ELSEVIER

Fisheries Research 20 (1994) 283–289

FISHERIES RESEARCH

Short communication

Effect of tagging on the growth rate of the neogastropod, *Buccinum undatum* in the laboratory

Ahmet E. Kideys

Institute of Marine Sciences, Middle East Technical University, P.O. Box. 28, 33731, Erdemli, Içel, Turkey

(Accepted 18 January 1994)

Abstract

The effect of tagging on the growth rate of *Buccinum undatum* was investigated in the laboratory. Tagging was conducted by drilling and wiring a plastic tag onto the near edge of the larger whorl of the shell. No tag losses occurred in animals kept in the laboratory during a one year experimental period. However the growth of the whelks was significantly slowed by the tagging technique employed.

1. Introduction

The use of marking techniques in studies of the dynamics of exploited bivalve populations has been extensive (see Murphy, 1986 for a review). However, perhaps because of difficulties owing to the shell shape, much less effort has been spent on marking methods for studying gastropod population dynamics. Differences in the methods between published studies are probably the result of application difficulties. For example, Hancock (1963) working on the east coast of England, marked *B. undatum* by painting its shell. The objective of the research was to estimate population size, growth, mortalities and rate of fishing of whelks. The same method was used by Ito et al. (1980) in the northern Japan Sea to study the behaviour of the sea snail (*Neptunea athritica*) towards traps. For a similar study in the northern Gulf of St. Lawrence, Himmelman (1988) tagged *B. undatum* using rubber bands around the shell. The growth of *Haliotis tuberculata* was studied in Guernsey by cementing a disc onto the shell surface of the ormer (Forster, 1967). Adhesion of a tag on the shoulder of *Busycon carica* shells was

SSDI 0165-7836(94)00279-6

used in Virginia for the same aim (Kraeuter et al., 1989). Ito et al. (1981), working in the northern Okhostk Sea, marked eight species of *Buccinum* by tagging their feet to investigate growth, migration, distribution and population dynamics. Kideys and Nash (1993) and Sire (1984) applied two types of marking methods to the common whelk, *Buccinum undatum* and the Polynesian gastropod, *Turbo setosus*, respectively: the shell was tagged after drilling and wiring; and chemical marking using fluorescent dyes to study shell and operculum growth.

Buccinum undatum (the common whelk) has a wide distribution on the east and west sides of the North Atlantic where it is fished commercially (McQuinn et al., 1988; Santarelli and Gros, 1986). A knowledge of growth, mortality and population size of *B. undatum* will be required for the establishment of whelk fisheries, and a reliable marking technique could enable the estimation of these parameters. The chosen method should ideally be free from tag losses and should not affect the accuracy of measurements. If tagging significantly affects the parameters under study, the conclusions drawn from such an investigation might lead to considerable error.

Given the wide application of marking methods, the lack of studies regarding their long-term effects on the growth of economically important marine animals is surprising. This paper examines the effect of tagging on the growth of the common whelk, *Buccinum undatum* L. in the laboratory.

2. Materials and methods

Buccinum undatum were collected using pots in December 1990 from an area approximately 0.5 miles southeast of Douglas (Isle of Man), central northern Irish Sea. Detailed information on the pots and sampling are given elsewhere (Kideys, 1991). Animals were transported to the laboratory whilst held in the pots. On arrival at the laboratory whelks were held in tanks with running seawater.

