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The common octopus fishery in South Portugal: a new shelter-pot

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The common octopus fishery in South Portugal: a new shelter-pot

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Résumé

Le poulpe est une des plus importantes ressources marines au Portugal, en particulier dans la région Sud (Algarve). Les engins de pêche les plus utilisés sont les "*alcatruz*" et le "*covo*". Le "*alcatruz*" est un pot-abri traditionnellement faite d'argile, avec une forme d'amphore, mais récemment des pots cylindriques en plastique ont été introduits et sont devenu plus populaire. Les “*covos*” sont des cages-pièges métalliques appâtés couverts par un filet en plastique.

Bien que très populaire parmi les pêcheurs, le “*alcatruz*” traditionnelle à base d’argile a été remplacée par des pots en plastique cylindriques avec un grand succès, en raison de sa résistance à frein. Dans une tentative de continuer à utiliser la forme traditionnelle d’amphore, un nouveau type de pot-abri en plastique a été construit en association avec les pêcheurs.

A fin d’étudier le comportement du poulpe commun (*Octopus vulgaris*) vers les pots traditionnels (pot amphore en argile), les pots plus modernes (pot cylindrique en plastique) et le nouveau pot (pot amphore en plastique), des expériences ont été réalisées dans des réservoirs contrôlés. Trois principales questions ont été tentées de répondre concernant les préférences des poulpes communs envers les pots: 1) Quel type de matériel: plastique ou argile (traditionnel); 2) Quelle forme: cylindrique ou amphore (traditionnel); 3) Quelle couleur: blanc, noir ou rouge brique (traditionnel). Les résultats n’ont indiqué pas de préférence vers le matériel de l’engin de pêche; une forte préférence pour la forme traditionnelle d’amphore; et une forte préférence pour la couleur noire.

Mots Clés: Pêcherie de poulpe; pots-abris; engins de pêche de poulpe; comportement du poulpe.

Abstract

The octopus is one of the most important marine resources in Portugal, especially in the South, the Algarve region. The fishing gears mostly used are the "*alcatruz*" and the "*covo*". The "*alcatruz*" is a shelter-pot traditionally made of clay, with an amphora shape, but recently plastic cylindrical pots were introduced and became more popular. "*Covos*" are baited metal cage-traps covered by a plastic net.

Although very popular among fishermen, the traditional "*alcatruz*" made of clay has been replaced by cylindrical plastic pots with great success, due to its resistance to brake. In an attempt to continue using the traditional amphora-shape, a new type of plastic pot was built in association with fishermen.

To study the behaviour of the common octopus (*Octopus vulgaris*) towards the traditional amphora clay shelter-pot, the cylindrical plastic shelter-pot and the new amphora plastic shelter-pot, several experiments were performed in controlled tanks. Three main questions were attempted to answer concerning the preferences of the common octopus towards the pots: 1) What kind of material: plastic or clay (traditional); 2) What shape: cylindrical or amphora (traditional); 3) What colour: white, black or red brick (traditional). The results showed no particular preference towards the material of the fishing

gear; a strong preference for the traditional amphora shape; and a strong preference for the black colour.

Keywords: Octopus fishery; octopus shelter-pots; octopus fishing gear; octopus behaviour.

Introduction

In Portugal, the common octopus (*Octopus vulgaris*) is the most relevant cephalopod species for the fishing sector, representing in the last few years an average of 6% of the total catch landed and 12% in value traded, which corresponds to the 3rd and 2nd place in the national ranking of important commercial species, respectively. The Algarve region is responsible for more then 50% of the national octopus landings, being mostly (90%) from the artisanal fishery (Docapesca, 2015).

One of the most traditional southern Portuguese fishing gear for the common octopus (*Octopus vulgaris*) is a shelter-pot made of clay or plastic, with one opening and not baited ("*alcatruz*"), hung from a line and set along the sea floor. This fishing method is based on the knowledge of the octopus behaviour, which presents cover-seeking habits and territoriality. As the animal prevents the entry of other individuals, a large number of pots must be set in order to make a commercially viable catch. Although, traditionally these shelter-pots are made of clay and with an amphora shape, more recently they have been replaced by cylindrical shape plastic shelter-pots due to their resistance to brake.

The success of a fishery depends of the fishermen knowledge of the natural conditions and behaviour of the species (Rathjen, 1991), specially the behaviour of the target species towards a specific fishing gear (Watanuki & Kawamura, 1999).

