding habits, *E. moschata* is predator and like other octopuses selects its prey mainly from the Crustacea (Nigmatullin and Ostapenko, 1976; Boyle and Knobloch, 1981; Moriyasu, 1981; Sanchez, 1981; Boyle et al., 1986) and Mollusca (Hartwick et al., 1978, 1981; Ambrose, 1983, 1984) as well as other invertebrates and fish (Boyle and Knobloch, 1981; Nixon, 1987). When attacking its prey octopus injects saliva that contains mixture of toxins (Ghiretti, 1959, 1960; Ballering et al., 1972; McDonald and Cottrell, 1972; Songdahl and Shapiro, 1974; Cariello and Zaretti, 1977) and hydrolytic enzymes (Morishita, 1978; Grisley and Boyle, 1987; Grisley, 1993). Saliva is produced by the posterior salivary glands that lie behind the head on the dorsal surface of the digestive gland. In vitro saliva injection into the eye of a crab was found to cause rapid paralysis (Grisley et al., 1996). *E. moschata* has been shown to attack and bore the carapace of tiny crabs almost as soon as they begin to take live food (Boyle and Knobloch, 1981). The anatomy and nervous control of the buccal apparatus has been described (Young, 1965a, b; Altman and Nixon, 1970; Boyle et al., 1979a, b).

Embryos of this species are devoid of an internal yolk sac from about stage XV on (Sacarrão, 1943) but very little is known about the embryonic development at all. In *E. cirrhosa* each growing egg is surrounded by a layer of follicle cells which proliferate faster then the growing egg can, consequently the layer becomes increasingly folded and invades the yolk space of the oocyte. These folds give a longitudinally striped appearance to each egg, obvious externally, which is a sure indication of developing maturity. In the final phase of egg expansion, the follicle cells are lost and the eggs become detached from the strings of germinal epithelium. The fully mature eggs then pass along the oviduct becoming reformed into strings with secretions of the oviducal glands prior to attachment to the substratum (Boyle and Knobloch, 1983).

MATERIALS AND METHODS

Two individuals of *E. moschata* were caught in mid October by apnoea diver at depth of 8 meters in front of the Institute of Oceanography and Fisheries in Split, Croatia (N Mediterranean Sea). They were placed in cylindrical concrete pools, 3 m^3 capacity each. Walls of pools were black with white bottom. Water flow was 10 l/min. Temperature ranged from 9.5 to 20.2 °C, with the same salinity as in the nearby sea, ranging from 31.7 to 39.6 %. Pools were inside the building and animals were maintained at normal photoperiod. On the bottom of the pools, plastic pipes as a shelter for animals were placed. Initial weights of the animals were 365.57 and 535.67 g. Octopuses were fed couple times a week with a frozen fish — two centime-