The animals were tagged soon after arrival at the laboratory. A vertically mounted electric drill was used to make a hole in the shell. Whelks were forced to withdraw into the mantle by gently touching them with a spatula. Animals were held steady in position on a plasticine base. The shell of each whelk was then carefully drilled through the near edge of the larger whorl. If there was any damage to the mantle or to the whorl (i.e. broken whorl), the animal was discarded. High speed drill bits (2.0 mm in diameter) were used. Dymo (orange 0145 04) embossing tape (12 mm wide) was used to prepare tags. Two alphanumeric characters were embossed on to the tapes with a dymo writer, holed with the same drilling bit used for shell drilling and cut into 1 cm lengths. The wire used was 0.375 mm hard drawn stainless steel (type 302). Prior to the tagging operation the wire was cut into short lengths, approximately 8 cm long. A length of the wire was inserted through the drilled hole. The tag was attached to each whelk by threading one end of the wire through the centre hole and twisting the ends of the wire firmly together with pliers. Excess wire was cut off to leave a wire tail 3–4 mm long. After tagging, the length (taken as the maximum distance between the tip of the spire and the tip of the siphonal canal) of each whelk was measured to the nearest 0.1 mm with vernier calipers and the whole animal, with tag, weighed to the nearest 0.1 g. With the marking technique used, animals with a shell length greater than 25 mm could be tagged successfully. The sex of each individual was recorded as described in Kideys et al. (1993).

The tagging method used was easy to apply and rapid enough not to cause undue stress to the animals even though they spent approx. 10 min out of water. The author was able to tag and record 40–50 whelks per hour.

The experiment was carried out using 50 tagged and 50 untagged whelks (five females and five males from each size group (30–39, 40–49, 50–59, 60–69 and 70–79)). Only ten animals (five tagged and five untagged) were put into each ca. 13 litre perspex tank which had a bottom area of 805 cm^2. There were no artificial substrates (sand etc.) in the tanks. Continuous seawater flow of approximately 5 l min^{-1} and aeration were supplied. In this way each whelk had a space of 80.5 cm^2 with 0.5 l ind^{-1} min^{-1} seawater flow rate. Each tank was provided with excess food (3–4 scallops, *Chlamys opercularis*) every 3 days. The number of live animals together with their length and weight were recorded at approximately monthly intervals. The experiment was terminated in December 1991.

3. Results

There were no losses of tags during laboratory experiment during a 1 year period. There was no evidence of tags causing interference with locomotion or feeding.

Table 1
Monthly growth increment of different size groups of tagged and untagged whelks between December 1990 and December 1991

Months	Size group (mm)									
	30–39		40–49		50–59		60–69		70–>70	
	T	U	T	U	T	U	T	U	T	U
December	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
January	0.3	1.1	0.4	1.1	0.3	1.5	0.5	1.4	0.7	1.1
February	0.8	1.7	0.7	1.5	0.6	1.6	0.7	1.3	0.9	0.9
March	1.8	2.3	1.9	2.2	1.8	2.9	1.2	2.1	1.6	2.0
April	2.1	2.2	2.2	2.3	2.2	2.5	1.8	1.9	1.5	2.0
May	2.2	2.1	2.0	2.0	1.7	2.0	2.1	1.6	0.8	1.3
June	2.7	2.8	2.7	2.5	2.4	2.6	1.6	2.3	1.0	2.0
July	1.9	1.8	1.5	1.5	1.4	1.8	1.1	1.0	0.5	0.4
August	2.8	2.7	1.6	2.0	2.3	1.9	1.3	1.2	0.3	0.4
September	2.1	3.3	3.5	3.2	2.7	2.3	1.8	2.3	0.2	0.6
October	3.7	2.3	2.2	1.9	1.6	1.5	0.9	1.2	0.1	0.2
November	2.4	1.8	2.2	1.6	1.4	1.9	0.8	0.8	−0.1	0.0

T, tagged; U, untagged.