Since in the commercial octopus fishery with shelter-pots, only the big size animals are kept to be sold (Sanchez & Obarti, 1993) and all small size individuals are discarded to sea mostly alive (Groneveld, 2000), with less impact to benthonic communities (Jennings & Kaiser, 1998; Eno *et al.*, 2001), a new type of plastic shelter-pot was built in association with fishermen, as an attempt to continue using the traditional amphora shape, as well as to decrease the costs since clay pots are more expensive than plastic pots and easily breakable.

Therefore, a new type of pot was constructed and several laboratory experiments were performed to study the behaviour and preferences of the common octopus concerning the material, shape and colour of the fishing shelter-pots.

Material and Methods

For the experiments, two similar cylindrical tanks were arranged (the adaptation tank and the experimental tank), with 2.5m diameter and 3.3m^3 of volume, both in an open water system. While the adaptation tank was covered with two nets – one to avoid possible escapes (Boyle, 1991; Wood & Anderson, 2004) and the second to avoid direct sun light – the water column of the experimental tank was decreased to avoid escapees.

All specimens of common octopus (*Octopus vulgaris*) were caught by fishermen with pots and traps and transferred immediately to the adaptation tank, where several PVC tubes were put in the tank, since the presence of shelters, good water quality and sufficient food allows several octopus specimens cohabit in the same tank without cannibalism problems (Boyle, 1991). Specimens weighed between 1.2kg and 1.9kg and with the exception of one, all were males.

Octopus were fed daily during daylight (8 to 10 o'clock in the morning) and feeding consisted of clams (*Cerastoderma edule*), crab (*Carcinus maenas*) and mussels (*Mytilus sp*). However, during experiments only mussels were given.

Fishing gear characteristics

The clay pots used in this experiment are the same as normally used in the fishery – amphora shape, redbrick colour, 33cm height, 13cm opening diameter, 9liters inside volume and a settling angle of 38º (Figure 1A).

The other two types of pots used were made of plastic (vinyl chloride), being one of cylindrical shape, black colour, 35cm height, 11cm opening diameter, 7liters volume and approximately 0º settling angle (Figure 1B), and the other (the new type of shelter-pot) of amphora shape, 31cm height, 12cm opening diameter, 8.6 litres volume and 30º settling angle (Figure 1C). On both plastic pots cement is used to be able to descend in the water column.

Observation system

To be able to observe the octopus behaviour with no interference from the observer (Martin & Bateson, 1996) and in a continuous form (24 hours a day), an observation system was mounted (Figure 2), with a record camera (EV-CAM HZr) above and in the middle of the experimental tank, to observe the full size tank. This camera was connected to a TV (Sony Digital 8 GV-D800E PAL) installed in an observatory room,

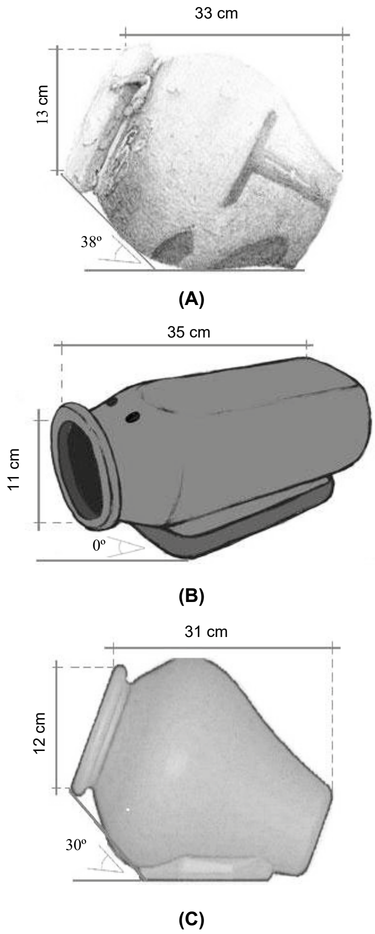

Figure 1. Characteristics of octopus fishing shelter-pots studied. (A) Traditional (amphora shape) clay shelter-pot (adapted from Borges, 2000). (B) Plastic shelter-pot (cylindrical shape). (C) New plastic shelter-pot (amphora shape).