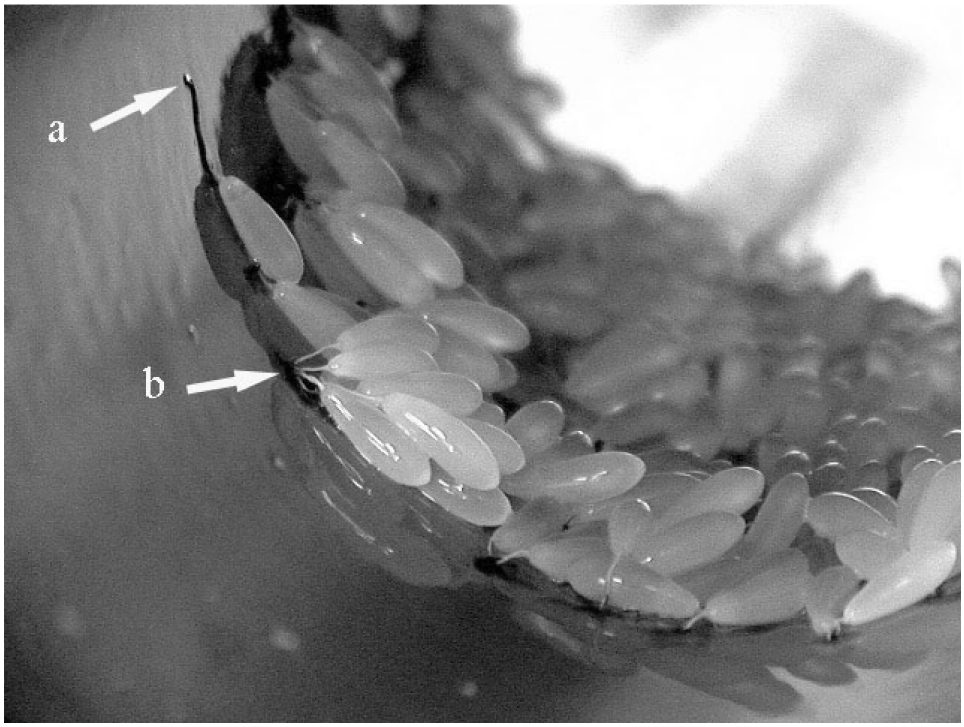

Fig. 1 Egg clusters of E. moschata *deposited on inner side of plastic pipe. Base of the cluster with one (a) and five (b) eggs*
Slika 1. Jaja E. moschata *u nakupinama, položena na unutrašnjoj strani plastične cijevi. Baza nakupine jaja s jednim (a) i pet (b) jaja*

tres–cut European anchovy (*Engraulis encrasicholus*) and European pilchard (*Sardina pilchardus*).

After two weeks, octopuses were placed together. Several days later, smaller octopus died. After five months, the other octopus started to behave unusually. It didn't go out or take any food; only its arm tips could occasionally be seen. After couple of days the pipe was examined which octopus used as its shelter and it was found that it had laid eggs spontaneously. *E. moschata* guarded egg clusters that were attached to the inner side of the plastic pipe. Pipe with eggs and *E. moschata* were immediately placed in more convenient 90 l open circuit glass aquarium. Water flow was 5 l/min. Over the aquarium black plastic sheet was placed to prevent the octopus from escaping with one side uncovered to observe its behaviour. Two egg clusters with one and nine eggs respectively were placed in smaller aquarium of 11 l with air pump to monitor them in controlled environment without disturbing the octopus. Temperature of aquariums ranged from 12.8 to 19.9 °C and from

12.2 to 21.2 °C respectively. In both aquariums salinity ranged from 28.1 to 37.6 %.

RESULTS

From the middle of October 2001 until the end of May 2002 female of *E. moschata* was kept in captivity. In the middle of March female deposited egg clusters on the inner side of the plastic pipe (Fig. 1). All clusters were deposited in small area like in *Octopus vulgaris*, while *E. cirrhosa* attaches egg clusters in different places (Mangold et al., 1971). Egg stalks were connected together in a cluster axis by white matrix, and it forms the base of the cluster like brown sheet. From one to several eggs were found on one of these sheets (Fig 1). Eggs are oval and prolonged, with mean values of 16.3 mm in length and 5.7 mm in diameter with stalk 11 mm in length. Two egg clusters with one and nine eggs respectively that were placed in smaller aquarium did not differ from those nursed by female. In the beginning colour of the eggs was milky white but transparent. It was expected that larvae would eventually hatch because ten days after transfer little changes in coloration were observed. Few weeks later it wasn't certain if eggs were fertilized for, except colour, nothing changed. In the middle of May female began to act differently, being more active, going out of the plastic pipe and leaving her eggs. At the time all eggs were untouched. During her nursing of eggs she had no interest in food. Four days later some of the eggs were crashed from their upper side and female was outside the pipe behaving very excited. There were no visible paralarvae in aquarium and eggs in other aquarium showed no changes. Following day all of the eggs were opened but after careful examination of aquarium and plastic pipe no paralarvae could be found. The female was transferred back to 3 m^3 concrete pool together with the plastic pipe and it died later.