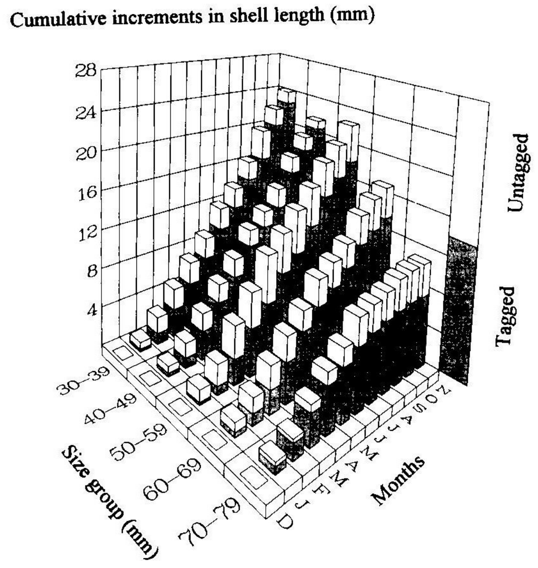

Fig. 1. *Buccinum undatum*: Mean monthly cumulative increments in shell length for each size group of tagged and untagged whelks from December 1990 to November 1991 inclusive.

The monthly growth increments for untagged whelks were always lower than those for tagged animals during the first few months (up to 8 months depending on size group) of the experiment (Table 1). The monthly cumulative increments in length of tagged and untagged whelks from five size groups are shown in Fig. 1. The cumulative growth rates of tagged whelks were consistently lower than untagged ones. These differences were tested using analysis of variance (ANOVA) and found to be significant ($P_{F\text{test}}<0.05$) during the first 10 months of the experiment. The effect of the tagging process subsequently disappeared after 10 months (in November 1991; $P_{F\text{test}}>0.05$). No sex-specific effect of tagging was evident during this experiment ($P_{F\text{test}}>0.05$).

4. Discussion

The tagging process should meet with certain criteria, most importantly that it: (a) does not affect the animal in any way (e.g. change its rate of mortality, growth, behaviour etc.); (b) persists throughout the study period; (c) is easy to apply and relatively inexpensive.

Many kinds of marks have been employed to discern the natural history and population dynamics of gastropods for several aims (Table 2). It seems that tagging has a clear advantage of durability over other methods of marking (i.e. painting and scrubbing the shell). For example, Kraeuter et al. (1989) stressed that "felt tip marks would not last more than 2 seasons". The author tried the lacquer painting method previously used by Hancock and Urquhart (1959) for

Table 2
External marking methods used for gastropods

Species	Marking method	Reference
Babylonica japonica	Drilling the shell	Yoshihara (1957)[1]
Buccinum spp.	(a) Drilling the operculum and foot[2]	
	(b) Painting	Ito et al. (1980)
B. undatum	Rubber bands	Himmelman (1988)
B. undatum	Painting and scrubbing	Hancock and Urquhart (1959)
B. undatum	Drilling the shell	This study
Busycon carica	(a) Scrubbing and felt tip marking	
	(b) Tag adhesion	Krauter et al. (1989)
Haliotis tuberculata	Cementing plastic discs	Forster (1967)
Neptunea arthritica	Painting	Ito et al. (1980)
Turbo setosus	Drilling the shell	Sire (1984)

[1]Quoted in Ito et al. (1980).
[2]All methods except drilling the operculum and foot were applied to the shell.

B. undatum. Two main disadvantages of this method were obvious: (a) limitation to larger sized animals (over 40 mm shell length); and (b) fading of paint via abrasion caused either by burrowing of the whelk or movement of the substratum, as pointed out by Hancock (1963). The latter observation was also made by Ito et al. (1980) who suggested that tagging the operculum and foot was more successful even though it caused "variable levels of serious damage" on different species of *Buccinum*. The rubber bands used by Himmelman (1988) who was interested in the movement of *B. undatum* towards a baited trap is obviously only suited to a very short term study (e.g. a few days). Forster (1967) perceived that Araldite X 83/73 resin, used for cementing the tag to the shell of *Haliotis tuberculata* was not drying fast enough, so tag losses were possible. However, Eastman 90 resin was found to be "very satisfactory". Similarly, Kraeuter et al. (1989) stated that marking the conch, *Busycon carica*, using a numbered adhesive backed tag covered by epoxy resin followed by a piece of fine mesh fibreglass cloth and another coat of epoxy resin was very efficient. However, it should be noted that *B. undatum* has a rounded shell surface compared with the more plane shell surface of *Haliotis tuberculata* and is comparatively smaller than *Busycon carica* making such resin applications inefficient. Additionally, the time needed for drying resin could enhance desiccation in the common whelk during marking because when removed from water, instead of withdrawing into the shell, it exposes a large amount of body surface which accelerates the rate of loss of water (Hancock and Urquhart, 1959).