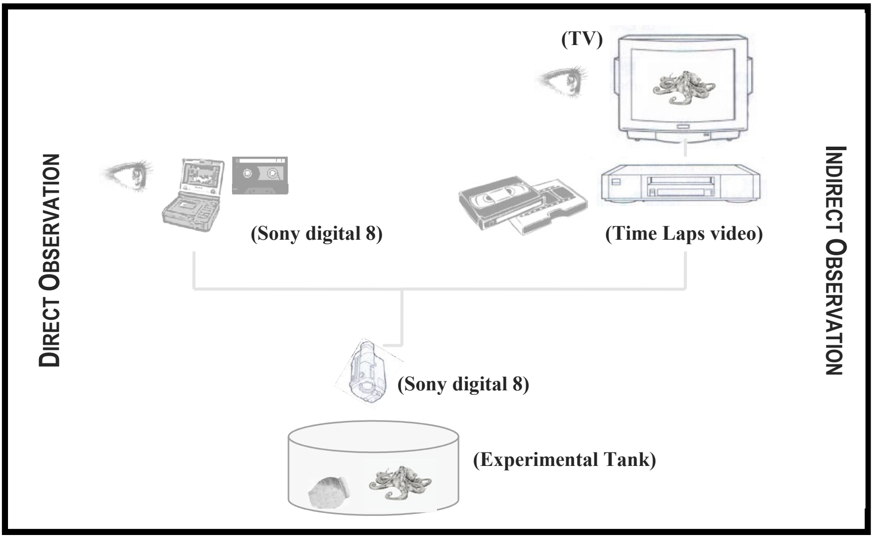

Figure 2. Diagram of the observation system mounted to observe and to record the octopus behaviour in continuous and without human interference.

through which direct observation were possible. In the absence of the observer, the camera was connected to a video "time-lapse 168" (STV-S3000P Sony), which would record everything and later images were studied. This type of record was used specifically during night-time. Above the tank a florescent light connected to a timer was used, to pattern natural photoperiod.

Experiment design and procedure

Three experiments were conducted to test the preferences concerning the type of material, the shape and the colour of the shelter-pots. Five specimens were used in each experiment, being one individual observed at each time, during three days and nights. Each of the experiments was already mounted when the specimens were put in the tank. For each experiment only one variable was tested.

To test the material – clay or plastic – the shelter-pots used were the traditional clay amphora shape pots and the new plastic amphora shape pots, two of each, all of redbrick colour.

To test the shape preferred – cylindrical or amphora – the pots used were the two types of plastic pots, two of each, and both black.

To test the colour – redbrick, black or white – the pots used were the new plastic amphora shape pots, two of each colour.

Procedure and data analyses

All behavioural experimental procedures and data analyses followed were according to Martin & Bateson, 1996.

The octopus position in relation to the shelter-pot was registered as sample points every fifteen minutes: 0 for absence (the octopus was not touching any shelter-pot) and 1 for presence in shelter-pot, being here differentiated the presence inside the shelter-pot or only touching the shelter-pot. The recorded position was the one observed at the beginning of every minute of every sample point.

The proportion of time spent by each specimen in different shelter-pots was calculated, being X one shelter-pot with a specific material, shape or colour:

$$\text{Proportion of time in } X = \text{n. of presences in } X \,/\, \text{n. of points in the sample}$$

The percentage of time spent by each specimen in each shelter-pot was calculated:

$$\%\ \text{time in } X_{total} = \text{n. of presences in } X_{total} \,/\, \text{n. of points in the sample} * 100$$

The average for each pot was also calculated, adding the percentages of all individuals:

$$\text{Average } \%\ \text{time in } X_{total} = \sum \%\ \text{time in } X_{total} \,/\, \text{n. of individuals}$$

All calculations were made for night and daytime data separately. For each of the experiments a χ^2 test was applied to check significant differences between the results obtained and the results expected (H_0 – no differences exist between the variables tested).

Results

The results obtained during day and night times for the three experiments are summarized in Table 1 and Figure 3.

The behaviour adopted by all specimens during the three experiments carried out, was similar. The specimens spent most of the time inside the shelter but also swimming and crawling across the tank, stopping in its different areas. When specimens were not inside shelter-pots, they often were in contact with it, assuming different positions in relation to it, like above the pot, half in half out, sideways, etc. However, the most adopted position by octopus specimens for all experiments was inside the shelter-pots.