DISCUSSION

Spawning of *E. moschata* in laboratory conditions was observed. This is very significant since cephalopods are an important group of organisms in nowadays aquaculture. There is a constant market demand for fresh and frozen cephalopods. What could be concluded is that *E. moschata* should be considered as a potential species for aquaculture. Further experiments should be made, to gain paralarvae and to determine their food requirements. Finding of »fake« eggs is another problem. Probably eggs were infertile like it was observed in *O. vulgaris* (Wodinsky, 1972). Further experiments should clarify this subject as well. Till then it is obvious that this species can lay »fake« eggs and this phenomenon should be recorded. Eggs of *E. cirrhosa* are sometimes eaten by the female (Mangold et al., 1971) and finding of opened

eggs with no visible paralarvae in aquarium could be explained in this way. On the other hand, although egg laying occurred much later then the first octopus died, it is known that females of the species *E. cirrhosa* may copulate several weeks before egg laying begins and it could preserve sperm for at least 6 weeks (Mangold et al., 1971).

Sažetak

»LAŽNI« MRIJEST MUZGAVCA, *Eledone moschata* (LAMARCK, 1798), U EKSPERIMENTALNIM UVJETIMA*

D. Valić

Muzgavac, *Eledone moschata,* rasprostranjen je u cijelom Sredozemlju i na različitim tipovima dna. Uobičajena je ribarska lovina, iako mu je ekologija slabo istražena. Živi do dvije godine. Mrijest ženke može trajati različito dugo, od nekoliko dana pa sve do nekoliko mjeseci. Ovo je istraživanje započelo kao pokušaj uzgoja paraličinaka te utvrđivanja prehrane za tek izvaljene jedinke. Primijećen je »lažni« mrijest u eksperimentalnim uvjetima. U ovom su radu opisana dobivena jaja i ponašanje ženke tijekom pokusa.

Ključne riječi: mrijest, *E. moschata*, muzgavac, ponašanje

REFERENCES

Altman, J. S., Nixon, M. (1970): Use of the beaks and radula by *Octopus vulgaris* in feeding. J. Zool. Lond., 161, 25–38.

Ambrose, R. F. (1983): Midden formation by octopuses: the role of biotic and abiotic factors. Mar. Behav. Physiol., 10, 137–144.

Ambrose, R. F. (1984): Food preferences, prey availability and diet of *Octopus bimaculatus* Verril. J. Exp. Mar. Biol. Ecol., 77, 29–44.

Ballering, R. B., Jalving, M. A., Van Tresca, D. A., Hallacher, L. E., Tomlinson, J. T., Wobber, D. R. (1972): Octopus envenomation through a plastic bag via a salivary proboscis. Toxicon, 10, 245–248.

Boyle, P. R., Daly, H. I. (2000): Fecundity and spawning in a deep–water cirrimorph octopus. Marine Biology, 137, 317–324.

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Boyle, P. R., Grisley, M. S., Robertson, G. (1986): Crustacea in the diet of *Eledone cirrhosa* (Mollusca: Cephalopoda) determined by serological methods. J. Mar. Biol. Ass. UK., 86, 867–879.

Boyle, P. R., Knobloch, D. (1981): Hole boring of crustacean prey by the octopus *Eledone cirrhosa* (Mollusca: Cephalopoda). J. Zool. Lond., 193, 1–10.

Boyle, P. R., Knobloch, D. (1983): The female reproductive cycle of the octopus, *Eledone cirrhosa*. J. Mar. Biol. Ass. UK., 63, 71–83.

Boyle, P. R., Mangold, K., Froesch, D. (1979a): The organisation of beak movements in *Octopus*. Malacologia, 18, 423–430.

Boyle, P. R., Mangold, K., Froesch, D. (1979b): The mandibular movements of *Octopus vulgaris*. J. Zool. Lond., 188, 53–67.

Cariello, L., Zaretti, L. (1977): á— and â–cephalotoxin: two paralyzing proteins from posterior salivary glands of *Octopus vulgaris*. Comp. Biochem. Physiol., 57C, 169–173.