The method of drilling the shell and wiring a tag in place has been extensively used for scallops (*Pecten maximus* and *Placopecten magellanicus*) (Posgay, 1963; Howell and Fraser, 1984; Naidu and Cahill, 1985; Murphy, 1986). However, it appears to have been used on only a few occasions for gastropods (Yoshihara, 1957 quoted in Ito et al. 1980; Laxton, 1970; Sire 1984). Of these, tag losses are reported only in Murphy (1986). The same method used in this study seems to be highly efficient. There were no tag losses in animals tagged and kept at the laboratory over 1 year. It should, however, be noted that abrasion caused by sand or other substrates in the natural environment where whelks often bury themselves may result in tag losses. Nevertheless, after his field mark-recapture experiment, Kideys (1993), who used the same marking method as in this study, observed all 13 recaptured whelks retained their tags intact. Additionally, with this technique it was possible to tag animals as small as 25–30 mm in shell length. The hole in the shell was observed to occlude quickly and the piece of the wire left between the mantle cavity and the inner shell also was covered with new shell material. The dymo tag used here makes the procedure cheap in comparison with using Petersen discs which are generally used in most other tagging studies. However, it is important to use stainless steel type wire to prevent any toxic effects to the animal arising from corrosion.

It has been stated that any tagging process has some effect on the animal (Parker et al., 1963). In this study the growth rate of whelks was found to be affected by the tagging process. A whelk with a hole in the shell created during tagging undoubtedly invests extra energy and time towards shell repair. For example, hypobranchial mucus, an energy-rich compound, is used in this process (Kideys and Hartnoll, 1991). Repair effort was also spent to cover the tag wire from the inner surface of the shell. These repair processes probably hindered the normal growth of the shell during the first few months of the experiment (Table 1). Results obtained in this study indicate that even 10 months after marking, growth of tagged whelks did not approximate that of untagged individuals. Unfortunately, there are very few parallel studies to use as comparisons with our results on the effect of tagging on the growth of marine organisms. However, Jensen (1963) observed that tagging inhibits growth of haddock, *Melonogrammus aeglefinus*. The results of the present study clearly indicate that in any tagging study, the negative effect of tagging on the growth rate of marine gastropods should be taken into account.

5. Acknowledgements

I would like to thank Professor T. Norton of Port Erin Marine Laboratory (University of Liverpool) for providing necessary laboratory facilities. I am also grateful to Dr. R.D.M. Nash for correction of the early drafts of the manuscript and for his comments, and Mrs Alison M. Kideys for her help during experiments and for improving the English of the text.

References

Forster, G.R., 1967. The growth of *Haliotis tuberculata*: Results of tagging experiments in Guernsey. J. Mar. Biol. Assoc. UK, 47:287–300.

Hancock, D.A., 1963. Marking experiments with the commercial whelk (*Buccinum undatum*). International Commission for the North Atlantic Fisheries (ICNAF) Special Publications, 4:176–187.

Hancock, D.A. and Urquhart, A.E., 1959. Methods for marking whelks (*Buccinum undatum* L.). J. Cons. Int. Explor. Mer, 24:494–496.

Himmelman, J.H., 1988. Movement of whelks (*Buccinum undatum*) towards a baited trap. Mar. Biol., 97:521–531.

Howell, T.R.W. and Fraser, D.I., 1984. Observations on the dispersal and mortality of the scallop, *Pecten maximus* (L.). International Council for the Exploration of the Sea (ICES) Shellfish Committee, CM 1984/K:35, 4 pp.