Concerning the experiment on shelter-pot material, the time spent by octopus specimens on each material did not vary much, with 26-24% of time spent on clay shelter-pots and 35-32% in plastic, day and night respectively. No significant statistical differences were found (χ^2 test with $P > 0.05$). (Table 1; Figure 3 A)

Concerning shape experiments, significant statistical differences were found (χ^2 test with $P < 0.05$) between the times spent by specimens in the amphora shelter-pots (53-41%)

	Day				Night			
Exps.	**Shelter-pot**	**% time**	**χ^2**	**Significance**	**Shelter-pot**	**% time**	**χ^2**	**Significance**
Material	Clay	26	>0,05	NS	Clay	24	>0,05	NS
	Plastic	35			Plastic	32		
Shape	Amphora	53	<0,05	SD	Amphora	41	<0,05	SD
	Cylindrical	30			Cylindrical	12		
Colour	Black	67	<0,05	SD	Black	52	<0,05	SD
	Redbrick	19			Redbrick	13		
	White	0			White	0,002		

Table 1. Data summary of the common octopus behaviour towards shelter-pots of different material, shape and colour, during day and night, with χ^2 test results applied to each experiment. (n = 5). (NS – not significant; SD – significant differences).

and in the cylindrical ones (30-12%), day and night respectively. (Table 1; Figure 3 B).

Concerning colour of the shelter-pots, significant statistical differences were also found (χ^2 test with $P < 0.05$) between the times spent by octopus in the black colour pots (67-52%), in the redbrick pots (19-13%) and in white pots (0-0.002%), day and night respectively. (Table 1; Figure 3 C).

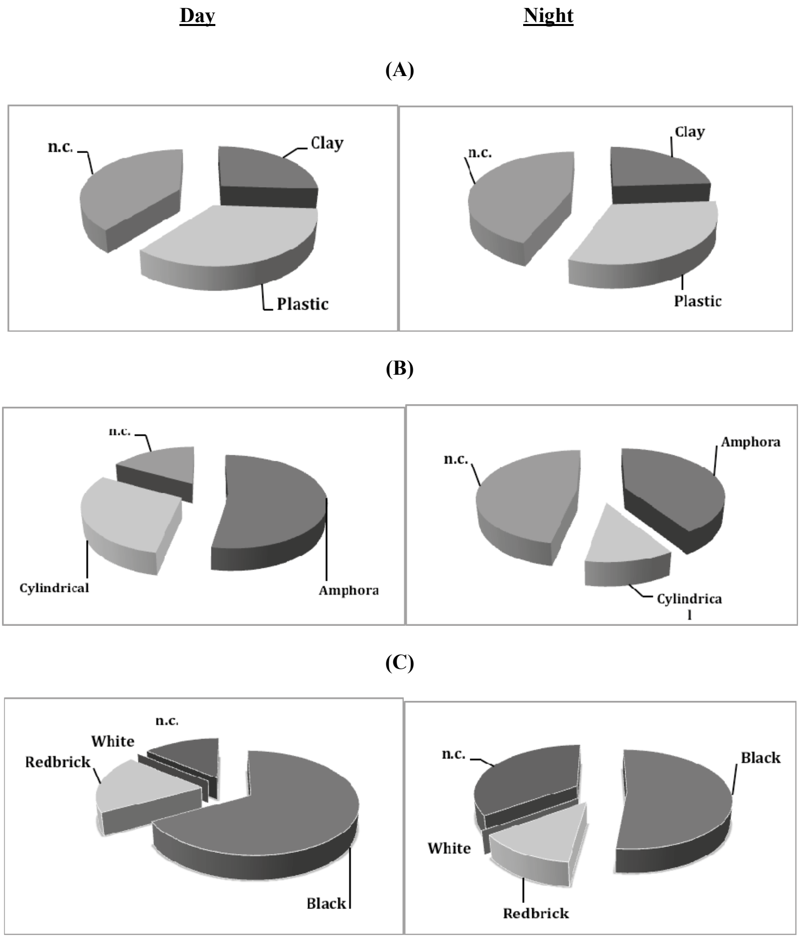

Figure 3. Percentage of time spent by octopus specimens in shelter-pots (A) of different material (clay *versus* plastic), (B) of different shape (amphora *versus* cylindrical) and (C) of different colours (black *vs.* redbrick *vs.* white), during day and night times. (n.c. – no choice)

Comparing day and night behaviour only results on the shelter-pot material experiment show significant statistical differences (χ^2 test with $P < 0.05$).

