OBSERVATIONS ON THE BREEDING OF THE OBLONG TURTLE (*CHELODINA OBLONGA*)

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INTRODUCTION

Female Oblong Turtles (*Chelodina oblonga*) are a common sight in the south-west of Western Australia in spring while they move from swamps to higher ground to lay their eggs. Nests have been studied by Russ (1970), Nicholson (1975) and Clay (1981) but there are few data on clutch size and incubation periods for this species.

On 25 October 1982 I watched a female Oblong Turtle walk 300 m from the western edge of Lake Joondalup (31 °47'S 115 °48'E) to a sheltered position (under the eaves) of our house. It excavated a hole 15 cm deep and laid 9 eggs. The nest site was kept slightly moist with tap water, shaded during very hot weather, protected by a cage and kept under observation. On 12 August 1983, 291 days after being laid, 7 hatchlings emerged from the nest.

For the first 90 days the hatchlings were kept in a container 60 x 25 cm which was filled with 8-10 cm of clean, damp sand. At one end was a container of water 2-6 cm deep which enabled the turtles to enter and leave the water at will. After 90 days, and until the present (20 April 1984) they have been kept in an aquarium 60 x 25 x 30 cm filled with water to a depth of 22 cm and stocked with *Gambusia affinis* and water plants.

OBSERVATIONS

Day 1	(12 August 1983) Seven eggs hatched, the first at 1100 hrs, the last at 1700 hrs. Each hatchling had a carapace length of 30 mm (± 5 mm). The remaining 2 eggs were dug up a few weeks later. One was infertile, the other contained a fully formed dead turtle.
Days 1-23	Hatchlings spent their time swimming, basking, buried or feeding on mosquito larvae and water fleas (*Daphnia*). On day 23 one of them began to slough scales.
Day 31	A few small fish (*Gambusia affinis*) that were introduced to the water were eaten.
Day 32	Dug up 2 turtles which had been buried since day 5. Both active.
Day 45	Turtles seen eating water plants which had been introduced to their container.
Day 46	Hatchlings now had grey-green spots on head and carapace.
Day 50	Most of remaining turtles had begun sloughing.
Day 55	The last turtle began sloughing.
Day 109	Hatchlings began sloughing for the second time.
Day 263	Of the seven turtles the longest carapace was 97 mm and the shortest 83 mm.

COMMENTS

Clay (1981) recognised two breeding seasons at his study sight at Thompsons Lake near Fremantle (September-November and December-January). The incubation period for his spring breeding period was 210-220 days compared to 181, 253 and 291 days for the nests studied by Russ, Nicholson and myself respectively. Spring clutch sizes in these studies varied between 2-15.

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ZOOGEOGRAPHICAL IMPORTANCE OF TROPICAL MARINE MOLLUSC SPECIES AT ROTTNEST ISLAND, WESTERN AUSTRALIA

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ABSTRACT

The marine mollusc species recorded from the western end of Rottnest I. are shown to have a tropical component twice as large as that of the eastern end of Rottnest I. or along

the Perth metropolitan coast. Quantitative measurements of total mollusc density and biomass showed that the tropical element was dominant on one Rottnest intertidal platform and was a major component on the second platform but was negligible on two inshore platforms examined. The published literature suggests that the zoogeographic importance of tropical species at Rottnest I. is a general feature, not restricted to molluscs. The south flowing Leeuwin Current is thought to be the mechanism allowing planktonic larvae of tropical species to reach Rottnest I. and survive.