Ito, H., Wakui, T. and Domon, Y., 1980. Methods for marking sea snails, Genus *Buccinum*. Bulletin of the Hokkaido Regional Fisheries Research Laboratory, 45:65–74.

Ito, H., Wakui, T., Tateuchi, Y. and Tachizawa, S., 1981. Observations on the behaviour of a sea snail, *Neptunea arthritica*, toward a trap. Bull. Hokkaido Reg. Fis. Res. Lab., 46:97–111.

Jensen, A.C., 1963. Further field experiments with tags for haddock. International Commission for the North Atlantic Fisheries (ICNAF) Special Publications, 4:194–203.

Kideys, A.E., 1991. The ecology of the common whelk, *Buccinum undatum* L. off Douglas, Isle of Man, with particular reference to its ecological energetics. Ph.D Thesis. The University of Liverpool, Liverpool, 161 pp.

Kideys, A.E., 1993. Estimation of the density of *Buccinum undatum* (Gastropoda) off Douglas, Isle of Man. Helgoländer Meeresuntersuchungen, 47(1):35–48.

Kideys, A.E. and Hartnoll, R.G., 1991. Energetics of mucus production in the common whelk *Buccinum undatum* L. J. Exp. Mar. Biol. Ecol., 150:91–105.

Kideys, A.E. and Nash, R.D.M., 1993. A note on the mortality associated with fluorescent marking in a gastropod. Doga Turkish J. Zool., 17:175–178.

Kideys, A.E., Nash, R.D.M. and Hartnoll, R.G., 1993. Reproductive cycle and energetic cost of reproduction of the neogastropod *Buccinum undatum* L. in the Irish Sea. J. Mar. Biol. Assoc. UK, 73:391–403.

Kraeuter, J.N., Castagna, M. and Bisker, R., 1989. Growth rate estimates for *Busycon carica* (Gmelin, 1791) in Virginia. J. Shellfish Res., 8(1):219–225.

Laxton, J.H., 1970. Shell growth in some New Zealand Cymatiidae (Gastropoda: Prosobranchia). J. Exp. Mar. Biol. Ecol., 4:250–260.

McOuinn, I.H., Gendron, L. and Himmelman, J.H., 1988. Area of attraction and effective area fished by a whelk (*Buccinum undatum*) trap under variable conditions. Can. J. Fish. Aquat. Sci., 45:2054–2060.

Murphy, E.J., 1986. An investigation of the population dynamics of the exploited scallop, *Pecten maximus* (L.) in the North Irish Sea. Ph.D. Thesis, University of Liverpool, Liverpool, 155 pp.

Naidu, K.S. and Cahill, F.M., 1985. Mortality associated with tagging in the sea scallop, *Placopecten magellanicus* (Gmelin). Canadian Atlantic Fisheries Scientific Advisory Committee (CAFNAC) Research Document, 85/21, 10 pp.

Parker, R.R., Black, E.C. and Larkin, P.A., 1963. Some aspects of fish-marking mortality. International Commission for the North Atlantic Fisheries (ICNAF) Special Publications, 4:117–122.

Posgay, J.A., 1963. Tagging as a technique in population studies of the sea scallop. International Commission for the North Atlantic Fisheries (ICNAF) Special Publications, 4:268–271.

Santarelli, L. and Gros, P., 1986. Modélisation bioéconomique de la pêcherie de Buccin (*Buccinum undatum* L.: Gastropoda) du port de Granville (Manche Ouest). Revue Travaux de l'Institut Pêches maritimes, 48(1 et 2):23–32.

Sire, J.-V., 1984. Vital staining technique in the study of the shell and calcified operculum's growth of the polynesian Gastropod, *Turbo setosus* Gmelin (Prosobranches, Turbinidae). Bull. Soc. Zool. Fr., 109(1):99–112.