Discussion

The success of a fishery depends on fishermen knowledge of the natural conditions and behaviour of the species (Rathjen, 1991), specially the behaviour of the target species towards a specific fishing gear (Watanuki & Kawamura, 1999). The octopus fishing success of the shelter-pots is mainly due to the fact that this fishing gear catches mainly big size animals, while fishing nets, like trawl nets, catch specimens of all sizes, mainly small size animals (Sanchez & Obarti, 1993).

In all experiments, the percentage of time spent by different individuals inside the shelter-pots was very high, reaching almost 100% in some cases. Several authors reached similar results, e.g., Mather (1988) determined a percentage of occupancy of 89%, while Katsanevakis & Verriopoulos (2004) presented a value of 93%. For these authors, this shows how important shelters are for octopus, probably one of the most important factors in their distribution (Mather, 1982a; Mather, 1982b).

During these experiments, although the specimens spent most of their time inside the shelter-pots to avoid predators (Mather, 1982b), it was also possible to observe that common octopus when not inside the shelter-pots were resting on top or beside them but always in contact with the shelter. This fact was also observed by Boyle (1980) showing the importance of the shelters for octopus.

In the experiment on material preferences, although showing a slight preference for the plastic, this difference was not statistically significant. According to Boyle (1980) and Katsanevakis & Verriopoulos (2004), this is probably due to the fact that octopus occupies and uses all type of materials and objects to shelter, from natural features on the substrate (stone assemblages, shells) to human waste (pieces of porcelain, tires, and all sort of debris). Both the clay and new designed plastic shelter-pots present more or less the same characteristics in terms of size, internal volume, settling angle, aperture size and light entrance capacity. Therefore, and since according to Mather (1982b) these are the main characteristics for choosing a shelter, no significant differences were found regarding the choice of material of the shelter-pots.

Concerning the preferences regarding shape (cylindrical *vs.* amphora) of the shelter-pots, octopus showed a preference towards the amphora shape. This may be due to the different shape, internal volume and settling angle of the pots, since the height and aperture diameter in both models seem to be not sufficiently different to influence the octopus choice. The amphora shape provides a narrow entrance to a wider inside area (greater inside volume) followed by a smaller inside area/volume in the back within the same housing/pot, which in the case of the cylindrical shelter-pots doesn't since the inside volume is the same all along the pot. This may determine the octopus choice since, according to Mather (1982b), octopus prefer gastropod shells to bivalve shells, being the form of the first more like the shape of the new amphora shape shelter-pot. In some laboratory experiments, Rama-Villar et al. (1997) observed that octopus showed a clear preference for larger shelters, and Mather (1982a) also say that octopus are attracted by large artificial shelters. Since the new amphora shape shelter-pots have a volume of 8.6 litres and the cylindrical shape 7.0 litres, their preference agrees with the literature. The fact that they spend most of their time inside shelters (Boyle, 1980), and they even consume their prey within this (Mather, 1991a; Sanchez and Obarti, 1993) may justify the octopus preference for a bigger volume.

In addition to size/volume, the fact that the new shelter-pots have a higher settling angle causes its opening to be more upwards, lying at a height of 12cm above the ground, providing a better ability for the octopus to observe the surroundings from inside the shelter, while remaining protected. According to Mather (1991b), this characteristic is very important for the octopus choice of shelters at sea. The opening of the cylindrical shelter-pot is 6cm from the ground, therefore, with a smaller settling angle, which probably reduces the octopus feeling of shelter, as well as the capacity of observation outside. In practice, the other disadvantage of a small or zero settling angle is that in the natural environment the probability of these shelter-pots to be filled with sediment are higher and consequently, not chosen by the octopus.

Regarding the octopus colour preferences, this was very clear, with the choice of black colour shelter-pots to be significant compared with the redbrick and white ones. Okamoto et al. (2001) also obtained the same results, stating that octopus prefer dark colours despite the contrast with the background. The percentage of occupancy of the white shelter-pots was almost negligible, even appearing that octopuses avoided this shelter-pot, which according to Bradley & Messenger (1977), can be explained by the fact that octopus are usually animals that hide and move in the dark. Roper (1997) makes a compilation of unpublished data from Voss, where it states that white shelter-pots do not give good catch results. According to Messenger (1977; 1979), it is likely that octopus cannot distinguish different colours but differentiates objects by way of contrast. However, studies by Kawamura et al. (2001) in *Octopus aegina*, demonstrates that the species has colour vision, whereas *Octopus vulgaris* did not, making choices based on the object tonality and preferring the darker ones.