INTRODUCTION

The marine fauna of Western Australia can be divided into three major components: tropical, temperate and endemic. The north coast of the state, north-eastwards from North West Cape, has a tropical fauna largely continuous with that of the remainder of northern Australia and other parts of the Indo-West Pacific. A temperate fauna continuous with the remainder of southern Australia occurs along the south coast eastwards from Cape Leeuwin. The west coast of the state, between Cape Leeuwin and North West Cape, is an overlap zone with varying proportions of tropical and temperate species. A small, but important fraction of the marine fauna is comprised of species endemic to Western Australia. The numerical importance of this element varies between groups. In an analysis of the distributions of 440 prosobranch gastropods 38 species, or 8.6% were found to be W.A. endemics (Wells, 1980). Of 114 asteroids studied 37% are endemic (Marsh, 1976). While endemic species occur in all areas of the state, most, particularly among the gastropods, have a portion of their distribution along the west coast. The marine fauna of the west coast is then a mixture of tropical, temperate and endemic species. The proportion of tropical species declines progressively south of North West Cape; temperate species decline north of Cape Leeuwin. For marine gastropods the major area of faunal change is between the Perth-Fremantle area, with 39% tropical species, and the Geraldton-Houtman Abrolhos area, with 70% (Wells, 1980).

Within the Perth-Fremantle area the fauna of the west end of Rottnest I. has been considered to have a more important tropical element than the fauna along the mainland coast. Hodgkin, Marsh and Smith (1959) recorded three tropical echinoids, six zooanthids, an actinarian, one coral, and seven gastropods. In a recent compilation of the available information Black and Johnson (1983) claimed that a large proportion of the fauna at Rottnest is of tropical origin and studies that have been undertaken on the reproductive biology of individual species have shown that the timing of reproduction is more characteristic of tropical situations than temperate localities. Despite the apparent importance of the tropical element in the fauna of the west end of Rottnest Island, a phenomenon known for the last 30 years, there has been no comparative study of the relative proportions of tropical species at the west end of Rottnest with that of inshore localities. The present paper presents such an analysis.

MATERIALS AND METHODS

The Western Australian Museum has been actively documenting the molluscs of the state for the last 20 years and now has a collection of 1/3 million specimens. Unfortunately the tremendous taxonomic problems associated with a phylum with several thousand marine species in W.A. prevent an analysis of the entire collection. To minimize the taxonomic difficulties a list of molluscs which might occur in the Perth-Fremantle area was compiled largely from published sources: Iredale and Hull (1927); Adam (1979); Wilson and Gillett (1979); Wells (1980), and Wells and Roberts (1981). In addition a thorough analysis of the molluscs of Cockburn Sound by B.R. Wilson, G.L. Kendrick and A. Brearley, which unfortunately remains unpublished, was consulted. The list was supplemented by opisthobranch species collected in the last few years. A total of 373 species in a variety of taxonomic groups were analyzed based on the W.A. Museum collections which have been accumulated over the last 30 years. The species were categorized as inshore, east or west Rottnest or simply Rottnest where no exact locality was available. Inshore localities were Warnbro Sound, Point Peron, Garden I., Carnac I., Cockburn Sound and metropolitan beaches. Rottnest data were divided into eastern and western halves with Green I. and Charlotte Point being the easternmost localities in the western half. Determinations of tropical, temperate and endemic distributions were based on museum collections and distributional information in the publications listed above.

Many of the species are recorded in the Perth-Fremantle area by a single specimen or a few individuals. To determine the relative importance of the faunal elements in terms of density and biomass, transects were made across the platform reefs of Triggs and Cottesloe on the mainland coast and Cape Vlamingh and Radar Reef on Rottnest I. between November 1981 and January 1982. Transects were placed 100 m apart on each Rottnest reef and 50 m apart on the inshore reefs. They were run from the base of the inshore cliff to the seaward edge of the platform. Every 5 m a l m^2 quadrat was sampled. All macro-molluscs were removed, placed in labelled calico bags and preserved in 10% buffered formalin. Where species were abundant the quadrat was subsampled. The following numbers of transects and stations were made: Triggs (5 transects, 48 stations), Cottesloe (3 transects, 24 stations), Cape Vlamingh (6 transects, 97 stations), Radar Reef (6 transects, 65 stations).