Ezzeddine–Najai, S. (1997): Maturation sexuelle d*Eledone moschata* (Cephalopoda, Octopoda) du golfe de Gabčs (Tunisie, Méditerranée Orientale). Vie Millieu., 47, 69–76.

Ghiretti, F. (1959): Cephalotoxin: the crab paralysing agent of the posterior salivary glands of cephalopods. Nature (London), 183, 1192–1193.

Ghiretti, F. (1960): Toxicity of *Octopus* saliva against crustacea. Ann. N. Y. Acad. Sci., 90, 726–741.

Grisley, M. S. (1993): Separation and partial characterisation of salivary enzymes expressed during prey handling in the octopus *Eledone cirrhosa*. Comp. Biochem. Physiol., 105B, 183–192.

Grisley, M. S., Boyle, P. R. (1987): Bioassay and proteolytic activity of digestive enzymes from octopus saliva. Comp. Biochem. Physiol., 88B, 1117–1123.

Grisley, M. S., Boyle, P. R., Key, L. N. (1996): Eye puncture as a route of entry for saliva during predation on crabs by the octopus *Eledone cirrhosa* (Lamarck). J. Exp. Mar. Biol. Ecol., 202, 225–237.

Hartwick, E. B., Thorarinsson, G., Tulloch, L. (1978): Methods of attack by *Octopus dofleini* (Wülker) on captured bivalve and gastropod prey. Mar. Behav. Physiol., 5, 193–200.

Hartwick, E. B., Tulloch, L., MacDonald, S. (1981): Feeding and growth of *Octopus dofleini* (Wülker). Veliger, 24, 129–138.

McDonald, N. M., Cottrell, G. A. (1972): Purification and mode of action of toxin from *Eledone cirrosa*. Comp. Gen. Pharmacol., 3, 243–248.

Mangold, K., von Boletzky, S., Frösch, D. (1971): Reproductive biology and embryonic development of *Eledone cirrosa* (Cephalopoda: Octopoda). Marine biology, 8, 109–117.

Morishita, T. (1978): Studies on the protein digestive enzyme of octopus *O. vulgaris* (Cuvier). Bull. Fac. Fish. Univ., 5, 197–282.

Moriyasu, M. (1981): Biologie des pches de céphalopodes benthiques. Application aux eledones, *Eledone cirrhosa (Lam. 1798)* du golfe du Lion. Thčse Doctorat, 3 čme cycle, Université des Sciences et Techniques du Languedoc, France 225 pp.

Nigmatullin, C. M., Ostapenko, A. A. (1976): Feeding of *Octopus vulgaris* Lam. from the northwest African coast. *ICES, C. M.,* 1976/K: 6 *Shellfish & Benthos Comm.,* 15 pp.

Nixon, M. (1987): Cephalopod diets. 201–219. In: Boyle, P. R. (Ed.) Cephalopod life cycles, Vol. 2., London: Academic Press.

Sacarro, A. F. (1943): Observations sur les dernières phases de la vie embryonnaire d*Eledone*. Archos Mus. Bocage., 14, 25–35.

Sanchez, P. (1981): Regime alimentaire d*Eledone cirrhosa* (Lamarck, 1798) (Mollusca: Cephalopoda) dans la Mer Catalane. Rapp. Comm. Int. Mer. Médit., 27, 209–212.

Songdahl, J. H., Shapiro, B. I. (1974): Purification and composition of a toxin from the posterior salivary gland of *Octopus dofleini*. Toxicon, 12, 109–115.

Wodinsky, J. (1972): Breeding Season of *Octopus vulgaris*. Marine Biology, 16, 59–63.

Young, J. Z. (1965a): The buccal nervous system of *Octopus*. Phil. Trans. R. Soc. London, Ser B., 249, 27–43.

Young, J. Z. (1965b): The nervous pathways for poisoning, eating and learning in *Octopus*. J. Exp. Biol., 43, 581–593.

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