Most of the studies done on this subject are experiences of punishment–reward type, where different colours and/or shapes of objects are displayed to octopus to see if they learn to distinguish those objects and not in terms of occupancy of a shelter of a particular colour. Sutherland (1962) conducted an experiment to see if octopus discriminate shapes but also used different colours, being possible to observe that the largest number of attacks was done to black objects. According to Messenger & Sanders (1972), octopus prefers black instead of white (in cream colour tanks). Bradley & Messenger (1977) state that the preference in octopus is by contrast and not by the colour itself. In experiments with *Sepia esculenta*, Watanuki et al. (2000) concluded that this species does not approach traps covered with black plastic in white background tanks because of the contrast and brightness caused by plastic. Therefore, these authors seem to suggest the same as the present study, namely that octopus prefers dark colours.

Octopus are nocturnal animals both in laboratory and in captivity (Wells et al., 1983), having different levels of activity during day and night, therefore, being able to have different choices during these two periods. However, this did not occur in our experiments, probably because according to Wells et al. (1983) *Octopus vulgaris* is no longer strictly nocturnal when it is fed in captivity by changing its cycle and level of activity depending on the time it is fed. If fed in the morning (as it was in these experiments) their activity peaks become less intense and more scattered throughout the day, increasing also the time they are active (Wells et al., 1983). Therefore, since their behaviour was fairly regular throughout the 24 hours of observations, there were no significant differences in the behaviour and choices of the shelter-pots between nocturnal and daytime. Another relevant factor may have been that the lighting system mounted did not cause a marked difference between the light intensity of day and night, not truly simulating the natural photoperiod, leading again individuals to divide their activity along the daily 24 hours and thus not to show behavioural differences over that period.

Conclusions

The conclusion reached was that the common octopus showed a clear preference for the new amphora shape shelter-pots, comparing to the cylindrical ones, and the black colour shelter-pots comparing to the redbrick or white. Concerning the material of the different shelter-pots there was no significant differences between plastic and clay. Therefore, it seems likely that the new shelter-pot will be more efficient in terms of catches.

References

BORGES, T.C.; ERZINI, K.; IVO, G.; GONÇALVES, I.A.; PEREIRA, A.; RAPOSO, C.; SENDÃO, J.C.; RAMOS, F.; SILVA, L. and SOBRINO, I. 2000. *Cephalopod resources dynamics and fisheries trends in the Algarve and the Gulf of Cadiz (ALCACEPH).* Centro de Ciências do Mar, Universidade do Algarve. Instituto Español de Oceanografia (IEO). Final Report to the European Commission DG Fisheries. Study Project Nº 97/086.

BOYLE, P.R. 1980. Home occupancy by male *Octopus vulgaris* in a large seawater tank. *Anim. Behav.* 28: 1123-1126.

BOYLE, P.R. 1991. *The UFAW handbook on the care and management of cephalopods in the laboratory.* UFAW Press.

BRADLEY, E.A. and MESSENGER, J.B. 1977. Brightness preference in Octopus as a function of the background brightness. *Mar. Behav. Physiol.* 4: 243-251.

ENO, N.; MACDONALD, D.; KINNEAR, J.; AMOS, S.; CHAPMAN, C.; BUNKER, F. and MUNRO, C. 2001. Effects of crustacean traps on benthic fauna. *ICES. J. Mar. Sci.* 58: 11-20.

GRONEVELD, J. 2000. Stock assessment, ecology and economics as criteria for choosing between trap and trawl fisheries for spiny lobster *Palinurus delagoae*. *Fish. Res.* 48: 141-155.

HANLON, R. and MESSENGER, J. 1996. *Cephalopod behaviour*. Cambridge University Press.

JENNINGS, S. and KAISER, M.J. 1998. The effects of fishing on marine ecosystems. *Adv. Mar. Biol.* 34: 201-352.

JOUFFRE, D.; INEJIH, A. and CAVERIVIÉRE, A. 2002. Les pots à poulpes: un danger pour la resource? In: Caverivière, A.; Thiam, M. and Jouffre, D. (eds). *Le Poulpe Octopus vulgaris: Sénégal et Côtes Nord-ouest Africaines*. Acts du Colloque. Centre de Recherches Océanografiques de Dakar-Thiaroye. (14-18 Février 2000): 247-255.