In the laboratory, collections from each station were sorted to species, identified, counted and the mean density for each reef calculated. To determine shell free dry weight biomass the shell of large specimens was cracked off and the animal placed in dilute hydrochloric acid; smaller animals were placed directly in acid. Additional acid was added daily until all reaction ceased. The animals were washed thoroughly in freshwater, dried to constant weight at 60° C and weighed to the nearest milligram on a Sartorius electronic balance. For abundant species subsamples were decalcified and the total dry weight adjusted accordingly. The data were then converted to weight per square meter.

RESULTS

Table 1 shows the number of species and the percentage composition of the three faunal elements (tropical, temperate and endemic) at Rottnest and inshore localities. The relative proportions of the three elements inshore and at eastern Rottnest are virtually identical: 67% temperate, 18% tropical and 15% endemic. The percentage of endemic species at the west end of Rottnest was also 15. The tropical species were nearly twice as common, 32%, as at the eastern end of the island or inshore, and temperate species were relatively less important. The difference in faunal composition between the west end of Rottnest and both the east end and inshore is statistically significant (X^2 test; $p < 0.05$). There is no difference in the faunal composition of the east end of Rottnest Island compared to the inshore mainland (X^2 test; $p > 0.05$).

Table 1: Categorization of mollusc species recorded from the Perth area into the faunal elements of temperate, tropical and endemic.

	Faunal Element							
	Temperate		Tropical		Endemic		Total	
Area	No.	%	No.	%	No.	%	No.	%
Inshore	226	67.3	65	19.3	45	13.4	336	100.0
East Rottnest	80	67.3	21	17.6	18	15.1	119	100.0
West Rottnest	59	51.7	37	32.5	18	15.8	114	100.0
Rottnest	103	56.3	51	27.9	29	15.8	183	100.0

Table 2: Categorization of mollusc species on intertidal beachrock platforms into the faunal elements of temperate, tropical and endemic.

	Faunal Element									
	Temperate		Tropical		Endemic		Unknown		Total	
	#	%	#	%	#	%	#	%	#	%
Triggs	27	75.0	3	8.3	2	5.6	4	11.2	36	100.1
Cottesloe	21	80.8	1	3.9	1	3.9	3	11.5	26	100.1
Radar	32	71.1	7	15.5	3	6.7	3	6.6	45	99.9
Cape Vlamingh	24	52.2	12	26.1	5	10.9	5	10.9	46	100.1

Table 3: Tropical species recorded on intertidal beachrock platforms examined quantitatively.

Species	Reef			
	Triggs	Cottesloe	Radar	Cape Vlamingh
Class Gastropoda				
Epitonium imperialis (Sowerby, 1844)	X			
Strombus mutabilis Swainson, 1821				X
Cypraea caputserpentis Linnaeus, 1758			X	X
Cymatium nicobaricum (Röding, 1798)				X
Drupa ricinus (Linnaeus, 1758)				X
Drupa marginalba Blainville, 1825			X	X
Mitra scutulata Gmelin, 1791				X
Hydatina physis Linnaeus, 1758			X	X
Chelidonura hirundinina (Quoy and Gaimard, 1828)				X
Aplysia oculifera Adams and Reeve, 1850	X		X	X
Dendrodoris nigra (Stimpson, 1855)			X	X
Class Bivalvia				
Septifer bilocularis (Linnaeus, 1758)			X	X
Pinctada fucata (Gould, 1850)	X	X	X	X

Table 2 demonstrates that in terms of numbers of species the temperate element dominated all four reefs examined quantitatively. A single W.A. endemic, the mitre *Vexillum marrowi* Cernohorsky, 1973, was found on all four reefs. Other endemic species found were: the turbinid *Turbo intercostalis* Menke, 1843 at Radar Reef and Cape Vlamingh; the chiton *Clavarizona hirtosa* (Blainville, 1825) at Triggs and Cape Valmingh; the cerith *Rhinoclavis bituberculatum* (Sowerby, 1865) at Radar Reef and Cape Vlamingh and the trochid *Chrysostoma zeus* (Fischer, 1874) and the mitre *Vexillum malleopunctum* Cernohorsky, 1980 at Cape Vlamingh. All of these species were collected in low numbers. Tropical species were more numerous than endemic species with one species recorded at Cottesloe (a single individual), three at Triggs (five individuals total), seven at Radar Reef and 12 at Cape Vlamingh (Table 3). All of these were encountered in low numbers except *Septifer bilocularis* (Linnaeus, 1758) which was abundant.