KATSANEVAKIS, S. and VERRIOPOULOS, G. 2004. The ecology of *Octopus vulgaris* Cuvier, 1797, on soft sediment: availability and types of shelter. *Sci. Mar.* 68: 147-157.

KAWAMURA, G., NOBUTOKI, K., ANRAKU, K., TANAKA, Y. and OKAMOTO, M. 2001. Color discrimination conditioning in two Octopus,

Octopus aegina and *Octopus vulgaris*. *Nippon Suisan Gakkaishi.* 67: 35-39.

MARTIN, P. and BATESON, P. 1996. *Measuring Behaviour – an introduction guide*. Cambridge University Press.

MATHER, J.A. 1982a. Factors affecting the spatial distribution of natural populations of Octopus joubini Robson. *Anim. Behav.* 30: 1166-1170.

MATHER, J.A. 1982b. Choice and competition: Their effects on occupancy of shell homes by *Octopus joubini*. *Mar. Behav. Physiol.* 8: 285-293.

MATHER, J.A. 1988. Daytime activity of juvenile *Octopus vulgaris* in Bermuda. *Malacologia*. 29: 69-76.

MATHER, J.A. 1991a. Foraging, feeding and prey remains in middens of juvenile *Octopus vulgaris* (Mollusca: Cephalopoda). *J. Zool. of Lond.* 224: 27-39.

MATHER, J.A. 1991b. Navigation by spatial memory and use of visual landmarks in octopuses. *J. Comp. Physiol. A.* 168: 491-497.

MESSENGER, J.B. 1977. Evidence that Octopus is colour blind. *J. Exp. Biol.* 70: 49-55.

MESSENGER, J.B. 1979. The eyes and skin of Octopus: compensating for sensory deficiencies. *Endeavour*. 3: 92-98.

MESSENGER, J.B. and SANDERS, G.D. 1972. Visual preference and two-cue discrimination learning in Octopus. *Anim. Behav.* 20 (3): 580-585.

OKAMOTO, M.; KAZUHICO, A.; KAWAMURA, G. and TANAKA, Y. 2001. Selectivity of color shelter by *Octopus vulgaris* and *Octopus aegina* under different background colors. *Nippon Suisan Gakkaishi*. 67: 672-677.

RAMA-VILLAR, A.; FAYA-ANGUEIRA, V.; MOXICA, C. and REY-MÉNDEZ, M. 1997. Engorde de pulpo (*Octopus vulgaris*) en batea. In: VI Congresso Nacional de Acuicultura. Cartagena. Ministério da Agricultura, Pesca y Alimentacion.

RATHJEN, W.F. 1991. Cephalopod capture methods: an overview. *Bull. Mar. Sci.* 49: 494-505.

ROPER, C.F. 1997. Experimental octopus fisheries: two case studies. In: Lang, M.A. and Hochberg, F.G. (eds.). *Proceedings of the Workshop on The Fishery and Market Potential of octopus in California*. Smithsonian Institution. Washington.

SANCHEZ, P. and OBARTI, R. 1993. The biology and fishery of *Octopus vulgaris* caught with clay pots on the Spanish Mediterranean coast. In: Okutani, T., O'Dor, R. and Kubodera, T. (eds.). *Recent Advances in Cephalopod Fisheries Biology*. Contributed papers to 1991 CIAC International Symposium and Proceedings of the Workshop on Age, Growth and Population Structure. Tokai University Press. Tokyo. 477-487.

SUTHERLAND, N.S. 1962. Visual discrimination of shape by Octopus: squares and crosses. *J. Comp. Physiol. Psychol*. 55: 939-943.

WATANUKI, N. and KAWAMURA, G. 1999. A review of cuttlefish basket trap fishery. *South Pacific Study.* 19: 31-48.

WATANUKI, N.; HIRAYAMA, I. and KAWAMURA, G. 2000. Why do cuttlefish *Sepia esculenta* enter basket traps? Space occupation habit hypothesis. *Fish. Sci.* 60: 190-197.

WELLS, M.J.; O'DOR, R.K.; MANGOLD, K. and WELLS, J. 1983. Diurnal changes in activity and metabolic rate in *Octopus vulgaris*. *Mar. Behav. Physiol.* 9: 275-287.

WOOD, J.B. and ANDERSON, R.C. 2004. Interspecific evaluation of octopus escape behaviour. *J. Appl. Ani. Welf. Sci*. 7: 95-106.