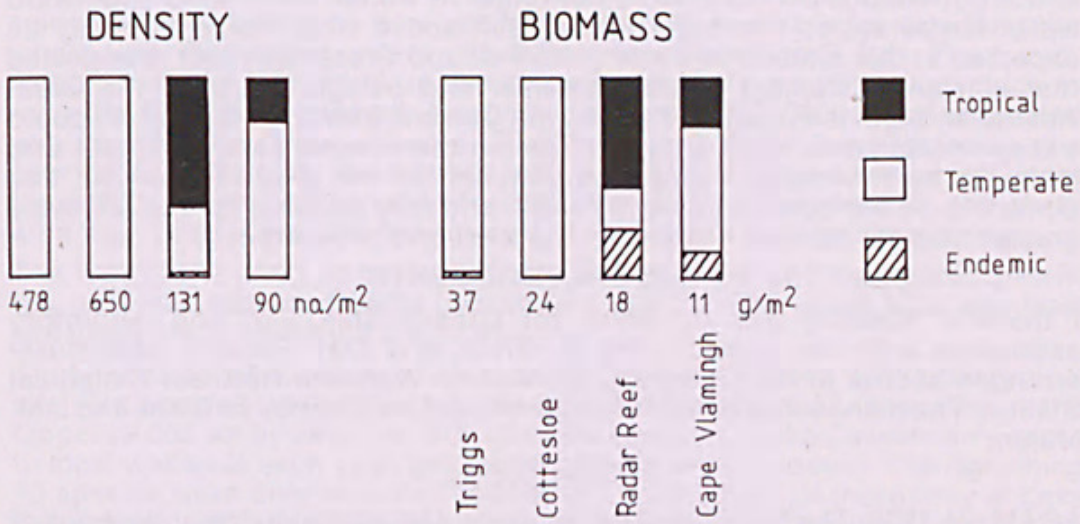

Figure 1. Categorization of mollusc densities and biomass on intertidal beachrock platforms into the faunal elements of temperate, tropical and endemic.

Figure 1 divides the densities and biomass of molluscs on the four reefs into the three categories of temperate, tropical and endemic. Seven rare species, with a total of 12 individuals, could not be identified and thus could not be categorized. Temperate species constituted virtually all of the molluscs collected at both Triggs and Cottesloe; tropical and endemic species combined were less than 0.2% of the total density. In terms of biomass, temperate species comprised 100.0% of the total at Cottesloe and 99.8% at Triggs. The results from the two Rottnest I. reefs were substantially different. Endemic species were 24.4% of the total biomass at Radar Reef and 13.8% at Cape Vlamingh; virtually all of this biomass was contributed by the large turbinid *Turbo intercostalis* Menke, 1843. Temperate species dominated at Cape Vlamingh with 76.5% of the density and 63.6% of the biomass; tropical species were significant elements with 22.8% of the total density and 23.6% of the biomass. The situation was reversed at Radar Reef, where tropical species were 63.0% of total density and 55.4% of total biomass; temperate species comprised 35.9% and 20.2% respectively. One species, the mussel *S. bilocularis*, was the most important constituent of the tropical element at Rottnest. Dense beds formed by *S. bilocularis* dominated both density and biomass. On the inshore reefs (Triggs and Cottesloe) mussel beds were formed by the temperate species *Brachidontes ustulatus* (Lamarck, 1819) and *Mytilus edulis planulatus* (Lamarck, 1819).

DISCUSSION

The data presented here clearly demonstrate that in terms of species of marine molluscs, proportionally twice as many topical species have been recorded at the western end of Rottnest I. as on the eastern end or at localities on or near the adjacent continental mainland. Tropical molluscs were dominant at Radar Reef in terms of both density and biomass; they were an important component of both density (22.8%) and biomass (23.6%) at Cape Vlamingh. In contrast there were almost no tropical species recorded on the transects at Triggs and Cottesloe; the molluscs were almost entirely temperate.

There has been no other comparative analysis of the importance of the tropical element in the Rottnest I. marine fauna compared with inshore localities, but the importance of the tropical element at Rottnest I. appears to be a general phenomenon, not limited to molluscs. The tropical sea urchin *Echinometra mathaei* (Blainville, 1825) is the dominant echinoderm on the west end (Hodgkin, Marsh and Smith, 1959; Pearse and Phillips, 1968). The tropical coral *Pocillopora damicornis* (Linnaeus, 1758) grows on a limestone platform near Parker Point (Hodgkin, Marsh and Smith 1959). The fauna associated with the coral is as diverse as at many tropical localities (Black and Prince, 1983). Hutchins (1979) recorded about 90 tropical fish species of a total of 350 at Rottnest I.

Creswell and Golding (1980) have recently described the Leeuwin Current which flows southward along the continental shelf from North West Cape to Cape Leeuwin and eastwards into the Great Australian Bight. The current flow is not continuous and tends to be stronger in winter. As it flows southward water temperatures decrease but are still above what would normally be expected at this latitude in winter. Maxwell and Cresswell (1981) suggested that a tropical element in the demersal and pelagic fauna of the Great Australian Bight is a result of the Leeuwin Current. Similarly, the current could transport planktonic mollusc larvae from northern localities to Rottnest I. and maintain warm enough water temperatures for the larvae to survive. The current is on the outer continental shelf, and may account for the relatively greater tropical mollusc element at the west end of Rottnest I.

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BIRDS OF LAKE CASSENCARRY

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Lake Cassencarry (33° 52' 10"S, 118° 29' 30"E) is situated in farmland 10km north of Ongerup. It is a flat-floored fossil lake covering about 230 ha that only fills about once every seven years following heavy falls of rain exceeding 100mm. When full, the water depth rarely exceeds 70cm. Other lakes in the general area are mainly much smaller than Lake Cassencarry, and also saline.

The lake was originally covered with *Eucalyptus occidentalis* 12-25m high over a second stratum of *Melaleuca cuticularis* 3-6m high and very dense in places. Half of the lake has been cleared for cropping and grazing, the remainder has been grazed by sheep (both for more than 50 years).

The lake last filled on 3 July 1978, after which the birds were censused. The lake's avifauna has not been previously documented.

A typical site (14 ha) of the cleared section at the lake's western end was selected for sampling as time was not generally available for sampling the whole lake. Recording, mainly by BJN, commenced on 7 July. From mid-August until the lake dried up the following January, an effort was made to record at fortnightly intervals. Recording began at 0700-0800 hours and lasted until all birds had been counted (20-60 minutes). When the population of a species exceeded 30, the number was usually estimated as the birds were frequently moving about while feeding. Maximum water depth in the study area was noted. The data are presented in Table 1 in columns a to m.

The typical site dried up between 6 and 25 December and the cleared area of the lake was censused twice (columns n and o). The whole lake was later censused twice (columns p and q).

Thirty species were recorded on the lake, and 25 of these within the typical site. Six species were breeding. Based on extensive bird recording in the Ongerup district by us since 1978, 20 of the species at Lake Cassencarry occur in local wetlands each year, but seven of these are infrequent. The remaining 10 species were only recorded following floods, and 6 of these only at Lake Cassencarry (Banded Stilt, Sharp-tailed Sandpiper, Red-necked Stint, Long-toed Stint, Curlew Sandpiper and Whiskered Tern). The Long-toed Stint had rarely been recorded in Western Australia prior to 1978 but it is now known to be a regular visitor (Blakers *et al.* 1984). Five of the species are trans-equatorial